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National and state-specific Td and Tdap vaccination of adult populations

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Abstract

Background—For adults, the Advisory Committee on Immunization Practices (ACIP) recommends a single dose of tetanus, diphtheria and acellular pertussis vaccine (Tdap) followed by tetanus and diphtheria toxoids (Td) booster doses every 10 years thereafter.

Purpose—To assess recent Td and Tdap vaccination among adult populations.

Methods—The 2013 BRFSS data were analyzed in 2015 to assess Td and Tdap vaccination coverage among adults at national and state levels. Multivariable logistic regression and predictive marginal models were performed to identify factors independently associated with vaccination.

Results—Overall, national vaccination coverage among adults 18 years for Td was 57.5% and for Tdap was 28.9%. Among states, Td vaccination coverage ranged from 47.8% in Nevada to 73.1% in Minnesota, and Tdap coverage ranged from 17.7% in Mississippi to 47.6% in Minnesota. Characteristics independently associated with an increased likelihood of Tdap vaccination among adults 18 years were: younger age; being female; American Indian/Alaska Native (AIAN) race; being never married; higher education; not being in the workforce, reporting a household income < \$75,000; living in the West or Midwest of the United States; reporting excellent, very good, good, or fair health; having health insurance; having a healthcare provider; having a routine checkup in the previous year; receipt of influenza vaccination in the previous year; and having ever received pneumococcal vaccination.

Conclusions—By 2013, Td and Tdap vaccination coverage were 57.5% and 28.9%, respectively. Coverage varied by state. Implementation of evidence-based programs are needed to improve Td and Tdap vaccination levels among adult populations.

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Conflict of Interest Statement:

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Keywords

Tetanus; diphtheria and acellular pertussis vaccine (Tdap); Tetanus; vaccination; coverage; adult. BRFSS (Behavioral Risk Factor Surveillance System)

Introduction

Pertussis, a respiratory illness commonly known as whooping cough, is a very contagious disease caused by the bacteria *Bordetella pertussis*. Pertussis remains endemic in the United States despite longstanding routine childhood pertussis vaccination. Since the 1980s, the number of reported pertussis cases has steadily increased, especially among adolescents and adults (1–5). Overall, reported cases of pertussis during 2013 were 28,639.^{1–3} An average of 22,785 pertussis cases were reported annually from 2004 to 2013.^{1–3}

Vaccination offers the best protection against pertussis infection. Adults and adolescents may become susceptible to pertussis due to waning immunity from childhood vaccinations. To protect adolescents and adults against pertussis, the Advisory Committee on Immunization Practices (ACIP) recommended the tetanus, diphtheria, and acellular pertussis vaccine (Tdap) in 2005 as a one-time replacement for the decennial tetanus diphtheria (Td) booster dose among persons 11–64 years.^{4–5} In October 2010, ACIP recommended Tdap for adults ≥ 65 years who have or who anticipate having close contact with an infant <1 year regardless of the interval since the last tetanus or diphtheria-toxoid containing vaccine.⁶ In February 2012, ACIP expanded the general adult Tdap recommendation to include all adults ≥ 65 years.⁷

This study used data from the 2013 Behavioral Risk Factor Surveillance System (BRFSS) to assess national and state-specific Td and Tdap vaccination coverage and identify factors independently associated with vaccination among adult populations in the United States. Such information will help in identifying strategies to improve vaccination coverage among adult populations.

Methods

The 2013 BRFSS data were analyzed in 2015. The BRFSS is a continuous, population-based telephone survey coordinated by state health departments in collaboration with the Centers for Disease Control and Prevention (CDC). The BRFSS collects information from non-institutionalized adults ≥ 18 years. The BRFSS is conducted monthly in all 50 states and the District of Columbia (D.C.). The objective of the BRFSS is to collect uniform, state-specific data on self-reported preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases. Individuals are selected randomly using a multistage cluster design. Data are weighted by age, sex, and, in some states, race/ethnicity, to reflect each area's estimated adult population.⁸ Beginning in 2011, surveys included landline and cellular telephone households and used a new method for weighting.⁹ For the 2013 BRFSS, the median state-specific AAPOR (American Association of Public Opinion Research) landline, cellular phone, and combined response rates were 49.6%

(range: 28.0%–63.7%), 37.8% (range: 19.6%–62.6%), and 46.4% (range: 29.0%–60.3%), respectively.¹⁰

To determine Td and Tdap vaccination status in all states, a new question regarding Td and Tdap vaccination was added to the 2013 BRFSS core questionnaire. Respondents were asked “Since 2005, have you had a tetanus shot?” Respondents who answered “yes” were asked “Was this Tdap, the tetanus shot that also has pertussis or whooping cough vaccine?” Respondents without “yes” or “no” responses for the questions were excluded from the assessment of Tdap vaccination. Sensitivity calculations were conducted to assess the magnitude of potential bias in this method of calculation, assuming those who answered they received a tetanus shot but were not sure what type either received Tdap vaccine or did not receive Tdap.

Td and Tdap vaccination levels were stratified by demographic and access to care characteristics: age group (18–49, 50–64, 65+), race/ethnicity (non-Hispanic whites, non-Hispanic black, Hispanic, non-Hispanic Asian, non-Hispanic American Indian/Alaska Native (AIAN), other), marital status (married or unmarried couple [unmarried couple indicates that someone is living with a partner before marriage], divorced/widowed/separated, never married), education (less than high school, high school graduate, some college or technical school, college graduate or higher), employment status (employed, unemployed, not in work force), household income (<\$20,000, \$20,000–\$49,999, \$50,000–\$74,999, \$75,000 or more), region (Northeast, Midwest, South, West), perceived health status (excellent/very good, good, fair, poor), medical insurance status (insured, uninsured), having a personal health care provider (yes, no), time since last routine checkup (<1 year, 1 year), unable to see doctor due to cost (yes, no), influenza vaccination in the last 12 months (yes, no), and ever received pneumococcal vaccination (yes, no).

SUDAAN (Software for the statistical analysis of correlated data, Research Triangle Institute, Research Triangle Park, NC) was used to calculate point estimates and 95% confidence intervals (CIs). All analyses were weighted to reflect the age, sex, and race/ethnicity of the U.S. non-institutionalized civilian population (Census-based population was used to base the age, sex, and race/ethnicity weights used in the analyses). All tests were 2-tailed with the significance level set at $\alpha < 0.05$. State-specific Td and Tdap vaccination coverage was also evaluated. Predictive marginal models were used to generate adjusted prevalence ratios and identify variables independently associated with Td and Tdap vaccination among persons ≥ 18 years.

Results

A total of 479,201 adults ≥ 18 years from the 2013 BRFSS were included in the study. Demographic characteristics of the study population are given in Table 1. The majority of participants were 18–49 years (55.0%), female (51.3%), non-Hispanic white (65.0%), married or a member of an unmarried couple (56.1%), had at least some college [or technical school] education (56.3%), were employed (56.1%), had medical insurance (82.5%), and had a personal health care provider (76.2%).

Td vaccination coverage was 57.5% (95% confidence interval [CI]=57.2%, 57.9%) among adults 18 years. Td vaccination coverage was significantly higher among adults 18–49 years (61.3%) and 50–64 years (56.0%) compared with adults 65 years (48.9%) ($p<0.05$) (Table 2). Td coverage was significantly lower among non-Hispanic blacks (53.4%), Hispanics (52.7%), and non-Hispanic Asians (52.6%) compared with non-Hispanic whites (59.3%) ($p<0.05$), but was higher for AIAN (64.1%) compared with non-Hispanic whites ($p<0.05$). Td vaccination coverage was significantly higher among persons who were male; were never married; reported having higher education; reported higher income; lived in the Midwest region of the United States; reported excellent, very good, or good health; reported having medical insurance; reported having a personal health care provider; reported having a routine checkup in the previous year; did not report that cost prevented them from seeing a doctor; reported receipt of influenza vaccination in the previous year; and reported having ever received pneumococcal vaccination ($p<0.05$) (Table 2). Td vaccination coverage was significantly lower among persons who reported being widowed, divorced, or separated; were unemployed or not in work force; or lived in the Southern region of the United States ($p<0.05$) (Table 2).

Overall, Tdap vaccination coverage was 28.9% (CI=28.5%, 29.2%) among adults 18 years. Tdap vaccination coverage was significantly higher among adults 18–49 years (34.4%) and 50–64 years (25.4%) compared with adults 65 years (18.7%) ($p<0.05$) (Table 2). Tdap coverage was significantly higher among non-Hispanic whites (29.9%) compared with non-Hispanic blacks (25.3%) and Hispanics (26.0%) ($p<0.05$), but was higher for AIAN (34.3%) compared with non-Hispanic whites ($p<0.05$). Characteristics associated with Tdap vaccination were similar to those for Td, except females had higher Tdap coverage while males had higher Td coverage, and persons who reported living in the Midwest or West had higher Tdap coverage while those who reported living in the Midwest had higher Td coverage (Table 2).

In the multivariable analysis, characteristics independently associated with an increased likelihood of Td vaccination among adults 18 years were: younger age; AIAN race; reporting never having been married; higher education; household income \geq \$50,000; living in the West or Midwest regions of the United States; reporting excellent, very good, or good health; having health insurance; having a personal health care provider; having a routine checkup in the previous year; reporting receipt of influenza vaccination in the previous year; and having ever received pneumococcal vaccination (Table 3). Being female, African American, Hispanic, Asian, widowed, divorced, or separated were independently associated with a decreased likelihood of Td vaccination among adults. Characteristics independently associated with an increased likelihood of Tdap vaccination among adults 18 years were similar to those for Td, except female sex and not being in the work force were also independently associated with an increased likelihood of Tdap vaccination (Table 3).

Td coverage varied widely among the 50 states and D.C., ranging from 47.8% in Nevada to 73.1% in Minnesota with a median of 58.7%. Coverage was below 50% in four states (Nevada, Mississippi, New Jersey, and Arkansas), and coverage was above 70% in three states (Wisconsin, Vermont, and Minnesota) (Table 4). Among adults 18 years, Tdap vaccination coverage ranged from 17.7% in Mississippi to 47.6% in Minnesota with a

median of 28.2%. Tdap vaccination coverage varied substantially by state. Coverage was below 20% in three states (Mississippi, Florida, New Jersey), and coverage was above 45% in three states (Wisconsin, Vermont, and Minnesota) (Table 4).

Depending on what proportion of excluded respondents actually received Tdap, the sensitivity analysis showed that actual Tdap coverage could fall within the range of 20.8% to 48.9% for adults < 18 years, 24.4% to 53.4% for adults 18–49 years, 18.3% to 46.3% for adults 50–64 years, and 13.8% to 39.8% for adults ≥ 65 years.

Discussion

By 2013, reported Td vaccination coverage was 57.5% among adults < 18 years, similar to estimates in 1999 (60.4%) and 2008 (61.6%),¹¹ indicating that approximately 40% adults had not received Td vaccination. In the United States, reported cases of tetanus have declined from 2044 cases in 1972 to 19 cases in 2009.¹² Several factors have contributed to the decline in tetanus morbidity and mortality, including the widespread use of Td vaccine.¹³ In addition to Td vaccine, other factors including improved wound care management, the use of tetanus immune globulin for post-exposure prophylaxis, and increased rural-to-urban migration with consequent decreased exposure to tetanus spores may also have contributed to the decline in tetanus morbidity and mortality.¹³ Although tetanus is rare in the United States, maintaining higher coverage of Td vaccination among the adult population is still important. Health-care providers should assess their patients' Td vaccination status with particular emphasis on up-to-date vaccination, especially if patients are older adults, injection-drug users, persons with diabetes, or persons with wounds.¹³

Reported Tdap vaccination coverage in 2013 was low at 28.9%. Although coverage is low, Tdap vaccination coverage among adults has increased slowly over time.^{4, 11, 14–17} The number of adults affected by pertussis is more common compared with tetanus.^{1–3} The number of pertussis cases is likely underreported since pertussis can have nonspecific symptoms, especially among adults, and often goes undiagnosed.^{1–3} The results from our study indicated that over 70% of U.S. adults did not report having received a Tdap vaccination at the time of the 2013 BRFSS survey.

Because the Td and Tdap vaccination information was newly added to the 2013 BRFSS core questionnaire, this is the first study to assess state-specific Td and Tdap vaccination coverage among adult populations. Results from this study provide a baseline for state-level Td and Tdap coverage in the United States. Substantial differences in coverage among states were observed for both Td and Tdap vaccination. Variation in state coverage could be due to differing medical care delivery infrastructure, socioeconomic factors, state laws, effectiveness of state and local immunization programs, and other factors.^{18–22} Assessing local, state, and national adult vaccination programs is necessary for evaluating progress. For example, state level comparisons may aid in designing tailored intervention programs and sharing best practices.²³

Both Td and Tdap vaccination coverage among adults 18–49 and 50–64 years were significantly higher than adults ≥ 65 years. This result remained unchanged after controlling

for other demographic and access-to-care variables. It is not unexpected that Tdap vaccination coverage among adults 65 years was lower compared with adults 64 years, because Tdap vaccination was initially recommended in 2006 only to adults 64 years. It was not until 2010, when ACIP first recommended limited use of Tdap in adults 65 years with close contact with an infant. In 2012, ACIP expanded the general adult Tdap recommendation to include all adults 65 years.⁴⁻⁶ Tdap vaccination coverage among adults 65 years is likely to continue increasing as the recommendations for routine Tdap vaccination of adults 65 years is more widely implemented. Higher Tdap vaccination coverage among younger adults and females might indicate that young parents or pregnant women are more likely to receive vaccination since they are a source of pertussis transmission to infants.^{24, 25} One recent study indicated that Tdap vaccination coverage among pregnant women was higher (53.4% in 2011), and the higher Tdap vaccination coverage among pregnant women compared with general population may indicate that pregnant women were more likely to receive Tdap vaccination to protect themselves and their babies.²⁵ Additionally, higher reported coverage in young adults might also reflect receipt of Tdap as older adolescents. For example, reported Tdap vaccination coverage among adolescents in 2013 (86%) was much higher compared with overall coverage among adults.²⁶

The racial and ethnic disparities seen in this study are similar to those in other reports.^{11, 14-17, 24} Overall, coverage was lower among non-Hispanic blacks and Hispanics but was higher among AIAN compared with non-Hispanic whites. This finding persisted after taking into account demographic and access to care characteristics of respondents. Several factors may play a role in racial/ethnic differences in coverage including differences in attitudes toward vaccination and preventive care, the propensity to seek and accept vaccination, and differences in quality of care received by racial/ethnic populations.^{11, 14-17, 24, 27, 28}

Higher education was independently associated with higher vaccination coverage. Higher education might be related to greater awareness of pertussis and its risk.^{3, 24} Additionally, having health insurance, having a personal health care provider, and having a routine checkup in the previous year were independently associated with higher vaccination coverage. These findings are consistent with previous reports.^{3, 11, 27, 29-33} Reported receipt of influenza and pneumococcal vaccination were also associated with vaccination and may reflect general health-seeking behavior and acceptance of or access to vaccinations, a positive attitude toward preventive measures, the quality of medical care or having providers who are more likely to vaccinate adults. Annual influenza vaccination could provide a platform for delivering Tdap vaccine and thus may help increase Tdap vaccination coverage among adult populations. Tdap vaccination coverage could be further improved if providers took advantage of other vaccination visits by adults to offer this vaccine.

The results from this study could be compared with estimates from the 2013 National Health Interview Survey (NHIS). The NHIS is a national household survey conducted annually by face-to-face interview and has higher response rates (61.2%) than BRFSS. Td coverage from the 2013 NHIS was somewhat higher than the estimates from BRFSS, and Tdap coverage was somewhat lower than BRFSS. Factors that may contribute to the differences in estimated coverage between the BRFSS and NHIS include a more representative sample

frame and higher response rates for the NHIS, survey mode (in person for the NHIS, telephone for BRFSS), and differences in survey operations and weighting procedures. 8–10, 17, 34

The findings in this report are subject to several limitations. First, vaccination coverage was self-reported and therefore might be subject to recall bias. Validity of Td and Tdap vaccination based on BRFSS were not reported; however, self-reporting of pneumococcal vaccination based on BRFSS was validated by medical record and had a sensitivity of 75% and a specificity of 83%.³⁵ In addition, adult self-reported vaccination status has been shown to be sensitive, and sensitivities (if a person received vaccination, how often it will be shown positive in medical record) were 73.8% for pneumococcal, 92.1% for tetanus, 91.2% for human papillomavirus, 90.7% for shingles, 62.5% for hepatitis A, 72.6% for hepatitis B, and 93.0% for influenza vaccinations.³⁶ Self-reported vaccination has not been shown to be as specific, and specificities (if a person did not receive vaccination, how often it will be shown negative in medical record) were 90.7% for pneumococcal, 11.0% for tetanus, 76.1% for human papillomavirus, 89.7% for shingles, 84.0% for hepatitis A, 66.6% for hepatitis B, and 65.7% for influenza vaccinations.³⁶ Second, the response rates for the 2013 BRFSS were low at only 49.6% for land lines, 37.8% for cell phones, and 46.4% for the combined sample. Some selection bias may remain. However, the basic demographic characteristics by age, gender, and race/ethnicity from the 2013 BRFSS were similar to those observed in the 2013 National Health Interview Survey (CDC unpublished data), which is considered a gold standard survey with a final response rate of 61.2% for the adult core data set.⁴ Third, many respondents were excluded from estimations of Tdap coverage, creating a potential for bias. Adults who reported a tetanus vaccination since 2005 but were unable to say whether Td or Tdap was given were excluded from the analysis. Sensitivity analyses were conducted to evaluate the magnitude of potential bias. Depending on what proportion of excluded respondents actually received Tdap, self-reported Tdap coverage among adult 18 years could range from 20.8% to 48.9%. Regardless, estimated Tdap vaccination coverage was low in 2013.

In summary, by 2013, our study indicated that more than 40% adults had not received Td and more than 70% adults had not received Tdap vaccinations. Most importantly, this is the first study to assess Td and Tdap vaccination at state level, and the results from this study provide a baseline for state level Td and Tdap coverage in the United States. The findings in this study showed that there was great variation in coverage by state; for example, only 17.7% of adults in Mississippi reported receipt of Tdap, but Tdap coverage was as high as 47.6% in Minnesota. Implementation of evidence-based programs are needed to improve Td and Tdap vaccination, and state immunization programs are encouraged to engage providers to implement interventions shown to be effective in increasing vaccination among adults. 23, 37–39 Additionally, the Affordable Care Act (ACA) program should also help to improve Td and Tdap vaccination coverage among adult populations.^{40, 41}

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Table 1

Sample characteristics among adults 18 years, BRFSS 2013

Characteristic	All adults	
	Sample (N)	Weighted* %
Total	479,201	100.0
Age		
18–49 years	169,437	55.0
50–64 years	151,258	26.3
65 years	158,506	18.7
Sex		
Male	196,743	48.7
Female	282,458	51.3
Race/ethnicity		
White, non-Hispanic	373,391	65.0
Black, non-Hispanic	38,675	11.7
Hispanic	30,804	15.6
Asian, non-Hispanic	8,826	4.6
American Indian/Alaska Native, non-Hispanic	7,627	1.0
Other	12,260	1.9
Marital status		
Married or unmarried couple	260,139	56.1
Divorced, widowed, or separated	143,438	20.2
Never married	73,004	23.7
Education level		
Less than high school	40,379	15.1
High school graduate	139,754	28.6
Some college or technical school	131,282	30.8
College graduate or higher education	165,955	25.5
Employment		
Employed	236,666	56.1
Unemployed	25,470	7.5
Not in work force	214,068	36.4
Income		
<20,000	83,028	21.4
20,000–49,999	149,216	34.8
50,000–74,999	64,533	14.8
75,000+	114,896	29.0
Region		
Northeast	83,032	18.0
Midwest	130,934	21.3
South	158,223	37.3
West	107,012	23.3

Characteristic	All adults	
	Sample (N)	Weighted* %
Perceived health		
Excellent or very good	239,744	50.8
Good	146,321	31.2
Fair	63,876	13.2
Poor	27,350	4.8
Have medical insurance		
Yes	423,296	82.5
No	54,149	17.5
Have personal health care provider		
Yes	399,989	76.2
No	77,534	23.8
Time since last routine checkup		
<1 year	346,683	69.6
1 year	122,100	30.4
Unable to see doctor due to cost		
Yes	58,441	15.9
No	419,591	84.1
Influenza vaccination in the past 12 months		
Yes	204,945	38.8
No	235,172	61.2
Ever received pneumococcal vaccination		
Yes	159,210	32.1
No	238,056	67.9

* Census-based population was used to base the age/sex/race-ethnicity weights used in the analyses.

Table 2

Td and Tdap vaccination coverage among adults by demographic and access-to-care variables, BRFSS 2013

Characteristic	Td vaccination coverage	Tdap vaccination coverage
	% (95% CI)	% (95% CI)
Total	57.5 (57.2–57.9)	28.9 (28.5–29.2)
Age		
18–49 years	61.3 (60.9–61.8) *	34.4 (33.9–35.0) *
50–64 years	56.0 (55.5–56.6) *	25.4 (24.8–26.0) *
65 years ^a	48.9 (48.3–49.5)	18.7 (18.2–19.2)
Sex		
Male ^a	59.5 (59.0–59.9)	27.4 (26.8–27.9)
Female	55.7 (55.3–56.1) *	30.2 (29.7–30.7) *
Race/ethnicity		
White, non-Hispanic ^a	59.3 (58.9–59.6)	29.9 (29.6–30.3)
Black, non-Hispanic	53.4 (52.3–54.4) *	25.3 (24.2–26.4) *
Hispanic	52.7 (51.6–53.9) *	26.0 (24.8–27.3) *
Asian, non-Hispanic	52.6 (50.2–55.0) *	30.6 (28.1–33.3)
American Indian/Alaska Native, non-Hispanic	64.1 (61.2–66.9) *	34.3 (31.3–37.4) *
Other	60.5 (58.3–62.7)	30.2 (27.8–32.8)
Marital status		
Married or unmarried couple ^a	58.0 (57.6–58.4)	29.8 (29.4–30.3)
Divorced, widowed, or separated	51.3 (50.6–51.9) *	21.4 (20.8–22.1) *
Never married	62.0 (61.2–62.8) *	33.6 (32.7–34.5) *
Education level		
Less than high school ^a	51.1 (50.0–52.2)	20.8 (19.7–21.9)
High school graduate	54.5 (54.0–55.1) *	24.0 (23.4–24.6) *
Some college or technical school	60.3 (59.7–60.9) *	31.3 (30.6–31.9) *
College graduate or higher education	61.1 (60.6–61.6) *	35.8 (35.2–36.3) *
Employment		
Employed ^a	59.0 (58.6–59.4)	30.7 (30.3–31.2)
Unemployed	56.1 (54.8–57.4) *	26.5 (25.2–27.9) *
Not in work force	55.7 (55.1–56.2) *	26.6 (26.1–27.2) *
Income		
<20,000 ^a	53.3 (52.4–54.1)	24.8 (23.9–25.6)
20,000–49,999	55.2 (54.7–55.8) *	25.8 (25.2–26.4)
50,000–74,999	60.2 (59.4–61.0) *	31.4 (30.5–32.3) *
75,000+	62.5 (61.9–63.1) *	35.8 (35.1–36.5) *

Characteristic	Td vaccination coverage	Tdap vaccination coverage
	% (95% CI)	% (95% CI)
Region		
Northeast ^a	57.5 (56.8–58.2)	27.3 (26.6–28.1)
Midwest	60.4 (59.8–61.0) *	31.1 (30.5–31.8) *
South	55.8 (55.3–56.4) *	25.4 (24.9–26.0) *
West	57.6 (56.7–58.4)	33.0 (32.2–33.9) *
Perceived health		
Excellent or very good	60.2 (59.8–60.7) *	32.9 (32.4–33.4) *
Good	55.6 (55.0–56.2) *	26.1 (25.4–26.7) *
Fair	53.0 (52.0–53.9)	23.1 (22.1–24.1) *
Poor ^a	54.0 (52.6–55.4)	20.8 (19.4–22.2)
Have medical insurance		
Yes	59.2 (58.9–59.6) *	30.6 (30.2–31.0) *
No ^a	49.2 (48.3–50.1)	20.9 (20.0–21.7)
Have personal health care provider		
Yes	59.5 (59.2–59.9) *	30.7 (30.3–31.1) *
No ^a	51.0 (50.3–51.8)	23.3 (22.5–24.0)
Time since last routine checkup		
<1 year	60.7 (60.3–61.1) *	31.8 (31.4–32.2) *
1 year ^a	51.5 (50.9–52.1)	23.5 (22.9–24.2)
Unable to see doctor due to cost		
Yes ^a	53.2 (52.3–54.1)	23.9 (23.0–24.7)
No	58.4 (58.0–58.7) *	29.9 (29.5–30.3) *
Influenza vaccination in the past 12 months		
Yes	63.1 (62.6–63.5) *	37.1 (36.5–37.7) *
No ^a	54.1 (53.7–54.5)	23.8 (23.4–24.3)
Ever received pneumococcal vaccination		
Yes	63.2 (62.7–63.8) *	35.2 (34.5–35.9) *
No ^a	53.0 (52.6–53.4)	24.9 (24.5–25.4)

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

* $p < 0.05$ by t-test comparing against reference group.

^aReference level.

Table 3

Multivariable logistic regression analysis of adults who reported received Td or Tdap vaccination, BRFSS 2013

Characteristic	Adjusted prevalence ratio (PR)	
	Td vaccination	Tdap vaccination
	PR (95% CI)	PR (95% CI)
Total		
Age		
18–49 years	1.57 (1.54, 1.61) *	2.77 (2.63, 2.91) *
50–64 years	1.37 (1.34, 1.41) *	1.90 (1.80, 2.00) *
65 years	Reference	Reference
Sex		
Male	Reference	Reference
Female	0.92 (0.91, 0.93) *	1.06 (1.03, 1.09) *
Race/ethnicity		
White, non-Hispanic	Reference	Reference
Black, non-Hispanic	0.90 (0.88, 0.93) *	0.91 (0.87, 0.96) *
Hispanic	0.92 (0.89, 0.94) *	0.93 (0.88, 0.98) *
Asian, non-Hispanic	0.84 (0.79, 0.89) *	0.86 (0.77, 0.95) *
American Indian/Alaska Native, non-Hispanic	1.07 (1.02, 1.13) *	1.13 (1.03, 1.24) *
Other	1.01 (0.97, 1.06)	0.98 (0.90, 1.08)
Marital status		
Married or unmarried couple	Reference	Reference
Divorced, widowed, or separated	0.97 (0.96, 0.99) *	0.92 (0.89, 0.96) *
Never married	1.04 (1.02, 1.06) *	1.09 (1.05, 1.14) *
Education level		
Less than high school	Reference	Reference
High school graduate	0.98 (0.95, 1.01)	0.99 (0.93, 1.06)
Some college or technical school	1.05 (1.02, 1.08) *	1.15 (1.08, 1.23) *
College graduate or higher education	1.04 (1.01, 1.07) *	1.25 (1.17, 1.33) *
Employment		
Employed	Reference	Reference
Unemployed	1.02 (0.99, 1.04)	1.01 (0.95, 1.08)
Not in work force	1.01 (1.00, 1.03)	1.05 (1.01, 1.09) *
Income		
<20,000	Reference	Reference
20,000–49,999	1.00 (0.98, 1.02)	0.97 (0.92, 1.01)
50,000–74,999	1.03 (1.01, 1.06) *	1.03 (0.98, 1.09)
75,000+	1.04 (1.01, 1.06) *	1.06 (1.01, 1.12) *

Characteristic	Adjusted prevalence ratio (PR)	
	Td vaccination	Tdap vaccination
	PR (95% CI)	PR (95% CI)
Region		
Northeast	Reference	Reference
Midwest	1.06 (1.04, 1.08) *	1.15 (1.11, 1.20) *
South	1.00 (0.98, 1.02)	0.99 (0.95, 1.02)
West	1.06 (1.04, 1.08) *	1.27 (1.22, 1.32) *
Perceived health		
Excellent or very good	1.07 (1.04, 1.11) *	1.34 (1.24, 1.46) *
Good	1.04 (1.00, 1.07) *	1.18 (1.09, 1.28) *
Fair	1.01 (0.98, 1.05)	1.14 (1.04, 1.24) *
Poor	Reference	Reference
Have medical insurance		
Yes	1.07 (1.04, 1.09) *	1.12 (1.06, 1.18) *
No	Reference	Reference
Have personal health care provider		
Yes	1.11 (1.08, 1.13) *	1.13 (1.08, 1.18) *
No	Reference	Reference
Time since last routine checkup		
<1 year	1.17 (1.15, 1.19) *	1.29 (1.25, 1.34) *
1 year	Reference	Reference
Unable to see doctor due to cost		
Yes	Reference	Reference
No	0.98 (0.96, 1.00)	1.02 (0.98, 1.07)
Influenza vaccination in the past 12 months		
Yes	1.14 (1.12, 1.15) *	1.48 (1.44, 1.53) *
No	Reference	Reference
Ever received pneumococcal vaccination		
Yes	1.26 (1.25, 1.28) *	1.60 (1.55, 1.65) *
No	Reference	Reference

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

* $p < 0.05$ comparing against the reference group.

Table 4

State-specific Td and Tdap vaccination coverage adults 18 years, BRFSS 2013

State	Sample size	Td vaccination coverage	Tdap vaccination coverage
		% (95% CI)	% (95% CI)
<i>Total</i>	479,201	57.5 (57.2–57.9)	28.9 (28.5–29.2)
<i>Median</i>		58.7	28.2
Alabama	6,452	53.5 (51.5–55.4)	24.2 (22.3–26.3)
Alaska	4,536	60.3 (58.0–62.5)	33.5 (31.0–36.1)
Arizona	4,207	53.1 (50.1–56.0)	24.0 (21.3–26.8)
Arkansas	5,209	49.5 (47.3–51.6)	20.8 (18.8–23.1)
California	11,508	56.0 (54.5–57.4)	32.3 (30.8–33.8)
Colorado	13,491	64.2 (63.0–65.4)	36.8 (35.4–38.3)
Connecticut	7,613	55.7 (53.8–57.5)	25.9 (23.9–27.9)
Delaware	5,152	58.7 (56.7–60.7)	27.0 (24.7–29.4)
District of Columbia	4,842	57.7 (55.1–60.2)	31.8 (29.0–34.7)
Florida	33,788	51.2 (49.9–52.5)	18.6 (17.4–19.9)
Georgia	8,051	55.0 (53.4–56.7)	25.2 (23.5–26.9)
Hawaii	7,788	55.5 (53.7–57.3)	20.7 (19.0–22.5)
Idaho	5,575	56.9 (54.8–58.9)	27.1 (25.0–29.4)
Illinois	5,586	54.8 (52.8–56.8)	27.9 (25.8–30.0)
Indiana	10,241	56.3 (54.9–57.6)	24.8 (23.3–26.4)
Iowa	8,095	65.5 (64.0–67.0)	35.5 (33.7–37.4)
Kansas	23,140	63.9 (63.1–64.7)	35.1 (34.1–36.1)
Kentucky	10,934	56.4 (54.8–57.9)	25.7 (24.1–27.4)
Louisiana	5,208	55.8 (53.4–58.1)	21.5 (19.1–24.0)
Maine	8,032	69.0 (67.6–70.5)	37.2 (35.3–39.1)
Maryland	12,838	59.0 (57.6–60.5)	27.0 (25.4–28.6)
Massachusetts	14,917	67.1 (65.7–68.4)	37.8 (36.1–39.6)
Michigan	12,647	60.0 (58.8–61.3)	27.6 (26.3–28.9)
Minnesota	14,182	73.1 (71.6–74.6)	47.6 (45.5–49.6)
Mississippi	7,401	48.3 (46.5–50.2)	17.7 (16.0–19.5)
Missouri	7,056	59.8 (58.0–61.7)	28.8 (26.7–31.0)
Montana	9,641	59.1 (57.6–60.5)	33.3 (31.7–35.0)
Nebraska	17,021	60.2 (58.9–61.5)	32.4 (30.9–34.0)
Nevada	5,047	47.8 (45.0–50.6)	21.6 (19.0–24.3)
New Hampshire	6,384	69.3 (67.6–71.0)	41.3 (39.1–43.6)
New Jersey	13,186	48.5 (47.0–50.0)	19.6 (18.3–20.9)
New Mexico	9,226	59.0 (57.4–60.6)	33.1 (31.3–34.9)
New York	8,812	55.1 (53.5–56.6)	24.6 (23.0–26.3)
North Carolina	8,769	64.1 (62.6–65.6)	36.0 (34.2–37.8)
North Dakota	7,731	68.6 (67.0–70.1)	40.3 (38.2–42.4)
Ohio	11,853	56.6 (55.1–58.0)	26.3 (24.9–27.9)

	Sample size	Td vaccination coverage	Tdap vaccination coverage
State		% (95% CI)	% (95% CI)
Oklahoma	8,202	57.2 (55.7–58.7)	29.1 (27.5–30.9)
Oregon	5,909	60.5 (58.6–62.4)	35.5 (33.4–37.7)
Pennsylvania	11,309	59.3 (57.9–60.6)	28.2 (26.7–29.7)
Rhode Island	6,455	61.8 (59.9–63.6)	35.4 (33.3–37.7)
South Carolina	10,603	58.1 (56.6–59.6)	24.6 (23.0–26.3)
South Dakota	6,860	64.8 (62.7–66.8)	36.2 (33.7–38.9)
Tennessee	5,755	52.8 (50.7–54.9)	26.7 (24.6–28.8)
Texas	10,788	56.6 (55.0–58.3)	26.3 (24.7–28.1)
Utah	12,649	59.9 (58.7–61.1)	36.9 (35.6–38.3)
Vermont	6,324	72.6 (71.1–74.2)	47.6 (45.5–49.7)
Virginia	8,377	59.7 (58.1–61.3)	31.5 (29.7–33.4)
Washington	11,065	65.6 (64.2–66.9)	47.0 (45.4–48.5)
West Virginia	5,854	55.1 (53.4–56.7)	22.1 (20.4–23.8)
Wisconsin	6,522	70.3 (68.3–72.2)	43.7 (41.3–46.1)
Wyoming	6,370	56.1 (54.2–58.0)	27.8 (25.8–29.9)
<i>range</i>		47.8–73.1	17.7–47.6