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Tetanus, diphtheria and acellular pertussis (Tdap) vaccination among healthcare personnel—United States, 2011

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Abstract

Background—Health-care personnel (HCP) are at risk for exposure to and possible transmission of vaccine-preventable diseases. Receiving recommended vaccines is an essential prevention practice for HCP to protect themselves and their patients. The tetanus, diphtheria and acellular pertussis vaccine (Tdap) was recommended by the Advisory Committee on Immunization Practices (ACIP) for HCP in 2006 for protection against pertussis. We assessed the recent compliance of U.S. HCP in receiving Tdap vaccination.

Methods—To estimate Tdap vaccination coverage among HCP, we analyzed data from the 2011 National Health Interview Survey (NHIS). Multivariable logistic regression and predictive marginal models were performed to identify factors independently associated with vaccination among HCP.

Results—Overall, Tdap vaccination coverage was 26.9% among HCP aged 18-64 years (95% confidence interval (CI)=24.3%, 29.7%), which was significantly higher compared with non-HCP among the same age group (11.1%; 10.5%–11.8%). Overall, vaccination coverage was significantly higher among physicians (41.5%) compared with nurses (36.5%) and other types of HCP (range 11.7% to 29.9%). Vaccination coverage was significantly higher among HCP aged 18-49 years compared with those 50-64 years (30.0% vs. 19.2%, respectively). Characteristics independently associated with an increased likelihood of Tdap vaccination among HCP were: younger age, higher education, living in the western United States, being hospitalized within past year, having a place for routine health care in clinic or health center, and receipt of influenza vaccination in the previous year. Marital status of widowed, divorced, or separated was independently associated with a decreased likelihood of Tdap vaccination among HCP.

Conclusions—By 2011, Tdap vaccination coverage was only 26.9% among HCP. Vaccination coverage varied widely by types of HCP and demographic characteristics. Emphasizing the

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benefits of HCP vaccination for staff and patients, providing vaccinations in the workplace and other non-traditional settings, and providing Tdap at no charge may help increase Tdap vaccination among HCP in all health-care settings.

Keywords

Tetanus; diphtheria and acellular pertussis vaccine (Tdap); vaccination; coverage; health-care personnel

Introduction

Healthcare personnel (HCP) may work (paid or unpaid) in settings with potential for exposure to patients and/or to infectious materials. HCP with such exposures include physicians, nurses, nursing assistants, therapists, technicians, emergency medical service personnel, dental personnel, pharmacists, laboratory personnel, autopsy personnel, students and trainees, and persons not directly involved in patient care but potentially exposed to infectious agents that can be transmitted to and from HCP and patients.^{1–2} HCP are at increased risk for acquiring pertussis infection as a result of contact with infected patients and waning protection from either childhood pertussis vaccination or prior pertussis infection.^{2–5} Healthcare-associated outbreaks of pertussis have been reported in healthcare facilities.^{6–8} About 8.5%–23% of HCP were infected with pertussis during these outbreaks.^{6–8} Infected HCP can serve as sources of infection for susceptible contacts, including patients, other HCP, and family members.^{9–16}

Vaccination offers the best protection against pertussis infection in HCP and in adults, in general.^{10–16} In 2006, the Advisory Committee on Immunization Practices (ACIP) recommended that HCP aged 19–64 years receive a single dose of the tetanus, diphtheria, and acellular pertussis vaccine (Tdap) to reduce the risk of transmission of pertussis in healthcare institutions.¹⁵ In 2010, ACIP updated HCP recommendations indicating that all HCP regardless of age should receive a single dose of Tdap as soon as feasible if they have not previously received Tdap.² Vaccinating HCP with Tdap can be a cost-effective strategy to prevent outbreaks in healthcare setting.^{11–15}

We used data from the 2011 National Health Interview Survey (NHIS) to assess Tdap vaccination and identify factors independently associated with vaccination among HCP in the United States.

Methods

We analyzed data from the 2011 National Health Interview Survey (NHIS) to assess Tdap vaccination among HCP. The NHIS is an annual household survey for the U.S. non-institutionalized, civilian population conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention.¹⁷ Estimates were weighted to the adult civilian population of the United States. Face to face interviews were conducted each week throughout the year in a probability sample of households. In the sample adult core, one adult per sampled family was randomly selected and asked to complete the sample adult

questionnaire. The study sample consisted of 25,823 adults aged 18-64 years. In 2011, the final response rate for the sample adult core was 66.3%.¹⁷

To determine Tdap vaccination status, respondents were asked “Have you received a tetanus shot in the past 10 years?” Respondents who answered “yes” were asked “Was your most recent tetanus shot given in 2005 or later?” An affirmative answer to this question prompted another question “Did the doctor tell you the vaccine included the pertussis or whooping cough vaccine?” Respondents without “yes” or “no” responses for the above three questions were excluded from the assessment of Tdap vaccination. Sensitivity calculations were conducted to assess the magnitude of potential bias, assuming all excluded respondents were either 1) not vaccinated or 2) vaccinated.

Healthcare personnel were defined as persons who answered “yes” to the following question: “Do you currently volunteer or work in a hospital, medical clinic, doctor’s office, dentist’s office, nursing home or some other health-care facility? This includes part-time and unpaid work in a health care facility as well as professional nursing care provided in the home”. The following question was asked regarding direct patient care: “Do you provide direct patient care as part of your routine work?” For this analysis, HCP included those reporting they did or did not provide direct patient care.

Among 2,455 HCP 18-64 years, Tdap vaccination status could be assessed for 1,769 respondents. Excluded were HCP without a “yes” or no” classification for tetanus vaccination status within the preceding 10 years (n=60 [2.4%]) and HCP without a tetanus vaccination status during 2005-2011 (n=86 [3.5%]) or those reported tetanus vaccination during 2005-2011 but were not told vaccine type by the provider (n=468 [19.0%]) or did not know vaccine type (Td, or Tdap) (n=72 [2.9%]). Among 23,368 non-HCP 18-64 years, Tdap vaccination status could be assessed for 15,893 respondents. Excluded were non-HCP without a “yes” or no” classification for tetanus vaccination status within the preceding 10 years (n=807 [3.5%]), for tetanus vaccination status during 2005-2011 (n=732 [3.1%]), or those who reported tetanus vaccination during 2005-2011, but were not told vaccine type by the provider (n=5117 [21.9%]) or did not know vaccine type (Td, or Tdap) (n=820 [3.5%]).

We used SUDAAN statistical software (Research Triangle Institute, Research Triangle Park, NC) to calculate point estimates and 95% confidence intervals (CIs) of vaccination coverage.¹⁸ HCP who reported a tetanus vaccination during 2005-2011, but were unable to say whether Td or Tdap was used, were excluded from the analysis. All analyses were weighted to reflect the age, sex, and race/ethnicity of the U.S. non-institutionalized, civilian population. Bi-variable analysis was conducted using a Pearson’s χ^2 to test population distributions between HCP and non HCP. We used t-tests to test the difference in vaccination coverage by HCP status and within each demographic and other characteristic category. Statistical significance was defined as $p < 0.05$. The adjusted risk ratio or prevalence ratio, based on the predictive marginal under multivariable logistic regression model, was used to identify factors independently associated with vaccination among HCP. The risk ratio or prevalence ratio is a direct measure of effect when outcomes are not rare. Separate full multivariable logistic regression models for HCP and non-HCP were used to determine adjusted prevalence ratio of Tdap vaccination by selected demographic and access to care

variables. Multivariable logistic regression models were conducted both ways (with influenza vaccination status in the model and without influenza vaccination status in the model) to check whether influenza vaccination status could change the outcome of the model.

Sensitivity analyses were conducted to evaluate the magnitude of potential recall bias for Tdap on the vaccination coverage estimate and factors associated with vaccination.

Results

Of the 25,823 adults, 9.3% (2,455) were HCP. Demographic characteristics of the study population are given in Table 1. The majority of HCP were 18-49 years (70.7%), female (71.8%), white (68.4%), married (56.2%), had a college education or higher (79.1%), were living at or above poverty (92.0%), had a place for routine health care (92.3%), and had health insurance (86.4%). Except for age group and hospitalization status, HCP differed significantly from non-HCP for all other characteristics.

Among those for whom vaccination status could be identified, Tdap vaccination coverage among HCP was 26.9% (95% confidence interval (CI)=24.3%, 29.7%), significantly higher than among non-HCP (11.1%) (Table 2). Tdap vaccination coverage was significantly higher among HCP compared with coverage among non-HCP across all subgroups except those reporting other race or ethnicity (Table 2). Tdap vaccination coverage was 29.6% (26.3%, 33.2%) among HCP with direct patient contact, which was significantly higher compared to HCP without direct patient contact (21.8%; 17.7%, 26.5%)

In bi-variable analysis, Tdap vaccination coverage was significantly higher among HCP 18-49 years (30.0%) compared to HCP 50-64 years (19.2%) (Table 2). Tdap vaccination coverage among HCP was significantly higher among persons who reported having higher education, living at or above poverty level, living in the western United States, having greater number of physician contacts in the past year, hospitalized within past year, having a clinic/health center or doctor's office/HMO as the usual place for health care, having health insurance, and having received influenza vaccination in the previous year (Table 2). Tdap vaccination coverage among HCP was significantly lower among persons who reported being widowed, divorced, or separated (Table 2).

In multivariable analysis, characteristics independently associated with an increased likelihood of Tdap among HCP were: younger age, higher education, living in the western United States, having been hospitalized within past year, having a clinic or health center as the usual place for health care, and receipt of influenza vaccination in the previous year (Table 3). Model results did not change whether influenza vaccination was included or not (data not shown in the Table). Marital status of widowed, divorced, or separated was independently associated with a decreased likelihood of Tdap vaccination among HCP. Characteristics independently associated with an increased likelihood of Tdap among non-HCP were: younger age, never married, higher education, living in the western United States, born in the United States, living with an infant aged <1 year, having greater number of physician contacts in the past year, having a clinic or health center or a doctor's office/

Health Maintenance Organization (HMO) as the usual place for health care, and receipt of influenza vaccination in the previous year (Table 3).

Tdap vaccination coverage was 41.5% (29.9%, 54.2%) for physicians, 36.5% (30.5%, 43.0%) for nurses, 29.9% (21.8%, 39.5%) for other healthcare support occupations, 27.0% (19.9%, 35.5%) for other non-physician/nurse practitioners, 25.1% (18.3%, 33.4%) for other health technologists, 13.9% (10.5%, 18.2%) for nursing, psychiatric and home health aids, and 11.7% (4.8%, 25.9%) for clinical laboratory staff (Table 4).

Depending on what proportion of excluded respondents actually received Tdap, the sensitivity analysis showed that actual Tdap coverage among HCP could fall within the range of 20.3% to 44.8%. Sensitivity analyses showed that actual Tdap coverage among non-HCP could fall within the range of 8.0% to 35.9% depending on what proportion of excluded respondents actually received Tdap. Factors associated with Tdap vaccination slightly changed when multivariable models were conducted using upper level of coverage (44.8% for HCP, 35.9% for non-HCP) as the outcome variable based on sensitivity analyses. Factors associated with Tdap vaccination did not change when multivariable models were conducted using lower level of coverage (20.3% for HCP, 8.0% for non-HCP) as the outcome variable based on sensitivity analyses.

Discussion

Healthcare personnel are recommended to receive Tdap vaccination to protect themselves, their patients, and their families.^{1, 2} While HCP were more likely to be vaccinated with Tdap than those who were non-HCP, even among HCP, only about 1 in 4 HCP (26.9%) reported receiving Tdap vaccination. HCP with direct patient contact reported higher coverage (29.6%) than those without direct patient care (21.8%). Vaccination coverage varied widely by types of HCP and demographic characteristics.

Reported Tdap vaccination coverage among HCP is suboptimal. Influenza and Hepatitis B (HepB) vaccines are two other vaccines recommended for HCP in the United States.^{2, 19, 20} Influenza vaccination coverage among HCP has ranged from 53.0% to 64.0% based on the 2011 NHIS (CDC unpublished data), the 2007 National Immunization Survey-Adult, and a 2011 HCP internet panel survey.^{19, 20} HepB coverage among HCP has ranged from 63% to 70% based on the 2007 National Immunization Survey-Adult, and the 2010 NHIS.^{20, 21} These estimates were higher compared with the 2011 estimated Tdap vaccination coverage among HCP. Influenza and HepB vaccination, however, have been recommended for HCP since 1984 and 1982, respectively, compared with Tdap which has been recommended for HCP only since 2006.^{15, 19, 21} Other factors, such as perceived risk and targeted vaccination campaigns, may also contribute to higher influenza and HepB vaccination among HCP.^{19–21} Since Tdap vaccination coverage was first assessed in the United States in 2008,²² Tdap coverage among HCP has increased from 15.9% in 2008^{20, 21} to 26.9% in 2011. Continued monitoring of Tdap vaccination among HCP is useful for evaluating vaccination campaigns, for planning, and to control pertussis among HCP and their contacts.

Suboptimal Tdap coverage may in part be due to lower awareness of Tdap vaccine. One study showed that only 19% of individuals in the general population and about 39% of HCP reported having ever heard of Tdap vaccine.²³ Additionally, the intent to receive Tdap vaccination is also low among HCP. One study indicated that only 13% of the respondents reported they planned to receive the vaccine.²⁴ Intent to receive Tdap was low among all HCP occupational groups, including physicians (22%), nurses (9%), nursing aides (18%), therapists (14%), persons with other occupations (14%), technicians and persons with other healthcare support occupations (12%), and nurse practitioners and physician assistants (11%).²⁴ Additional education of HCP about the benefits of vaccination might help increase vaccination coverage. Confusion about the interval to receive Tdap after receipt of the last Td vaccination might also have affected Tdap uptake among HCP. Not all HCP were instructed to get Tdap on a shortened interval: the 2006 ACIP recommendation stated that HCP who have direct patient contact should receive a single dose of Tdap as soon as feasible, with an interval as short as 2 years from the last dose of Td. HCP without direct patient contact were recommended to receive a single dose of Tdap to replace the next scheduled Td vaccination according to the routine recommendation at an interval no greater than 10 years since the last Td vaccination (15). ACIP recently (2011) recommended use of Tdap regardless of interval since the last tetanus- or diphtheria-toxoid containing vaccine.¹⁶

Several characteristics were associated with Tdap vaccination coverage. As seen in other studies, age, education, and marital status were associated with vaccination.^{20, 22, 23, 25} Reported receipt of influenza vaccination in the past year among HCP was also associated with Tdap vaccination. Receipt of influenza vaccination in the past year may be a reflection of health seeking behavior and acceptance of or access to vaccinations or preventive services in general.²⁵ Annual influenza vaccination among HCP in work settings could provide a platform for delivering Tdap vaccine and thus may help increase Tdap vaccination coverage among HCP.

We found that Tdap vaccination coverage among HCP who reported a clinic or health center as the place they usually go to for health care or had been hospitalized in the past 12 months was significantly higher than those who did not have a place they usually go for health care or had not been hospitalized in the past 12 months, even after controlling for other demographic and access-to-care factors. Having contact with a physician plays an important role in vaccination uptake.^{13, 14} Routine provider contacts or hospitalization can provide important opportunities for providers to recommend and vaccinate HCP to improve Tdap vaccination coverage. However, one study showed that the most common reason given by HCP who did not plan to receive Tdap vaccine is that their provider did not recommend the vaccine to them.²⁴ Healthcare providers should take advantage of opportunities to recommend and vaccinate their patients when they access the medical system.

Living in the western United States was independently associated with a higher Tdap vaccination coverage among HCP. This result may reflect the percentage of hospital requirements for Tdap vaccination of HCP by region. One study indicated that about 31% of U.S. hospitals required HCP to receive Tdap vaccine and this percentage varied significantly by region.²⁶ The percentage of hospitals requiring HCP to receive Tdap vaccine was 22.5% in the Midwest, 27.8% in the Northeast, 30.1% in the South, and 47.4% in the West. The

percentage of hospitals in the western United States requiring HCP to receive Tdap vaccine was significantly higher compared with other regions.²⁶ In addition, our study indicated that vaccination coverage was higher in hospital settings, which is consistent with another study indicating that influenza vaccination coverage was higher in hospital settings as well.²⁰

A comprehensive employer vaccination program including education about the benefits of vaccination, convenient access to vaccination services, the provision of Tdap vaccination at no charge, and vaccination requirements may help improve vaccination coverage.^{2, 15, 27–29} Institutional requirements for influenza vaccination have led to higher vaccination levels.²⁷ One study examined influenza vaccination coverage following institution of vaccination policies, within a sample of U.S. hospitals, and found that single season influenza vaccination rates increased approximately 15% after institution of hospital policies requiring receipt of influenza vaccination.²⁷ Policies requiring vaccination with Tdap vaccine have also improved vaccination levels.^{28, 29} In 2010, the University of North Carolina made employment of HCP with direct patient contact conditional upon Tdap vaccination. After implementation of the policy, a nearly 100% compliance rate was achieved.²⁹ Hospitals and other healthcare institutions should consider providing vaccination at no or minimal cost to their employees and should consider policies to encourage vaccination.

The findings in this report are subject to several limitations. First, vaccination coverage was self-reported and therefore might be subject to recall bias. No studies have evaluated the validity of self-reported Tdap vaccination among HCP. Self-reported influenza and pneumococcal vaccination status among adults have been shown to be fairly sensitive and specific.^{30–33} Second, many respondents were excluded from estimations of Tdap coverage, creating a potential for bias. HCP who reported a tetanus vaccination during 2005–2011, but were unable to say whether Td or Tdap was used, were excluded. Sensitivity analyses were conducted to evaluate the magnitude of potential bias. Depending on what proportion of excluded respondents actually received Tdap, actual self-reported Tdap coverage among HCP could fall within the range of 20.3% to 44.8%. Based on our study, the percentages of respondents who reported unknown vaccine type were lower among HCP compared to non-HCP. Since vaccination is based on self-report and HCP have greater awareness of Tdap and Td differences and less likely to report unknown vaccine type, and thus might yield a higher coverage among HCP compared to non-HCP. Finally, confusion with Td and changes in ACIP recommendations since 2006 may affect the accuracy of self-reported Tdap vaccination coverage and thus future studies in terms of validity of Tdap vaccination are necessary.^{2, 15}

Tdap vaccination among HCP is crucial to minimize risk of pertussis infection among HCP, their patients, and their families. Despite the availability of a safe and effective vaccine, Tdap vaccination coverage among HCP was low (26.9%). Comprehensive strategies are needed to further improve uptake of Tdap vaccination coverage for HCP. Recommended approaches include: emphasizing the benefits of HCP vaccination for staff and patients; considering the level of vaccination coverage among HCP to be one measure of patient safety and quality assurance; electronic tracking of coverage levels by ward, unit, and occupation; providing vaccinations in the workplace and free of charges; identifying where vaccination coverage levels are low and using the information to target interventions;

developing comprehensive health care workplace infectious control programs that include pertussis control and address Tdap vaccination of HCP; and implementing catch-up vaccination programs for HCP who are already employed and ensuring that newly hired HCP receive necessary vaccinations.^{2, 34–36} Any comprehensive strategy needs to be tailored to the needs of the health care institution to improve coverage and protect HCP, their patients, and their families.

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TABLE 1

Sample characteristics of participants 18–64 years in the United States, by healthcare personnel status, demographic and access-to-care variables—National Health Interview Survey (NHIS), 2011

Characteristic	Healthcare personnel		Non healthcare personnel	
	Sample	Weighted %	Sample	Weighted %
Total	2,455	9.3	23,368	90.7
Age				
18-49	1,736	70.7	16,017	69.0
50-64	719	30.3	7,351	31.0
Sex				
Male	629	28.2	11,262	51.5*
Female	1,826	71.8	12,106	48.5
Race/ethnicity				
Non-hispanic White	1,465	68.4	13,007	65.0*
Non-hispanic Black	434	14.4	3,502	11.8
Hispanic	319	9.6	4,783	16.1
Asian	186	5.5	1,514	4.9
Other	51	2.1	562	2.2
Marital status				
Married	1,121	56.2	10,334	52.5*
Widowed/divorced/separated	498	13.8	4,658	13.4
Never married	830	30.0	8,326	34.1
Education				
High school or less	509	20.9	9,543	40.3*
Some college or college graduate	1,542	63.1	11,601	50.5
Above college graduate	401	16.0	2,121	9.2
Poverty level				
At or above poverty	1,995	92.0	16,841	84.1*
Below poverty	245	8.0	4,501	15.9
Region				

Characteristic	Healthcare personnel		Non healthcare personnel		
	Sample	Weighted %	Sample	Weighted %	
US Born	Northeast	426	19.5	3,585	17.4*
	Midwest	660	27.3	5,090	22.9
	South	838	33.5	8,436	35.8
	West	531	19.7	6,257	23.9
Living with an infant aged<1 year	Yes	2,034	84.1	18,304	81.8*
	No	421	15.9	5,052	18.2
Physician contacts within past year	Yes	66	2.8	955	4.4*
	No	2,391	97.2	22,441	95.6
Hospitalization within past year	None	362	13.3	5,444	22.5*
	1	443	18.3	4,238	18.7
	2-3	730	31.0	5,793	25.5
	4-9	607	25.4	5,902	21.3
	10	308	12.0	2,931	12.0
Usual place for health care	Yes	181	7.2	1,929	7.8
	No	2,273	92.8	21,432	92.2
Health insurance	Clinic or health center	534	18.6	5,475	20.7*
	Doctor's office or HMO [†]	1,612	70.3	13,391	61.9
	Some other place	86	3.4	932	3.6
Influenza vaccination	None	208	7.7	3,469	13.8
	Yes	2,095	86.4	17,799	78.5*
	No	351	13.6	5,486	21.5

Characteristic	Healthcare personnel		Non healthcare personnel	
	Sample	Weighted %	Sample	Weighted %
Yes	1,374	55.2	6,602	29.5*
No	1,080	44.8	16,540	70.5

* Significant difference between healthcare personnel and non healthcare personnel (by chi-square test, $p < 0.05$).

[†] Health maintenance organization.

TABLE 2

Tdap vaccination coverage by healthcare personnel status, demographic and access-to-care variables among persons 18-64 years in the United States, NHIS 2011

Characteristic	Healthcare personnel		Non healthcare personnel	p-Value*
	% (95% CI)		% (95% CI)	
Total	26.9 (24.3-29.7)		11.1 (10.5-11.8)	<0.001
Age				
	18-49	30.0 (26.8-33.5) [†]	12.3 (11.4-13.2) [†]	<0.001
	50-64 [‡]	19.2 (15.4-23.7)	8.5 (7.7-9.5)	<0.001
Sex				
	Male [‡]	26.4 (21.2-32.4)	9.9 (9.0-10.8)	<0.001
	Female	27.1 (24.2-30.2)	12.4 (11.5-13.4) [†]	<0.001
Race/ethnicity				
	Non-hispanic White [‡]	27.4 (24.2-30.8)	12.5 (11.6-13.4)	<0.001
	Non-hispanic Black	22.1 (16.8-28.5)	10.0 (8.5-11.6) [†]	<0.001
	Hispanic	29.8 (22.5-38.3)	6.4 (5.4-7.6) [†]	<0.001
	Asian	27.6 (19.0-38.2)	9.6 (7.6-12.1) [†]	<0.001
	Other	31.2 (16.9-50.4)	18.4 (13.7-24.4) [†]	0.155
Marital Status				
	Married [‡]	28.9 (25.4-32.6)	11.2 (10.3-12.1)	<0.001
	Widowed/divorced/separated	16.9 (12.4-22.6) [†]	8.6 (7.3-10.1) [†]	0.001
	Never married	27.9 (23.4-32.9)	12.1 (10.9-13.3)	<0.001
Education				
	High school or less [‡]	16.3 (11.8-22.2)	8.3 (7.4-9.3)	0.003
	Some college or college graduate	28.3 (25.1-31.7) [†]	12.8 (11.8-13.7) [†]	<0.001
	Above college graduate	34.3 (27.9-41.3) [†]	15.1 (13.0-17.4) [†]	<0.001
Poverty level				
	At or above poverty	27.7 (24.9-30.7) [†]	11.6 (10.9-12.5)	<0.001
	Below poverty [‡]	20.0 (13.6-28.3)	10.1 (8.7-11.6)	0.001
Region				
	Northeast [‡]	21.8 (16.6-28.1)	9.7 (8.2-11.6)	<0.001
	Midwest	25.2 (20.7-30.2)	12.1 (10.6-13.7) [†]	<0.001
	South	26.2 (22.2-30.7)	10.0 (8.9-11.3)	<0.001
	West	35.4 (28.4-43.1) [†]	12.9 (11.6-14.2) [†]	<0.001
US Born				
	Yes	27.5 (24.6-30.6)	12.3 (11.5-13.1) [†]	<0.001
	No [‡]	23.6 (18.3-29.9)	6.4 (5.4-7.6)	<0.001
Living with an infant aged<1 year				

Characteristic	Healthcare personnel		Non healthcare personnel	
		% (95% CI)	% (95% CI)	p-Value*
Physician contacts within past year	Yes	31.8 (18.6-48.8)	20.6 (17.0-24.8) [†]	0.167
	No [‡]	26.7 (24.0-29.6)	10.7 (10.1-11.4)	<0.001
Hospitalization within past year	None [‡]	14.9 (10.4-20.7)	6.3 (5.4-7.5)	0.002
	1	25.2 (20.0-31.4) [†]	9.5 (8.3-11.0) [†]	<0.001
	2-3	30.0 (25.6-34.8) [†]	11.9 (10.7-13.1) [†]	<0.001
	4-9	28.8 (23.6-34.7) [†]	14.4 (12.9-16.1) [†]	<0.001
	10	31.6 (24.6-39.7) [†]	16.9 (14.7-19.5) [†]	<0.001
Usual place for health care	Yes	39.0 (29.3-49.6) [†]	17.7 (14.8-20.9) [†]	<0.001
	No [‡]	26.0 (23.3-29.0)	10.6 (9.9-11.3)	<0.001
Health insurance	Clinic or health center	33.1 (27.1-39.8) [†]	12.6 (11.3-14.2) [†]	<0.001
	Doctor's office or HMO [§]	27.0 (24.0-30.2) [†]	12.1 (11.2-13.1) [†]	<0.001
	Some other place	30.4 (17.4-47.5)	8.9 (6.6-12.0) [†]	0.008
	None [‡]	13.5 (8.9-20.1)	5.6 (4.5-6.9)	0.006
Influenza vaccination, past year	Yes	28.1 (25.3-31.2) [†]	12.4 (11.6-13.2) [†]	<0.001
	No [‡]	18.7 (13.4-25.4)	6.9 (5.9-8.1)	<0.001
Influenza vaccination, past year	Yes	34.4 (30.8-38.2) [†]	18.5 (17.0-20.2) [†]	<0.001
	No [‡]	17.7 (14.5-21.4)	8.3 (7.7-9.0)	<0.001

* p value by t test for comparisons between healthcare personnel and non-healthcare personnel within each level of each characteristic.

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

[‡]Reference level.

[§]Health maintenance organization.

TABLE 3
 Multivariable logistic regression analysis of persons 18-64 years who reported received Tdap vaccination, by healthcare personnel status, demographic and access-to-care variables, United States, NHIS 2011

Characteristic	Healthcare personnel		Non healthcare personnel	
	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value *	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value *
Age				
18-49	1.6 (1.3-2.1)	<0.001	1.6 (1.4-1.8)	<0.001
50-64	Referent		Referent	
Sex				
Male	Referent		Referent	
Female	1.0 (0.8-1.3)	0.955	1.1 (1.0-1.2)	0.321
Race/ethnicity				
Non-hispanic White	Referent		Referent	
Non-hispanic Black	1.0 (0.7-1.3)	0.926	0.9 (0.7-1.0)	0.105
Hispanic	1.1 (0.8-1.5)	0.462	0.6 (0.5-0.8)	<0.001
Asian	1.0 (0.7-1.5)	0.970	1.0 (0.7-1.3)	0.785
Other	1.0 (0.6-1.8)	0.944	1.5 (1.1-2.0)	0.025
Marital Status				
Married	Referent		Referent	
Widowed/divorced/separated	0.7 (0.5-0.9)	0.009	0.9 (0.7-1.1)	0.189
Never married	1.0 (0.8-1.2)	0.992	1.2 (1.0-1.3)	0.015
Education				
High school or less	Referent		Referent	
Some college or college graduate	1.7 (1.2-2.3)	0.002	1.2 (1.1-1.4)	0.005
Above college graduate	2.0 (1.4-2.8)	<0.001	1.4 (1.1-1.7)	0.001
Poverty level				
At or above poverty	1.1 (0.8-1.6)	0.503	1.0 (0.8-1.2)	0.793
Below poverty	Referent		Referent	
Region				
Northeast	Referent		Referent	

Characteristic	Healthcare personnel		Non healthcare personnel	
	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value *	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value *
US Born	Midwest	1.0 (0.7-1.3)	1.2 (0.9-1.4)	0.160
	South	1.1 (0.9-1.5)	1.1 (0.9-1.3)	0.423
	West	1.6 (1.2-2.2)	1.5 (1.2-1.8)	<0.001
Living with an infant aged<1 year	Yes	1.2 (0.9-1.7)	1.5 (1.2-1.8)	<0.001
	No	Referent	Referent	
Physician contacts within past year	Yes	0.9 (0.5-1.6)	1.5 (1.2-1.9)	0.001
	No	Referent	Referent	
Hospitalization within past year	None	Referent	Referent	
	1	1.2 (0.8-1.7)	1.2 (1.0-1.5)	0.091
	2-3	1.3 (0.9-1.9)	1.4 (1.1-1.7)	0.002
	4-9	1.3 (0.9-1.8)	1.6 (1.3-2.0)	<0.001
	10	1.2 (0.8-1.8)	1.6 (1.3-2.1)	<0.001
Usual place for health care	Yes	1.5 (1.0-2.0)	1.1 (0.9-1.4)	0.392
	No	Referent	Referent	
Health insurance	Clinic or health center	1.8 (1.2-2.8)	1.5 (1.2-1.9)	0.001
	Doctor's office or HMO [†]	1.5 (1.0-2.2)	1.3 (1.0-1.6)	0.040
	Some other place	1.7 (0.9-3.4)	1.4 (1.0-2.0)	0.051
Influenza vaccination, past year	None	Referent	Referent	
	Yes	1.1 (0.8-1.6)	1.1 (0.9-1.3)	0.192
Influenza vaccination, past year	No	Referent	Referent	
	Yes	2.0 (1.6-2.4)	2.0 (1.8-2.2)	<0.001

Characteristic	Healthcare personnel		Non healthcare personnel	
	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value*	Prevalence Ratio (PR) (adjusted) (95% CI)	p-Value*
	No	Referent	Referent	Referent

* p<0.05 by t test for comparisons within each variable with the indicated reference level.

† Health maintenance organization.

TABLE 4

Tdap vaccination coverage by types of healthcare personnel and facilities among persons 18-64 years in the United States, NHIS 2011

Occupations	Ambulatory health care services % (95% CI)	Hospitals % (95% CI)	Nursing and residential care facilities % (95% CI)	Total % (95% CI)
Total	25.5 (21.6-30.0)	35.2 (29.9-40.9)	14.3 (9.7-20.5)	27.3 (24.4-30.4)
Physicians	31.4 (18.7-47.8)	58.6 (37.3-77.2)		41.5 (29.9-54.2)
Nurses	39.8 (28.7-52.0)	38.3 (30.8-46.5)	18.7 (8.2-37.0)	36.5 (30.5-43.0)
Others in non-physician/nurse practitioners group *	24.6 (16.2-35.4)	36.1 (21.1-54.4)	†	27.0 (19.9-35.5)
Clinical laboratory	†	†	†	11.7 (4.8-25.9)†
Health technologists [§]	23.1 (14.0-35.6)	31.8 (20.6-45.7)	12.2 (3.0-38.3)	25.1 (18.3-33.4)
Nursing, psychiatric, and home health aids	11.1 (6.8-17.8)†	20.3 (12.0-32.2)†	†	13.9 (10.5-18.2)†
Healthcare support occupations ^{//}	29.3 (20.2-40.5)	35.5 (18.2-57.5)	†	29.9 (21.8-39.5)

* Including chiropractors, dentists, dietitians and nutritionists, optometrists, pharmacists, physician assistants, podiatrists, audiologists, occupational therapists, physical therapists, radiation therapists, respiratory therapists, etc.

† Estimates are not reliable due to sample size is less than 30.

‡ p<0.05 by t test for comparisons within each healthcare setting with physicians as the reference level.

§ Including dental hygienists, diagnostic related technologists and technicians, emergency medical technicians and paramedics, health diagnosing treating practitioner support technicians, medical records and health information technicians, opticians, dispensing, etc.

// Including occupational therapist assistants and aides, physical therapist assistants, massage therapists, dental assistants, medical assistants, etc.