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Factors Related to Pertussis and Tetanus Vaccination Status Among Foreign-Born Adults Living in the United States

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Abstract

Pertussis is a common vaccine-preventable disease (VPD) worldwide. Its reported incidence has increased steadily in the United States, where it is endemic. Tetanus is a rare but potentially fatal VPD. Foreign-born adults have lower tetanus–diphtheria–pertussis (Tdap) and tetanus–diphtheria (Td) vaccination coverage than do U.S.-born adults. We studied the association of migration-related, socio-demographic, and access-to-care factors with Tdap and Td vaccination among foreign-born adults living in the United States. The 2012 and 2013 National Health Interview Survey data for foreign-born respondents were analyzed. Multivariable logistic regression was conducted to calculate prevalence ratios and 95% confidence intervals, and to identify variables independently associated with Tdap and Td vaccination among foreign-born adults. Tdap and Td

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Compliance with Ethical Standards

Conflict of interest: The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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vaccination status was available for 9316 and 12,363 individuals, respectively. Overall vaccination coverage was 9.1% for Tdap and 49.8% for Td. Younger age, higher education, having private health insurance (vs. public insurance or uninsured), having visited a doctor in the previous year, and region of residence were independently associated with Tdap and Td vaccination. Among those reporting a doctor visit, two-thirds had not received Tdap. This study provides further evidence of the need to enhance access to health care and immunization services and reduce missed opportunities for Tdap and Td vaccination for foreign-born adults in the United States. These findings apply to all foreign-born, irrespective of their birthplace, citizenship, language and years of residence in the United States. Addressing vaccination disparities among the foreign-born will help achieve national vaccination goals and protect all communities in the United States.

Keywords

Adult vaccination; Foreign-born; Pertussis; Tetanus; Vaccination coverage

Introduction

Pertussis, among the most common vaccine-preventable diseases (VPD) worldwide [1], is endemic in the United States, with an average of approximately 23,000 cases reported annually during the past decade [2]. The number of cases increased to more than 48,000 in 2012, the most reported since 1955, and included 20 related deaths [3]. In 2014, the state of California experienced an epidemic with 11,000 cases and 3 infant deaths [4, 5].

Although considered a childhood disease, pertussis incidence among adults has increased steadily, with one-fifth of U.S. cases reported in 2013 in persons >20 years old [6]. This rise in the incidence has been attributed to improved awareness among healthcare providers, availability of polymerase chain reaction (PCR) as a diagnostic method, and improved surveillance and case reporting. Infected adults are an important source for pertussis transmission to infants and children who are too young to be vaccinated or have not received vaccination for another reason [7–9]; up to 55% of cases in infants have been attributed to adult family members [10].

Tetanus is a potentially fatal VPD that has become rare in the United States (26 cases reported in 2013) [11]. Most (90%) cases reported from 2001 to 2008 occurred in adults ≥20 years of age. The case-fatality rate was 13%. Of case-patients with known vaccination status, 40% had received no tetanus vaccine [12].

The Advisory Committee on Immunization Practices (ACIP) currently recommends a single tetanus, diphtheria, acellular pertussis (Tdap) dose for all adults aged 19 and older [13] and a dose of Tdap for women during each pregnancy, preferably during the third trimester, to provide passive newborn immunity via maternal antibodies. For non-pregnant adults, tetanus and diphtheria toxoid (Td) boosters without the pertussis component should be administered every 10 years after the previous tetanus toxoid-containing vaccine [13].

Tdap vaccination coverage among all adults aged ≥19 years in the United States is low (14% in 2012 and 17% in 2013) [14, 15]. The proportion of all adults aged ≥18 years reporting

having received any tetanus toxoid-containing vaccination (either Tdap or Td) was higher (62%) in 2012 [16], but has not increased substantially since 1999 [17]. Vaccination levels are generally lower among racial and ethnic minorities compared with non-Hispanic Whites [14, 18]. A recent study using 2012 National Health Interview Survey (NHIS) data identified significant disparities for Tdap and Td vaccination between foreign-born adults and the U.S.-born population [16]. These findings have high public health relevance because the foreign-born constitute an increasing share of the U.S. population (13% in 2013; expected to be 18% by 2050) [19–21]. Most immigrants come from countries with different immunization schedules and access to vaccines compared with the United States [22]. For Tdap and Td adult vaccination, most countries other than the United States only target specific sub-populations (e.g., healthcare providers, pregnant women, and other high-risk groups) [23–25]. The foreign-born also experience barriers to accessing healthcare and preventive services once they have migrated [16].

In a previous study, vaccination disparities among the foreign-born remained after adjusting for relevant sociodemographic and access-to-care characteristics [16]. However, the individual effects of those variables and of specific migration-related factors (e.g., birthplace, citizenship, language and years in the United States) on Tdap and Td vaccination coverage was explored only through bivariate analysis. Our study was restricted to foreign-born participants. We used data from the 2012 and 2013 NHIS to identify sociodemographic, access-to-care, and migration-related characteristics that are independently associated with Tdap and Td vaccination among foreign-born adults living in the United States. Immunization programs and vaccine providers can use this information when developing strategies and interventions to eliminate disparities in coverage.

Methods

Study Design, Setting, and Population

This study was restricted to the foreign-born participants in the 2012 and 2013 NHIS. The NHIS is an annual household cross-sectional survey conducted by the CDC's National Center for Health Statistics, which collects health information on the U.S. civilian, non-institutionalized population [26]. In the sample adult core, one adult per sampled family in each household was randomly selected to complete questions about vaccination history. The final response proportion for the sample adult core was 61.2% in both 2012 and 2013 [26]. The NHIS has routinely collected Tdap/Td vaccination information since 2008 through a series of three questions. Respondents are first asked, "Have you received a tetanus shot in the past 10 years?" If respondents answer "yes" they are asked, "Was your most recent tetanus shot given in 2005 or later?" Respondents who answer "yes" to this question are then asked, "Thinking back to your most recent tetanus shot, did your healthcare provider tell you, or did the vaccine information sheet say, the vaccine included the pertussis or whooping cough vaccine?" Among 13,154 foreign-born respondents ≥18 years, those without a "yes" or "no" classification for tetanus vaccination status within the preceding 10 years (n = 791 [6.0%]) were excluded from the Td analysis, yielding a sample of 12,363 for whom Td vaccination status could be assessed. Those without a "yes" or "no" classification for tetanus vaccination status during 2005–2013 [n = 349 (2.7%)], those who reported tetanus

vaccination during 2005–2013 but were not told vaccine type by the provider [n = 2222 (16.9%)], or those who did not know vaccine type (Tdap or Td) [n = 476 (3.6%)] were excluded, yielding a sample of 9316 respondents ≥18 years for whom Tdap vaccination status could be assessed.

Exposures, Outcomes, Covariates

Outcomes of interest were Tdap vaccination (Tdap vaccine received at any time since 2005) and Td vaccination (Td vaccine received in the previous 10 years). Exposures of interest included migration-related factors (birthplace, duration of residence in the United States, U.S. citizenship status, language of interview), and healthcare access-related factors (health insurance status, number of doctor visits in the past year, whether the respondent had a usual source of healthcare). For statistical stability and to preserve confidentiality, countries of birth were grouped into five regions in the analysis: Mexico/Central America/Caribbean Islands, South America, Europe, Asia, and Other. Covariates to measure associations with vaccination coverage included: age, sex, race/ethnicity, marital status, living with an infant age <1 year, education, employment status, poverty level, self-reported health status, and region of U.S. residence. Poverty status was defined using U.S. Census Bureau poverty thresholds, with “below poverty” defined as total family income of <$23,492 or <$23,834 for a family of four in 2012 and 2013, respectively [27].

Statistical Analysis

SUDAAN statistical software (Research Triangle Institute, Research Triangle Park, NC) was used to calculate weighted point estimates and 95% confidence intervals (CI) of vaccination coverage [28]. Multivariable logistic regression and predictive marginal modeling were used to generate adjusted prevalence ratios and identify variables independently associated with Tdap and Td vaccination. Sensitivity analyses were conducted to assess the magnitude of potential bias resulting from respondent exclusions, assuming those who answered that they received a tetanus shot but were not sure what type had either received Tdap vaccine or did not receive Tdap vaccine. Statistical significance was defined as $p < 0.05$. The NHIS was approved by the Research Ethics Review Board (ERB number 2009–16) of the National Center for Health Statistics, CDC.

Results

Of 13,154 foreign-born participants in the 2012 and 2013 NHIS, 9316 were included in the analysis for Tdap and 12,363 in the analysis for Td. The sociodemographic, access-to-care, and migration-related characteristics of the study population are presented in Table 1. Most participants were aged 18–49 years (64.0%), female (51.3%), Hispanic (49.5%), married (62.6%), had high school or higher education (71.8%), and were employed (64.1%). Most had health insurance (68.4%), reported having visited a doctor at least once during the previous year (69.9%), and reported having a usual source for healthcare (74.5%). Most of the subjects had been in the United States for at least 10 years (79.3%) and were U.S. citizens (53%). An interview language other than English was reported by 30.7%. Birthplace was Mexico/Central America/Caribbean (48.2%), Asia (23.2%), Europe (12.5%), and South America (6.2%).

Vaccination coverage for Td (overall 49.8%) was consistently higher than that for Tdap (overall 9.1%) among all subpopulations (Table 2). Depending on what proportion of excluded respondents actually received Tdap, the sensitivity analysis suggested actual Tdap coverage within the range of 7.0–30.1%.

In bivariate analysis (Table 2), coverage for both vaccines was significantly lower among Hispanics (6.5% for Tdap and 48.4% for Td) than among non-Hispanic whites (10.5% for Tdap and 54.7% for Td), and lower among people living below poverty (5.6% for Tdap and 42.5% for Td) than among those living at or above poverty (10.7% for Tdap and 52.6% for Td). Significantly higher coverage for both vaccines was associated with completing at least some college education, having private health insurance, and having a usual source of healthcare (Table 2). Coverage was higher for those reporting at least one doctor visit in the previous year. However, additional analysis (data not shown) indicated that a large proportion (66.3%) of those who had not received Tdap reported one or more doctor visits during the previous year. Among those with 10 or more doctor visits in the previous year, coverage was 13.4% (95% CI, 10.7%, 16.5%) for Tdap and 56.1% (95% CI, 52.4%, 59.6%) for Td. Among adults who had not received Tdap, 65.5% had either private insurance (43.5%) or had public insurance (22.0%) (data not shown).

Significantly lower coverage for both vaccines was found among those reporting to be non-U.S. citizens and those interviewed in a language other than English. Individuals born in Mexico, Central America, or Caribbean Islands had the lowest Tdap and Td vaccination coverage compared with other birth regions (Table 2). Foreign-born persons residing in the United States for ≥10 years had significantly lower vaccination coverage for Tdap compared with more recent arrivals (≤5 years) (Table 2).

In multivariable analysis, characteristics independently associated with an increased likelihood of Tdap and Td vaccination among foreign-born adults were younger age, higher education, having private insurance, and reporting having had at least one visit with a doctor in the previous year, with a trend towards an increased prevalence ratio for vaccination with increasing number of visits (Table 3). Individuals living in the Northeast region were less likely to have received Td when compared with all other regions, and were less likely to have received Tdap when compared with the Midwest and West regions, but not with the South region (Table 3).

Discussion

Adult vaccination in the United States remains low for most recommended vaccines, including Tdap and Td, and continues to be a public health challenge [14, 15]. For Tdap, coverage remains low despite recommendations since 2005 that included all adults up to age 64 and since 2012 all adults aged ≥19 years [13], as well as strategies targeting adults who have close contact with newborns (i.e., “cocooning”) [14, 15, 29]. For Td, a booster every 10 years has been recommended for all adults for more than 20 years [30], but low coverage persists. Reasons for low adult vaccination coverage include limitations of the adult vaccination delivery system and physician-related barriers (e.g., not routinely administering indicated vaccines during patient visits) [31]. Several socioeconomic and access-to-care

factors (e.g., race/ethnicity, older age, lower education and income, lack of health insurance, access to care, and region of residence in the United States) have been independently associated with lower likelihood of Tdap and Td vaccination among U.S. adults [18]. For the foreign-born, vaccination coverage has been reported to be affected by birthplace, citizenship, language spoken, and years of residence in the United States [16].

In this study, we explored the effect of migration-related factors on vaccination coverage when analyzed together with relevant sociodemographic and access-to-care characteristics. Our findings indicate that for foreign-born adults, the primary factors independently associated with Tdap and Td vaccination are similar to those reported for the general U.S. population: age, education level, poverty (for Td vaccination only), healthcare access, and region of residence in the United States.

After controlling for all other variables in the multi-variable model, migration-related factors (i.e., birthplace, citizenship, language of the interview, duration of residence) did not significantly affect the likelihood of having received Tdap or Td vaccinations among the foreign-born. These findings suggest that strategies to address barriers to Tdap and Td vaccination are needed for all in the foreign-born population, irrespective of migration-related factors, and are similar to those needed in the general U.S. born population.

Adults <50 years old were more likely to be vaccinated with Tdap and Td than older adults, a finding also reported for sub-populations in the United States such as healthcare providers and parents of children and adolescents [29, 32]. Younger adults may be better informed about vaccines, exposed to college campus prevention programs and vaccine requirements for enrollment, vaccinated in adolescent programs, or have more contact with healthcare providers through their young children. Recall bias could also partially explain this difference, with older adults having problems remembering receipt of vaccines that are scheduled in 10-year intervals.

We found a trend toward higher prevalence of Tdap and Td vaccination with higher levels of education, similar to trends seen for several vaccines among more highly educated populations in the United States [33–35]. The association between education and vaccination status might be related to greater vaccine and disease awareness. A physician’s or other healthcare provider’s recommendation has been shown to be a powerful determinant for adults to receive vaccinations [29], although such recommendations are provided inconsistently [33]. Higher educational attainment might make an adult more knowledgeable about vaccine recommendations and more willing to ask the health-care provider to provide them.

Individuals living below poverty level were significantly less likely to have received Td vaccine. Financial barriers have been reported previously as a factor associated with suboptimal vaccination coverage among pregnant women, Latinos, and rural adults in the United States [34–37].

In our study, individuals who had public health insurance or were uninsured were less likely to be vaccinated with Tdap and Td than were those with private health insurance. In 2012, Singer et al. also reported higher Tdap vaccination coverage among adults with private

health insurance plans [38]. Provider reimbursement might be an important factor, as primary care physicians have reported dissatisfaction with payments for vaccine purchase and payments by third-party payers, especially payers for public health insurance [39]. With the introduction of the Patient Protection and Affordable Care Act (ACA) in 2010, all new health insurance plans are required to include ACIP-recommended vaccines for adults in their covered services without charging any fee [40]. The effect of the ACA on vaccination coverage among adults, particularly among the foreign-born, has yet to be determined.

Having one or more doctor visits in the year prior to the interview was significantly associated with greater Tdap and Td vaccination coverage when compared with individuals lacking such visits; this association strengthened with higher number of visits. Although similar findings have been reported for the overall U.S. adult population [18], our study demonstrated that coverage remains suboptimal even with repeated health encounters. These findings, along with the lower Tdap and Td vaccination coverage among those with public health insurance, and the high proportion (86.7%) of privately insured foreign-born adults who had not received Tdap, strongly suggest that substantial opportunities for vaccination are missed in this population, particularly for public insurance holders.

Additional reasons for low vaccination levels among adults have been reported for the general U.S. population, including limited knowledge about VPD risks and adult vaccination recommendations and negative beliefs about the efficacy and safety of vaccines [29, 33, 41]; however, information about the knowledge and beliefs of respondents regarding VPDs and vaccines was not available for this study. Further research is needed to characterize knowledge and attitudes about vaccines among the foreign-born population, as well as potential differences by subpopulations (e.g., by country of origin, education, acculturation).

The findings in this study are subject to at least three limitations. First, vaccination status was self-reported and might be subject to recall bias. However, self-reported tetanus vaccination has been shown to be sensitive, but not specific, suggesting that coverage estimates are more likely to be erroneously high than low [42]. Second, the Tdap estimates are subject to considerable uncertainty because respondents who reported a tetanus vaccination, but were unable to say whether Tdap or Td was used, were excluded from the estimations of Tdap coverage, creating a potential for bias. Although sensitivity analyses showed a wide range for Tdap estimates depending on what proportion of excluded respondents might actually have received Tdap and coverage could be underestimated, the upper limit (30.1%) is still suboptimal. Language of the interview might not be a good proxy for primary language of the respondent or English-speaking ability, variables that are easier to interpret and for which there is greater evidence of their effect on access-to-care and receipt of prevention services. Finally, birthplace was available only by region, so determination of the impact of actual country of birth was not possible.

Factors associated with low Tdap and Td vaccination coverage among foreign-born adults in this study were primarily related to education, access to care (including type of health insurance) and failure to utilize existing opportunities to vaccinate. Thus, strategies are needed to enhance access to health insurance and vaccination services for foreign-born individuals, and to utilize all opportunities to vaccinate when they do contact the health

system, especially in public health insurance settings. A systems approach including adequate reimbursement, standing vaccination orders not requiring physician involvement, and patient and provider education has proven to be effective in enhancing adult vaccination [43, 44]. Strategies should also target healthy adult foreign-born individuals who have little contact with healthcare providers, and include vaccinations in nontraditional settings (e.g., churches, pharmacies, and workplaces) in localities with high concentration of foreign-born residents. Culturally and linguistically appropriate education and outreach to these populations are also needed [30]. Since most foreign-born are of Latino or Asian origin [45], addressing vaccination in these populations would have the greatest impact on reducing racial and ethnic disparities, reaching national vaccination goals, and protecting everyone in the United States.

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Table 1

Sociodemographic and health access characteristics of foreign-born adults ≥18 years of age, National Health Interview Survey (NHIS), 2012–2013, United States

Characteristic	N	Weighted %
Total	13,154	100.0
Age		
18–49 years	8193	64.0
50–64 years	2835	22.9
65+ years	2126	13.1
Sex		
Male	5976	48.7
Female	7178	51.3
Race/ethnicity		
Non-Hispanic white	1867	19.3
Non-Hispanic black	1016	7.5
Hispanic	7013	49.5
Non-Hispanic other	3258	23.7
Marital status		
Married	6963	62.6
Widowed/divorced/separated	2807	14.1
Never married	3351	23.3
Living with an infant aged <1year		
Yes	575	4.9
No	12,579	95.1
Education		
Less than high school	4097	28.2
High school graduate	2782	22.2
Some college	1610	12.8
Associate degree	1014	8.0
Bachelor’s degree or higher	3526	28.8
Employment status		
Employed	8115	64.1
Unemployed	791	6.0
Not in work force	4239	29.9
Poverty level[a]		
At or above poverty	8739	78.8
Below poverty	3195	21.2
Health insurance		
Yes, private	5665	47.4
Yes, public	3233	21.0
Not insured	4218	31.5
Number of doctor visits in past year		

Characteristic	N	Weighted %
0	3943	30.1
1	2357	19.1
2–3	2943	23.5
4–9	2503	18.5
10+	1194	8.8
Usual source of care		
Yes	9633	74.5
No	3420	25.5
Self-reported health status		
Excellent/very good	7378	58.8
Good	3818	28.2
Fair	1544	10.2
Poor	407	2.8
Duration of residence		
In U.S. <5 years	1162	8.4
In U.S. 5 to <10 years	1574	12.3
In U.S. ≥10 years	10,283	79.3
Citizenship		
U.S. citizen	6698	53.0
Not U.S. citizen	6392	47.0
Language of the interview		
English	8673	69.3
Not English	4481	30.7
Birthplace		
Mexico/Central America/Caribbean Islands	6804	48.2
South America	827	6.2
Europe	1235	12.5
Asia	3160	23.2
Others	1096	9.9
Region of U.S. residence		
Northeast	2568	21.2
Midwest	1402	11.2
South	4254	32.6
West	4930	34.9

[a]Poverty level as determined by Federal poverty guidelines

Table 2

Tetanus, diphtheria and acellular pertussis (Tdap) or tetanus-diphtheria (Td) vaccination coverage among of foreign-born adults ≥18 years of age by sociodemographic and health access characteristics—National Health Interview Survey (NHIS), 2012–2013, United States

	Tdap		Td	
	% (95% CI)	p value	% (95% CI)	p value
Total	9.1 (8.4–9.9)	–	49.8 (48.7–51.0)	–
Age				
18–49 years[a]	10.7 (9.7–11.7)	–	51.4 (49.9–52.8)	–
50–64 years	7.1 (5.9–8.7)*	<0.001	49.6 (47.1–52.2)	0.24
65+ years	5.3 (3.7–7.4)*	<0.001	42.5 (39.7–45.3)*	<0.001
Sex				
Male[a]	8.0 (7.0–9.1)	–	50.1 (48.3–51.9)	–
Female	10.2 (9.3–11.3)*	<0.001	49.6 (48.0–51.1)	0.66
Race/ethnicity				
Non-Hispanic white[a]	10.5 (8.5–12.8)	–	54.7 (51.4–57.9)	–
Non-Hispanic black	11.7 (8.4–16.0)	0.60	50.1 (45.9–54.3)	0.07
Hispanic	6.5 (5.7–7.5)*	<0.001	48.4 (46.7–50.2)*	<0.001
Non-Hispanic other	12.6 (10.9–14.5)	0.16	48.6 (46.4–50.9)*	<0.001
Marital status				
Married[a]	9.4 (8.5–10.5)	–	51.4 (49.9–52.8)	–
Widowed/divorced/separated	6.5 (5.3–8.0)*	<0.001	45.3 (42.9–47.6)*	<0.001
Never married	9.7 (8.2–11.4)	0.80	48.4 (46.0–50.7)*	0.03
Living with an infant aged <1 year				
Yes[a]	11.5 (8.4–15.7)	–	50.0 (45.3–54.6)	–
No	9.0 (8.3–9.8)	0.19	49.8 (48.6–51.1)	0.96
Education				
Less than high school[a]	4.8 (3.8–6.0)	–	45.2 (43.1–47.3)	–
High school graduate	6.1 (4.9–7.7)	0.14	43.6 (41.1–46.1)	0.32
Some college	9.2 (7.2–11.7)*	<0.001	52.4 (48.9–55.8)*	<0.001
Associate degree	13.6 (10.8–16.9)*	<0.001	56.2 (52.5–59.9)*	<0.001
Bachelor’s degree or higher	14.7 (13.2–16.3)*	<0.001	56.6 (54.3–58.9)*	<0.001
Employment status				
Employed[a]	9.9 (9.0–10.8)	–	51.8 (50.4–53.2)	–
Unemployed	7.0 (4.9–10.0)*	0.04	46.7 (41.9–51.5)*	0.04
Not in work force	8.0 (6.9–9.4)*	0.02	46.2 (44.1–48.2)*	<0.001
Poverty level				
At or above poverty[a]	10.7 (9.8–11.6)	–	52.6 (51.3–54.0)	–

	Tdap		Td	
	% (95% CI)	p value	% (95% CI)	p value
Below poverty	5.6 (4.4–7.1) *	<0.001	42.5 (40.1–45.0) *	<0.001
Health insurance				
Yes, private[a]	13.3 (12.1–14.6)	–	56.9 (55.2–58.5)	–
Yes, public	6.0 (4.7–7.6) *	<0.001	43.9 (41.3–46.6) *	<0.001
Not insured	5.5 (4.5–6.6) *	<0.001	43.2 (41.3–45.1) *	<0.001
Number of doctor visits in past year				
0[a]	5.1 (4.3–6.2)	–	40.6 (38.5–42.6)	–
1	10.2 (8.5–12.2) *	<0.001	53.5 (51.0–56.0) *	<0.001
2–3	10.6 (9.0–12.4) *	<0.001	51.2 (48.9–53.5) *	<0.001
4–9	11.5 (9.8–13.3) *	<0.001	56.7 (54.4–59.0) *	<0.001
10+	13.4 (10.7–16.5) *	<0.001	56.1 (52.4–59.6) *	<0.001
Usual source of care				
Yes[a]	10.4 (9.5–11.2)	–	52.6 (51.3–53.9)	–
No	5.9 (4.7–7.4) *	<0.001	41.8 (39.5–44.2) *	<0.001
Self-reported health status				
Excellent/very good[a]	10.7 (9.7–11.8)	–	51.2 (49.7–52.8)	–
Good	7.2 (6.1–8.5) *	<0.001	48.1 (46.1–50.0) *	0.01
Fair	6.5 (4.8–8.7) *	<0.001	48.3 (44.7–52.0)	0.14
Poor	4.9 (2.8–8.6) *	<0.001	43.1 (36.4–50.1) *	0.02
Duration of residence				
In U.S. <5 years[a]	12.1 (9.1–16.0)	–	50.7 (46.7–54.7)	–
In U.S. 5 to <10 years	11.5 (9.0–14.4)	0.75	51.8 (48.3–55.3)	0.66
In U.S. ≥10 years	8.5 (7.7–9.3) *	0.04	49.4 (48.0–50.7)	0.55
Citizenship				
U.S. citizen[a]	10.2 (9.2–11.2)	–	51.9 (50.3–53.4)	–
Not U.S. citizen	8.0 (7.0–9.2) *	0.01	47.6 (45.8–49.3) *	<0.001
Language of the interview				
English[a]	11.2 (10.3–12.2)	–	51.9 (50.5–53.4)	–
Not English	4.6 (3.7–5.7) *	<0.001	45.1 (43.0–47.2) *	<0.001
Birthplace				
Mexico/Central America/Caribbean Islands[a]	6.4 (5.6–7.4)	–	48.0 (46.2–49.9)	–
South America	8.8 (6.3–12.2)	0.13	49.4 (45.3–53.5)	0.56
Europe	10.5 (8.1–13.4) *	<0.001	55.1 (51.5–58.6) *	<0.001
Asia	12.1 (10.4–14.0) *	<0.001	49.1 (46.8–51.5)	0.51
Others	13.9 (10.7–17.7) *	<0.001	54.4 (49.7–59.1) *	0.02
Region of U.S. residence				

	Tdap		Td	
	% (95% CI)	p value	% (95% CI)	p value
Northeast[a]	7.0 (5.5–8.8)	–	45.4 (43.3–47.6)	–
Midwest	12.7 (10.2–15.7) *	<0.001	53.4 (49.8–56.9) *	<0.001
South	7.8 (6.7–9.0)	0.43	49.8 (47.9–51.8) *	<0.001
West	10.5 (9.4–11.8) *	<0.001	51.4 (49.2–53.5) *	<0.001

[a] Reference level

* P value by *t* test for comparisons for Tdap and Td within each level of each characteristic

Table 3

Multivariable logistic regression and prevalence ratios of foreign-born adults ≥18 years of age who reported tetanus, diphtheria and acellular pertussis (Tdap) or tetanus-diphtheria (Td) vaccination, by socio-demographic and health access characteristics, National Health Interview Survey (NHIS) 2012–2013, United States

	Tdap		Td	
	Adjusted prevalence ratio (PR) (95% CI)	**p value**	**Adjusted prevalence ratio (PR) (95% CI)**	**p value**
Age				
18–49 years[a]	Referent	–	Referent	–
50–64 years	0.65 (0.52, 0.83) *	<0.001	0.90 (0.84, 0.96) *	<0.001
65+ years	0.54 (0.34, 0.84) *	<0.001	0.80 (0.73, 0.88) *	<0.001
Sex				
Male[a]	Referent	–	Referent	–
Female	1.15 (0.96, 1.38)	0.14	0.95 (0.90, 1.00)	0.07
Race/ethnicity				
Non-Hispanic white[a]	Referent	–	Referent	–
Non-Hispanic black	1.34 (0.82, 2.21)	0.26	0.97 (0.85, 1.12)	0.70
Hispanic	1.23 (0.73, 2.08)	0.43	1.07 (0.93, 1.22)	0.33
Non-Hispanic other	1.74 (1.00, 3.01)	0.07	0.88 (0.74, 1.05)	0.16
Marital status				
Married[a]	Referent	–	Referent	–
Widowed/divorced/separated	0.91 (0.71, 1.16)	0.42	0.95 (0.89, 1.02)	0.14
Never married	1.19 (0.96, 1.47)	0.12	1.01 (0.95, 1.07)	0.72
Living with an infant aged <1 year				
Yes[a]	Referent	–	Referent	–
No	0.88 (0.63, 1.24)	0.49	0.99 (0.89, 1.10)	0.88
Education				
Less than high school[a]	Referent	–	Referent	–
High school graduate	1.06 (0.77, 1.45)	0.73	0.94 (0.87, 1.01)	0.09
Some college	1.23 (0.84, 1.79)	0.29	1.06 (0.97, 1.16)	0.20
Associate degree	1.84 (1.28, 2.63) *	<0.001	1.17 (1.07, 1.27) *	<0.001
Bachelor's degree or higher	1.71 (1.23, 2.38) *	<0.001	1.12 (1.03, 1.23) *	0.01
Employment status				
Employed[a]	Referent	–	Referent	–
Unemployed	0.76 (0.51, 1.12)	0.11	0.96 (0.86, 1.08)	0.51
Not in work force	0.96 (0.77, 1.20)	0.71	0.97 (0.91, 1.03)	0.30
Poverty level				
At or above poverty[a]	Referent	–	Referent	–
Below poverty	0.82 (0.63, 1.09)	0.14	0.92 (0.87, 0.99) *	0.02
Health insurance				

	Tdap		Td	
	Adjusted prevalence ratio (PR) (95% CI)	**p value**	**Adjusted prevalence ratio (PR) (95% CI)**	**p value**
Yes, private[a]	Referent	–	Referent	–
Yes, public	0.67 (0.51, 0.88)*	<0.001	0.85 (0.78, 0.92)*	<0.001
Not insured	0.73 (0.54, 0.97)*	0.02	0.88 (0.82, 0.95)*	<0.001
Number of doctor visits in past year				
0[a]	Referent	–	Referent	–
1	1.61 (1.20, 2.17)*	<0.001	1.23 (1.14, 1.33)*	<0.001
2–3	1.74 (1.31, 2.31)*	<0.001	1.18 (1.09, 1.29)*	<0.001
4–9	2.21 (1.67, 2.92)*	<0.001	1.39 (1.28, 1.51)*	<0.001
10+	2.74 (1.91, 3.94)*	<0.001	1.40 (1.27, 1.55)*	<0.001
Usual source of care				
Yes[a]	Referent	–	Referent	–
No	0.89 (0.66, 1.19)	0.40	0.88 (0.82, 0.95)*	<0.001
Self-reported health status				
Excellent/very good[a]	Referent	–	Referent	–
Good	0.88 (0.72, 1.09)	0.23	0.97 (0.92, 1.02)	0.26
Fair	0.89 (0.63, 1.25)	0.46	1.00 (0.91, 1.09)	0.91
Poor	0.88 (0.48, 1.63)	0.67	0.97 (0.84, 1.12)	0.67
Duration of residence				
In U.S. <5 years[a]	Referent	–	Referent	–
In U.S. 5 to <10 years	1.06 (0.75, 1.50)	0.74	1.01 (0.91, 1.11)	0.87
In U.S. ≥10 years	0.73 (0.53, 1.00)	0.09	0.92 (0.84, 1.00)	0.07
Citizenship				
U.S. citizen[a]	Referent	–	Referent	–
Not U.S. citizen	0.93 (0.75, 1.16)	0.52	0.96 (0.91, 1.02)	0.17
Language of the interview				
English[a]	Referent	–	Referent	–
Not English	0.79 (0.59, 1.05)	0.08	1.00 (0.93, 1.07)	0.98
Birthplace				
Mexico/Central America/Caribbean Island[a]	Referent	–	Referent	–
South America	0.99 (0.69, 1.43)	0.98	0.95 (0.86, 1.05)	0.28
Europe	1.02 (0.63, 1.64)	0.94	1.05 (0.92, 1.21)	0.48
Asia	0.67 (0.38, 1.18)	0.16	1.01 (0.84, 1.21)	0.91
Others	1.30 (0.86, 1.95)	0.22	1.09 (0.95, 1.23)	0.22
Region of U.S. residence				
Northeast[a]	Referent	–	Referent	–
Midwest	1.56 (1.14, 2.15)*	0.01	1.16 (1.07, 1.25)*	<0.001
South	1.18 (0.90, 1.56)	0.22	1.09 (1.03, 1.16)*	<0.001

	Tdap		Td	
	Adjusted prevalence ratio (PR) (95% CI)	**p value**	**Adjusted prevalence ratio (PR) (95% CI)**	**p value**
West	1.64 (1.28, 2.10) *	<0.001	1.12 (1.06, 1.20) *	<0.001

[a] Reference level

* P value <0.05 by *t* test within each variable with the indicated reference level