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Seasonal influenza vaccination coverage trends among adult populations, United States, 2010–2016

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Abstract

Background: Influenza is a major cause of morbidity and mortality among adults. The most effective strategy for preventing influenza is annual vaccination. However, vaccination coverage has been suboptimal among adult populations.

Purpose: To assess trends in influenza vaccination among adult populations.

Methods: Data from the 2010–2016 National Health Interview Survey were analyzed in 2018 to estimate vaccination coverage during the 2010–11 through 2015–16 seasons. Trends of vaccination in recent years were assessed. Vaccination coverage by race/ethnicity within each group was assessed. Multivariable logistic regression and predictive marginal models were conducted to assess factors associated with vaccination, and interactions between race/ethnicity and other demographic and access-to-care characteristics were assessed.

Results: Vaccination coverage among adults aged ≥18 years increased from 38.3% in the 2010–11 to 43.4% in the 2015–16 season, with an average increase of 1.3 percentage points annually. From the 2010–11 through 2015–16 seasons, coverage was stable for adults aged ≥65 years, and changed by –0.1–9.9 percentage points for all other subgroups examined. Coverage in 2015–16 was 70.4% for adults aged ≥65 years, 46.4% for those aged 50–64 years, and 32.3% for those aged 18–49 years; 47.9% for persons aged 18–64 years with high-risk conditions; 64.8% for HCP; and 50.3% for pregnant women. Among adults aged ≥18 years for the 2015–16 season, coverage was

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significantly lower among non-Hispanic blacks and Hispanics compared with non-Hispanic whites.

Conclusions: Overall, influenza vaccination coverage among adults aged ≥ 18 years increased during 2010–2016 but still remained below the national target of 70%. Vaccination coverage varied by age, risk status, race/ethnicity, and HCP and pregnancy status. Targeted efforts are needed to improve coverage and reduce disparities.

Keywords

influenza vaccine; health care personnel; vaccination; coverage; high-risk conditions; pregnant women; trends

Introduction

Annual influenza epidemics typically occur during the late fall through early spring in the United States. Influenza is a major cause of morbidity and mortality among adults.^{1–4} The Centers for Disease Control & Prevention (CDC) estimates that influenza has resulted in between 140,000 and 960,000 hospitalizations annually since 2010.² Influenza-associated respiratory & circulatory (R&C) deaths have ranged from a low of 12,000 (during 2011–12) to a high of 79,000 (during 2017–18).² Influenza illness burden among healthy adults aged 18–49 years is an important cause of outpatient medical visits and loss of workdays.^{5, 6} Influenza vaccination is a cost-effective tool for reducing morbidity and mortality associated with influenza among adults.^{5, 7–19} Since the 2010–11 influenza season, the Advisory Committee on Immunization Practices (ACIP) has recommended annual influenza vaccination for all persons aged ≥ 6 months.¹

Influenza vaccination by race/ethnicity, access-to-care, and other factors among adults were reported previously indicating that vaccination coverage was suboptimal.^{1, 20–26} However, trends of vaccination coverage in recent years and assessment of factors independently associated with vaccination using recent data are limited.^{1, 20–26} The objective of this study is to examine the following questions using the 2010–2016 National Health Interview Survey (NHIS): (1) What is the influenza vaccination coverage among adult populations in the 2015–16 season? (2) What are the coverage trends for recent years among persons aged ≥ 18, 18–49, 50–64, ≥ 65 years, those with high-risk conditions, health care personnel (HCP), and pregnant women? Does vaccination coverage significantly increase or plateau in recent years? (3) What kinds of factors are independently associated with vaccination in recent years among adults aged ≥ 18 years?

Methods

Data from the 2010–2016 NHIS were analyzed in 2018. The NHIS is a national cross-sectional household survey conducted by the U.S. Census Bureau for CDC's National Center for Health Statistics.²⁷ The survey samples civilian, non-institutionalized populations living in the United States at the time of the survey. Face-to-face interviews are conducted weekly throughout the year among a probability sample of U.S. households. Final response rates for the core survey sample of adults ranged from 54.3% in 2016 to 66.3% in 2011.^{28, 29}

Seasonal influenza vaccination status was assessed by asking respondents whether they had received influenza vaccine during the past 12 months and in what month and year the vaccine was received. High-risk persons were defined as individuals who self-reported one or more of the following: ever being told by a physician they had diabetes, emphysema, chronic obstructive pulmonary disease (COPD), coronary heart disease, angina, heart attack, or other heart condition; being diagnosed with cancer in the past 12 months (excluding non-melanoma skin cancer) or ever being told by a physician they had lymphoma, leukemia, or blood cancer; during the past 12 months, being told by a physician they had chronic bronchitis or weak or failing kidneys; or reporting an asthma episode or attack in the past 12 months.^{1, 19, 24} Information on COPD was not collected in the NHIS during 2010–2011. Persons with those high-risk conditions are at increased risk for severe complications from influenza.^{1, 19, 24}

The sample of pregnant women for this analysis included female respondents aged 18–49 years who would have been pregnant at any time during August–March of each respective influenza season. HCP were defined as adults aged ≥ 18 years who reported they currently volunteered or worked in a hospital, medical clinic, doctor’s office, dentist’s office, nursing home, or some other health care facility, including part-time and unpaid work in a health care facility as well as professional nursing care provided in the home.

SUDAAN software (Research Triangle Institute, Research Triangle Park, NC, version 11.0.1), a statistical tool for complex sample surveys, was used to calculate point estimates and 95% confidence intervals (CIs). The sample population of this study was described. In bivariate analyses, influenza vaccination coverage among adults was stratified by demographic and access-to-care characteristics. To better assess influenza vaccination coverage for each season, analysis of season-specific coverage was restricted to individuals interviewed during August through June, and vaccinated during July–May, using the Kaplan-Meier survival analysis procedure. For example, respondents interviewed during August 2015 through June 2016 were analyzed to estimate influenza vaccination received during July 2015 through May 2016. For the Kaplan-Meier survival analysis, vaccination month is the time-to-event variable. Time-to-event variable considered censored if a person was not vaccinated by month of interview, or person vaccinated in same month as interviewed. Time-to-event variable is considered not censored if a person was vaccinated in a month prior to month of interview. *T*-tests for linear trends in recent years were conducted for each group, and for comparison between persons with and without high-risk conditions. All analyses were weighted to reflect the age, sex, and race/ethnicity of the U.S. non-institutionalized, civilian population. Multivariable logistic regression and predictive marginal models were used to generate adjusted vaccination coverage and prevalence ratios, and identify variables independently associated with influenza vaccination. The variables selected in the model were covariates which may be associated with vaccination coverage empirically or based on previous studies.^{20–24} For multivariable logistic regression, the data were restricted to individuals interviewed during August 2015 through June 2016, and the outcome variable was whether individuals received influenza vaccination in the past 12 months or not. Overall, 8.1% of participants are missing from logistic regression model. Interactions between race/ethnicity and other demographic and access-to-care characteristics were assessed. All tests were 2-tailed with the significance level set at $\alpha < 0.05$.

In the 2010–11 through the 2015–16 seasons, the NHIS analytic sample size ranged from 28,445 to 33,126 adults. Individuals who refused to answer the influenza vaccination question or did not know their vaccination status (about 1.6% annually) were excluded from the analysis. Vaccination month and year were imputed for individuals who reported they received vaccination but did not report their month and year of vaccination (about 3.8% annually).

Results

Sample characteristics of the study population by age and high-risk status are given in Table 1. During the 2010–11 through 2015–16 influenza seasons, the prevalence of high-risk conditions ranged from 13.0% to 14.0%, and 30.8% to 31.9% for adults aged 18–49 years and 50–64 years, respectively. During the 2010–11 through 2015–16 influenza seasons, the proportion of persons in the samples who were classified as HCP ranged from 8.1% to 8.7%. The proportion of pregnant women (18–49 years) among the adult (aged 18 years) population was 2.0% for all influenza seasons assessed (Table 1).

Overall, influenza vaccination coverage among adults aged 18 years, 18–64 years, and 18–49 years increased significantly from 38.3%, 31.7%, and 26.3%, respectively in the 2010–11 season to 43.4%, 36.8%, and 32.3%, respectively in the 2015–16 season, with respective annual average percentage point increases of 1.3%, 1.2%, and 1.4% (test for trend, $P<0.05$) (Table 2, Appendix Figure 1). Among adults aged 18 years, annual average percentage point increases were 1.2% for non-Hispanic whites, 1.4% for non-Hispanic blacks, and 1.1% for Hispanics (Table 2, Appendix Figure 2). Coverage for adults aged 50–64 and 65 years was stable (test for trend, $P>0.05$).

Among adults with high-risk conditions, influenza vaccination coverage for adults aged 18–64 years, 18–49 years, and 50–64 years was stable during the 2010–11 through 2015–16 seasons (test for trend, $P>0.05$) (Table 2, Appendix Figure 1). Among adults without high-risk conditions, influenza vaccination coverage for adults aged 18–64 years and those aged 18–49 years significantly increased from 28.3% and 24.5%, respectively, in the 2010–11 season to 34.1% and 31.6%, respectively, in the 2015–16 season, with a respective annual average percentage point increase of 1.5%, and 1.7% (test for trend, $P<0.05$) (Table 2, Appendix Figure 1). For all years, within each age group, vaccination coverage was significantly lower among those without high-risk conditions compared with those with high-risk conditions (Table 2, Appendix Figure 1).

Influenza vaccination coverage for the 2015–16 season was 64.8% for HCP and 50.3% for pregnant women (Table 2). Linear trends for both groups were not statistically significant (Table 2, Appendix Figure 1). Among HCP, coverage increased from 55.9% in 2010–11 to 61.6% in 2011–12 and 66.9% in 2012–2013, and then ranged from 64.8 to 68.6 in subsequent seasons.

Influenza vaccination coverage for the 2015–16 season by race and ethnicity, age group, and high-risk status are shown in Table 3. For the 2015–16 season, vaccination coverage was significantly lower for non-Hispanic blacks compared with non-Hispanic whites among

those aged 18 years (39.7% versus 46.1%, respectively) and 65 years (65.1% versus 72.0%, respectively) (Table 3). Coverage for the 2015–16 season among adults aged 18–64 years with high-risk conditions was similar across racial/ethnic groups. Vaccination coverage was significantly lower for Hispanics compared with non-Hispanic whites in all age sub-groups and among persons who reported having no high-risk conditions (Table 3). For the 2015–16 season, influenza vaccination coverage among HCP was significantly lower for non-Hispanic black HCP (56.7%) compared with non-Hispanic white HCP (66.7%) (Table 3). For the 2015–16 season, influenza vaccination coverage among pregnant women was significantly lower for non-Hispanic black (31.3%) and Hispanic pregnant women (36.1%) compared with non-Hispanic white pregnant women (63.6%) (Table 3).

Three interactions including race/ethnicity and age group, race/ethnicity and educational level, and race/ethnicity and the U.S.-born status were significant in the multivariable logistic model. Multivariable analysis showed that, when three interactions were also adjusted in the model, characteristics independently associated with increased likelihood of vaccination among adults aged 18 years were Asian race (among those aged 18–64 years, those with less than college education, or those who were born in the U.S. or born outside of the U.S. and stayed in the U.S. 10 years), being married, not being employed, having 1 physician contact within the past year, being hospitalized in the past 12 months, having high-risk conditions, having a usual place for health care, having health insurance, and being an HCP (Table 4). Blacks and Hispanics were less likely to be vaccinated (among those aged 65 years, those with some college or college education, or those who were born in the U.S.) (Table 4).

Discussion

Overall, influenza vaccination coverage among adults aged 18 years increased during these survey seasons but was still below the national target of 70%.³⁰ Vaccination coverage varied widely by age, risk status, race/ethnicity, and HCP and pregnancy status. Vaccination coverage among all groups recommended for vaccination remains suboptimal, including HCP and pregnant women. Targeted efforts are needed to improve coverage and reduce disparities.

By the 2015–16 season (five seasons after annual influenza vaccination was recommended for all adults), vaccination coverage among adults aged 18 years was 43.4%, with vaccination coverage estimates steadily increasing from the 2010–11 through the 2015–16 seasons. Vaccination coverage also increased steadily during 2010–11 through 2015–16 among healthy adults (those without high-risk conditions) aged 18–49 years, with an annual average increase of 1.7 percentage points. In 2010, healthy adults aged 18–49 years were included for the first time among those for whom annual vaccination is recommended by ACIP.¹ This group was added given the substantial morbidity and economic impact of influenza in working-age adults.^{5, 6, 12} Previous studies indicated that higher vaccination coverage could have prevented a substantial number of influenza cases and hospitalizations.^{31, 32}

Influenza vaccination coverage among adults aged 18–64 years with high-risk conditions remains suboptimal. In 2015–16, only 47.9% had received the vaccination, and vaccination coverage did not significantly increase during the 2010–11 through 2015–16 influenza seasons. There may be several factors associated with lower influenza vaccination coverage among adults with high-risk conditions. There might not be a preexisting relationship between state immunization programs and providers who serve adults at high risk. Persons with underlying health conditions might not consider themselves as high risk, limiting the effectiveness of targeted messages. Finally, many people with high-risk conditions see subspecialists, but subspecialists are less likely to recommend influenza vaccination than general practitioners.^{20, 33–35} Additionally, one previous study showed that 90% of unvaccinated high-risk individuals may have missed at least one potential opportunity for receiving vaccination,³⁶ which could result in lower vaccination coverage and put those unvaccinated individuals at risk.^{25, 36} Even though the influenza vaccination recommendation was expanded to include all persons aged ≥ 6 months in the 2010–11 season, the ACIP continued to emphasize that persons with high-risk conditions should be a focus of vaccination efforts.¹

Our study showed that vaccination coverage for adults aged ≥ 65 years has plateaued in recent years. The lack of change in influenza vaccination coverage in this age group indicates that new approaches are needed to increase influenza vaccination. One study indicated that adults aged ≥ 65 years are more likely to receive their influenza vaccination in a clinical setting than younger adults.³⁷ An increase in vaccination in alternative settings (e.g., community immunizers, health department clinics, pharmacies, and educational settings) may help improve influenza vaccination; however, individuals must be motivated to seek out vaccination. A provider's recommendation remains one of the most important determinants of vaccination. However, one recent study indicated that only about 51% of adults aged ≥ 65 years received a vaccination recommendation from a provider.³⁸ Adults aged ≥ 65 years are likely to be at highest risk of influenza complications and more likely to have a chance to visit a doctor.¹

Findings from this study showed that, for persons aged ≥ 18 years, influenza vaccination among non-Hispanic whites, non-Hispanic blacks, Hispanics, and others significantly increased over these survey seasons, but in the 2015–16 season racial/ethnic disparities, especially vaccination differences between older Hispanics and non-Hispanic blacks compared with whites, still remained. Racial/ethnic disparities in influenza vaccination have been described in previous studies.^{21–22, 25, 39} Multiple factors likely contribute to racial and ethnic differences in adult vaccination, including differences in attitudes toward vaccination and preventive care, propensity to seek and accept vaccination, variations in the likelihood that providers recommend vaccination, differences in quality of care received by racial and ethnic populations, differences in access to healthcare, differences in concerns about vaccination, including vaccine safety^{21–22, 25, 39–42}, and differences in perceived discrimination in the healthcare system.⁴³

Substantial improvement in annual influenza vaccination of adults is needed to maximally reduce the health impact of influenza. Primary care providers, subspecialists, and pharmacists should routinely recommend and offer vaccinations when all adult patients

access the medical system.⁴⁴ Use of standing-order programs can help reduce the number of missed opportunities for vaccination of individuals who have already accessed the medical system and should be instituted in all health care settings, including inpatient and outpatient settings.⁴⁴ Incorporating the standards of practice for adult immunizations, which include routinely assessing vaccination needs during clinical encounters, providing a strong recommendation for vaccination to patients in need of vaccines, and then offering vaccination at the visit, can have a significant impact on coverage and reduce disparities.⁴⁴

Additionally, several demographic and access-to-care characteristics such as employment, number of physician contacts in the past 12 months, hospitalization status, having high-risk conditions, having a usual place for health care, having health insurance, and being HCP were independently associated with vaccination in this study, similar to findings from previous reports.^{36, 38–41, 44} Intervention programs should target groups where vaccination coverage was low.

Influenza vaccination coverage ranged 56–69% among HCP over six seasons, and coverage among HCP was only 64.8% in 2015–16, well below the *Healthy People 2020* target of 90%.³⁰ Employers and health care administrators should implement evidence-based interventions to increase influenza vaccination coverage among HCP, including on-site vaccination at no or low cost to HCP.^{45, 46} The highest influenza vaccination coverage among HCP continues to be reported in worksites with employer requirements for vaccination.⁴⁷ Such requirements could significantly improve influenza vaccination coverage among HCP.⁴⁶ Additional approaches include electronic tracking of coverage levels by ward, unit, and occupation; a mandatory declination policy; mask-wearing for non-vaccinated HCP; highly visible acknowledgement of vaccinated HCP; weekly compliance reports to managers and other administrators; disciplinary measures for noncompliant HCP; vaccination stations at facility entrances; and employee financial incentives for achieving high facility vaccination rates.^{45–48}

Vaccination could help protect pregnant women and also protect their baby for several months after birth.⁴⁹ However, only half of pregnant women reported receiving influenza vaccination during the 2015–16 season. Pregnant women's low awareness of their increased risk for complications from influenza infection and misconceptions about vaccination safety and effectiveness have been reported as barriers to vaccination uptake.^{50–52} Lower coverage among non-Hispanic black or Hispanic women compared with white women might be partly because of differences in socio-economic norms and differences in access to vaccines and healthcare services.^{50, 52, 53} Provider recommendations and offers of vaccination have been reported as the strongest predictor for vaccination acceptance among pregnant women.⁴⁸ Positive attitudes toward and advocacy of influenza vaccination among physicians may facilitate counseling, discussion, and recommendation of vaccination to pregnant women and help increase vaccination acceptance and uptake.⁵⁴

In the 2015–16 season, coverage from NHIS (43.0% for adults aged 18 years, 64.8% for HCP, and 50.3% for pregnant women) differ from other estimates based on surveys including Behavioral Risk Factor Surveillance System (BRFSS) (41.7% for adults aged 18 years), and Internet panel surveys (IPS) for pregnant women (49.9%) and healthcare

personnel (79.0%).²⁹ Differences in estimates across these surveys might be due to different sampling frame, survey mode, survey questions, order of survey questions, operations, response rates, and weighting.⁵⁵

Several limitations should be considered in interpreting these results. First, information on influenza vaccination was self-reported and may be subject to recall bias. However, self-reported seasonal influenza vaccination status has been shown to have relatively high agreement with vaccination status ascertained from medical records.^{56–59} Second, high-risk conditions were self-reported and not validated by medical record. Third, the analyses in this study generated results that are associative and not causal. Fourth, the sampling redesign of the 2016 NHIS may have impact on influenza vaccination coverage estimates. Finally, other factors associated with vaccination were not measured by the NHIS (e.g., concerns of vaccine safety or effectiveness) and could not be ascertained in this analysis.

Influenza vaccination coverage among persons aged 18 years, HCP, and pregnant women remained suboptimal. Vaccination coverage varied by age, risk status, race/ethnicity, and HCP and pregnancy status. Substantial improvement in annual influenza vaccination is needed to maximally reduce the health impact of influenza. Expanded access through greater use of complimentary settings and vaccine providers,⁴⁴ and better use of evidence-based practices at medical sites (e.g., standing orders, and reminder/recall notification) are important to improve influenza vaccination coverage further.⁴⁶

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1. Characteristics of participants aged 18 years during the 2010-2011 through 2015-2016 influenza seasons

Subgroup and age group (years)	Influenza season ^a																																																																																																																																																																																																																											
	2010-2011		2011-2012		2012-2013		2013-2014		2014-2015		2015-2016																																																																																																																																																																																																																	
	No. of Persons	Weighted %	No. of Persons	Weighted %	No. of Persons	Weighted %	No. of Persons	Weighted %	No. of Persons	Weighted %	No. of Persons	Weighted %																																																																																																																																																																																																																
All participants													18	28,445	100.0	30,194	100.0	31,077	100.0	33,126	100.0	32,790	100.0	29,345	100.0	18-64	22,574	82.9	23,835	82.5	24,233	81.9	25,555	81.4	24,839	81.0	21,602	80.4	18-49	15,635	57.5	16,094	56.7	16,268	56.0	17,008	55.4	16,385	55.1	14,021	54.8	50-64	6,939	25.4	7,741	25.7	7,965	25.9	8,547	25.9	8,454	25.9	7,581	25.6	65	5,871	17.1	6,359	17.5	6,844	18.1	7,571	18.6	7,951	19.0	7,743	19.6	Race/ethnicity (aged 18 years)													Non-Hispanic White	16,568	68.2	17,954	67.1	18,542	66.3	20,321	66.0	20,368	65.3	19,406	64.5	Non-Hispanic Black	4,351	11.3	4,430	11.4	4,510	11.4	4,562	11.5	4,310	11.6	3,472	11.6	Hispanic	5,163	13.8	5,327	14.6	5,406	15.0	5,490	15.0	5,489	15.4	4,044	15.7	Other	2,363	6.6	2,483	6.9	2,619	7.3	2,753	7.4	2,623	7.7	2,423	8.2	Person with high-risk conditions ^b													18-64	4,478	19.5	4,704	19.1	4,853	18.9	5,175	19.0	5,021	18.9	4,389	18.9	18-49	2,178	14.0	2,184	13.6	2,264	13.4	2,352	13.5	2,257	13.0	1,927	13.0	50-64	2,300	31.9	2,520	31.3	2,589	30.8	2,823	30.9	2,764	31.3	2,462	31.4	Health-care personnel (18 years) ^c	2,300	8.2 ^d	2,541	8.5 ^d	2,597	8.7 ^d	2,651	8.2 ^d	2,646	8.4 ^d	2,458	8.1 ^d	Pregnant women (18-49 years) ^e	NA	NA	NA	NA	697	2.0 ^f	712	2.0 ^f	655	2.0 ^f	559	2.0 ^f
18	28,445	100.0	30,194	100.0	31,077	100.0	33,126	100.0	32,790	100.0	29,345	100.0																																																																																																																																																																																																																
18-64	22,574	82.9	23,835	82.5	24,233	81.9	25,555	81.4	24,839	81.0	21,602	80.4																																																																																																																																																																																																																
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50-64	6,939	25.4	7,741	25.7	7,965	25.9	8,547	25.9	8,454	25.9	7,581	25.6																																																																																																																																																																																																																
65	5,871	17.1	6,359	17.5	6,844	18.1	7,571	18.6	7,951	19.0	7,743	19.6																																																																																																																																																																																																																
Race/ethnicity (aged 18 years)													Non-Hispanic White	16,568	68.2	17,954	67.1	18,542	66.3	20,321	66.0	20,368	65.3	19,406	64.5	Non-Hispanic Black	4,351	11.3	4,430	11.4	4,510	11.4	4,562	11.5	4,310	11.6	3,472	11.6	Hispanic	5,163	13.8	5,327	14.6	5,406	15.0	5,490	15.0	5,489	15.4	4,044	15.7	Other	2,363	6.6	2,483	6.9	2,619	7.3	2,753	7.4	2,623	7.7	2,423	8.2	Person with high-risk conditions ^b													18-64	4,478	19.5	4,704	19.1	4,853	18.9	5,175	19.0	5,021	18.9	4,389	18.9	18-49	2,178	14.0	2,184	13.6	2,264	13.4	2,352	13.5	2,257	13.0	1,927	13.0	50-64	2,300	31.9	2,520	31.3	2,589	30.8	2,823	30.9	2,764	31.3	2,462	31.4	Health-care personnel (18 years) ^c	2,300	8.2 ^d	2,541	8.5 ^d	2,597	8.7 ^d	2,651	8.2 ^d	2,646	8.4 ^d	2,458	8.1 ^d	Pregnant women (18-49 years) ^e	NA	NA	NA	NA	697	2.0 ^f	712	2.0 ^f	655	2.0 ^f	559	2.0 ^f																																																																														
Non-Hispanic White	16,568	68.2	17,954	67.1	18,542	66.3	20,321	66.0	20,368	65.3	19,406	64.5																																																																																																																																																																																																																
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Person with high-risk conditions ^b													18-64	4,478	19.5	4,704	19.1	4,853	18.9	5,175	19.0	5,021	18.9	4,389	18.9	18-49	2,178	14.0	2,184	13.6	2,264	13.4	2,352	13.5	2,257	13.0	1,927	13.0	50-64	2,300	31.9	2,520	31.3	2,589	30.8	2,823	30.9	2,764	31.3	2,462	31.4	Health-care personnel (18 years) ^c	2,300	8.2 ^d	2,541	8.5 ^d	2,597	8.7 ^d	2,651	8.2 ^d	2,646	8.4 ^d	2,458	8.1 ^d	Pregnant women (18-49 years) ^e	NA	NA	NA	NA	697	2.0 ^f	712	2.0 ^f	655	2.0 ^f	559	2.0 ^f																																																																																																																																															
18-64	4,478	19.5	4,704	19.1	4,853	18.9	5,175	19.0	5,021	18.9	4,389	18.9																																																																																																																																																																																																																
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50-64	2,300	31.9	2,520	31.3	2,589	30.8	2,823	30.9	2,764	31.3	2,462	31.4																																																																																																																																																																																																																
Health-care personnel (18 years) ^c	2,300	8.2 ^d	2,541	8.5 ^d	2,597	8.7 ^d	2,651	8.2 ^d	2,646	8.4 ^d	2,458	8.1 ^d																																																																																																																																																																																																																
Pregnant women (18-49 years) ^e	NA	NA	NA	NA	697	2.0 ^f	712	2.0 ^f	655	2.0 ^f	559	2.0 ^f																																																																																																																																																																																																																

^a Estimates are based on interviews conducted during August-June for each influenza season (e.g., the 2010-2011 season included persons interviewed from August 2010 through June 2011, and vaccination received during July 2010-May 2011).

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^b Adults categorized as being at high risk for influenza-related complications reported 1 or more of the following: 1) ever being told by a physician that they had diabetes, emphysema, chronic obstructive pulmonary disease (COPD, starting from the 2012-13 season), coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding non-melanoma skin cancer) or ever being told by a physician that they had lymphoma, leukemia, or blood cancer; 3) being told by a physician that they had chronic bronchitis or weak or failing kidneys during the preceding 12 months; or 4) reporting an asthma episode or attack during the preceding 12 months. In addition, the weighted percentage is prevalence of high-risk conditions by age groups.

^c Adults were classified as health-care personnel if they reported they currently volunteer or work in a hospital, medical clinic, doctor's office, dentist's office, nursing home or some other health care facility including part-time and unpaid work in a health care facility as well as professional nursing care provided in the home.

^d Percentage of adults aged 18 years who were health-care personnel.

^e Adult women were classified as pregnant if they reported they were pregnant anytime during August through March for each influenza season. Data were not available for the 2010-11 and 2011-12 influenza seasons.

^f Percentage of pregnant women among adults aged 18 years.

Table 2. Influenza vaccination coverage among adults aged 18 years during the 2010–2011 through 2015–2016 influenza seasons

Subgroup and age group (years)	Influenza Season ^a												Total change% ^b	Average annual change % ^c
	2010-2011		2011-2012		2012-2013		2013-2014		2014-2015		2015-2016			
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI		
All participants														
18	38.3	(37.4-39.2)	39.4	(38.5-40.3)	42.6^d	(41.6-43.7)	42.9	(41.8-44.1)	44.6^d	(43.6-45.7)	43.4	(42.3-44.6)	5.1	1.3^e
18-64	31.7	(30.7-32.6)	32.7	(31.8-33.7)	36.1^d	(34.9-37.2)	36.5	(35.3-37.7)	37.7	(36.6-38.8)	36.8	(35.5-38.1)	5.1	1.2^e
18-49	26.3	(25.2-27.4)	27.3	(26.2-28.4)	30.5^d	(29.2-31.9)	31.3	(29.9-32.8)	32.5	(31.1-34.0)	32.3	(30.7-33.9)	6.0	1.4^e
50-64	43.8	(42.2-45.4)	44.8	(42.9-46.7)	48.0^d	(46.1-50.0)	47.7	(45.7-49.7)	48.7	(46.6-50.8)	46.4	(44.4-48.4)	2.6	0.7
65	70.4	(68.5-72.3)	70.2	(68.3-72.1)	71.6	(69.6-73.7)	71.5	(69.6-73.3)	73.5	(71.7-75.2)	70.4^d	(68.6-72.2)	0.0	0.3
Race/ethnicity (aged 18 years)														
Non-Hispanic White	41.1	(40.0-42.3)	42.5	(41.3-43.7)	46.5^d	(45.2-47.8)	46.4	(45.0-47.9)	48.2	(46.9-49.5)	46.1^d	(44.9-47.4)	5.0	1.2^e
Non-Hispanic Black	32.4	(29.8-35.1)	34.1	(31.9-36.5)	33.5	(30.8-36.3)	36.5	(34.2-38.9)	37.7	(35.2-40.3)	39.7	(36.4-43.2)	7.3	1.4^e
Hispanic	29.3	(27.5-31.2)	28.5	(26.3-30.9)	30.5	(28.4-32.8)	32.9	(30.6-35.4)	33.3	(31.2-35.5)	33.2	(30.1-36.6)	3.9	1.1^e
Other	37.8	(34.3-41.5)	40.9	(38.1-43.8)	46.7^d	(43.6-50.0)	42.6	(39.0-46.4)	47.3	(43.6-51.2)	46.7	(42.6-51.0)	8.9	1.8
Person with high-risk conditions ^g														
18-64	45.8^f	(43.3-48.4)	45.1^f	(42.8-47.5)	49.5^{d,f}	(47.2-51.9)	47.2^f	(44.9-49.6)	46.0^f	(43.5-48.5)	47.9^f	(45.2-50.7)	2.1	0.3
18-49	36.9^f	(33.5-40.5)	36.5^f	(33.1-40.2)	39.0^f	(35.8-42.4)	37.5^f	(34.2-41.1)	35.8^f	(32.6-39.1)	36.8^f	(33.2-40.6)	-0.1	-0.1
50-64	54.6^f	(51.2-58.1)	53.6^f	(50.6-56.7)	59.3^{d,f}	(55.8-62.8)	56.7^f	(53.7-59.7)	55.0^f	(51.3-58.8)	57.4^f	(53.7-61.1)	2.8	0.5
Person without high-risk conditions														
18-64	28.3	(27.3-29.3)	29.8^d	(28.8-30.9)	32.9^d	(31.6-34.2)	33.9	(32.6-35.3)	35.8^d	(34.6-37.0)	34.1	(32.7-35.6)	5.8	1.5^e
18-49	24.5	(23.5-25.6)	25.8	(24.7-27.0)	29.2^d	(27.8-30.7)	30.3	(28.8-31.9)	32.1	(30.6-33.6)	31.6	(29.9-33.3)	7.1	1.7^e

Subgroup and age group (years)	Influenza Season ^d										Total change% ^b	Average annual change % ^c		
	2010-2011		2011-2012		2012-2013		2013-2014		2014-2015				2015-2016	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI			%	95% CI
50-64	38.8	(36.9-40.7)	40.8	(38.4-43.2)	42.8	(40.5-45.2)	43.7	(41.3-46.0)	45.8	(43.3-48.4)	41.1 ^d	(38.7-43.5)	2.3	0.8
Health-care personnel (< 18 years) ^h	55.9	(52.8-59.0)	61.6 ^d	(58.5-64.7)	66.9 ^d	(63.4-70.3)	64.9	(60.5-69.3)	68.6	(65.0-72.2)	64.8	(61.2-68.4)	8.9	1.9
Pregnant women (18-49 years) ⁱ	NA	NA	NA	NA	40.4	(34.0-47.4)	45.4	(38.5-52.8)	43.1	(36.0-51.0)	50.3	(41.9-59.3)	9.9	2.6

Note: Boldface indicates statistical significance (P<0.05).

Abbreviation: CI, confidence interval

^a Estimates are based on interviews conducted during August-June for each influenza season (e.g., the 2010-2011 season included persons interviewed from August 2010 through June 2011, and vaccination received during July 2010-May 2011).

^b Total change from the 2010-2011 season to the 2015-2016 season. Change from the 2012-2013 to 2015-2016 seasons for pregnant women (data were not available prior to the 2012-13 season).

^c Average annual change from the 2010-2011 season to the 2015-2016 season, estimated by weighted linear regression. Change from the 2012-2013 to 2015-2016 seasons for pregnant women (data were not available prior to the 2012-13 season).

^d P< 0.05 for comparison with the previous season (t test for comparison between 2 seasons, with the prior season as the reference group- for example, 2011-2012 vs. 2010-2011, 2012-2013 vs. 2011-2012, 2013-2014 vs. 2012-2013, 2014-2015 vs. 2013-2014, and 2015-2016 vs. 2014-2015).

^e P< 0.05 for overall trend (L-iner trend test for trend from the 2010-2011 season through the 2015-2016 season).

^f P< 0.05 for comparison between high-risk and low-risk participants (t test for comparison between persons with high-risk conditions and persons without high-risk conditions within the same age group in each season).

^g Adults categorized as being at high risk for influenza-related complications reported 1 or more of the following: 1) ever being told by a physician that they had diabetes, emphysema, chronic obstructive pulmonary disease (COPD, starting from the 2012-13 season), coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding non-melanoma skin cancer) or ever being told by a physician that they had lymphoma, leukemia, or blood cancer; 3) being told by a physician that they had chronic bronchitis or weak or failing kidneys during the preceding 12 months; or 4) reporting an asthma episode or attack during the preceding 12 months.

^h Adults were classified as health-care personnel if they reported they currently volunteer or work in a hospital, medical clinic, doctor's office, dentist's office, nursing home or some other health care facility including part-time and unpaid work in a health care facility as well as professional nursing care provided in the home.

ⁱ Adult women were classified as pregnant if they reported they were pregnant anytime during August through March for each influenza season. Data were not available for 2010-11 and 2011-12 influenza seasons.

Table 3. Influenza vaccination coverage among adults 18 years during the 2015-2016 influenza season, by race/ethnicity ^a

Subgroup and age group (years)	Race/Ethnicity							
	Non-Hispanic White		Non-Hispanic Black		Hispanics		Other ^b	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
All participants								
18	46.1	(44.9-47.4)	39.7 ^c	(36.4-43.2)	33.2 ^c	(30.1-36.6)	46.7	(42.6-51.0)
18-64	38.2	(36.7-39.7)	35.3	(31.7-39.1)	30.1 ^c	(26.9-33.7)	42.3	(37.9-47.1)
18-49	33.3	(31.4-35.2)	31.3	(27.0-36.1)	27.5 ^c	(23.7-31.9)	37.0	(32.5-41.9)
50-64	46.7	(44.6-48.9)	44.7	(39.0-50.7)	39.7 ^c	(33.8-46.2)	56.4 ^c	(47.7-65.4)
65	72.0	(69.9-74.0)	65.1 ^c	(59.2-70.9)	60.0 ^c	(52.3-67.8)	74.2	(66.2-81.5)
Person with high-risk condition ^d								
18-64	47.8	(44.7-51.1)	48.8	(41.8-56.4)	46.3	(39.1-54.2)	50.6	(40.0-62.1)
18-49	37.8	(33.6-42.4)	39.5	(29.7-51.1)	33.1	(23.3-45.5)	34.9	(24.5-48.1)
50-64	55.6	(51.2-60.0)	57.3	(47.2-67.8)	60.6	(50.7-70.6)	67.4	(51.8-82.2)
Person without high-risk condition								
18-64	35.8	(34.1-37.5)	31.7	(27.9-35.9)	27.0 ^c	(23.3-31.2)	40.3	(35.9-45.1)
18-49	32.6	(30.5-34.7)	30.1	(25.6-35.3)	26.9 ^c	(22.8-31.5)	37.2	(32.4-42.3)
50-64	42.8	(40.2-45.4)	36.8	(30.0-44.5)	27.3 ^c	(21.1-35.0)	51.0	(40.9-62.0)
Health-care personnel (18 years) ^e	66.7	(62.7-70.6)	56.7 ^c	(47.8-66.0)	59.4	(47.4-71.8)	70.9	(56.4-84.0)
Pregnant women (18-49 years) ^f	63.6	(52.0-75.0)	31.3 ^c	(17.0-53.0)	36.1 ^c	(21.0-57.4)	42.5	(22.2-70.4)

Note: Boldface indicates statistical significance (P<0.05).

Abbreviation: CI, confidence interval

^aEstimates are based on interviews conducted during August 2015-June 2016 and vaccination received during July 2015-May 2016.

^bIncluded Asian, American Indian/Alaska Native, and multiple races.

^cP<0.05 for race/ethnicity (t test for comparison with non-Hispanic whites).

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^d Adults categorized as being at high risk for influenza-related complications reported 1 or more of the following: 1) ever being told by a physician that they had diabetes, emphysema, chronic obstructive pulmonary disease (COPD, starting from the 2012-13 season), coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding non-melanoma skin cancer) or ever being told by a physician that they had lymphoma, leukemia, or blood cancer; 3) being told by a physician that they had chronic bronchitis or weak or failing kidneys during the preceding 12 months; or 4) reporting an asthma episode or attack during the preceding 12 months.

^e Adults were classified as health-care personnel if they reported they currently volunteer or work in a hospital, medical clinic, doctor's office, dentist's office, nursing home or some other health care facility including part-time and unpaid work in a health care facility as well as professional nursing care provided in the home.

^f Adult women were classified as pregnant if they reported they were pregnant anytime during August through March.

Multivariable logistic regression analyses of persons 18 years who received influenza vaccination, 2015-2016 influenza season

Table 4.

Characteristic	Adjusted coverage % (95% CI) ^a	Prevalence ratio (95% CI) ^b
Age and race/ethnicity		
18-49		
Non-Hispanic White	34.0 (32.4-35.6)	Reference
Non-Hispanic Black	33.7 (30.6-37.0)	0.99 (0.90-1.10)
Hispanic	34.1 (31.2-37.1)	1.00 (0.91-1.10)
Asian	47.8 (41.5-54.1)	1.40 (1.22-1.62)^c
Other	32.8 (27.0-39.3)	0.97 (0.79-1.17)
50-64		
Non-Hispanic White	42.1 (40.2-44.0)	Reference
Non-Hispanic Black	38.4 (34.1-42.9)	0.91 (0.81-1.03)
Hispanic	38.9 (34.3-43.7)	0.92 (0.82-1.05)
Asian	53.7 (44.4-62.7)	1.28 (1.07-1.53)^c
Other	52.3 (42.2-62.2)	1.24 (1.02-1.52)
65		
Non-Hispanic White	59.5 (57.3-61.6)	Reference
Non-Hispanic Black	53.4 (48.5-58.1)	0.90 (0.82-0.98)^c
Hispanic	49.4 (43.8-54.9)	0.83 (0.74-0.93)^c
Asian	64.7 (55.9-72.7)	1.09 (0.95-1.25)
Other	59.3 (47.6-69.9)	1.00 (0.82-1.21)
Sex		
Male	42.0 (40.8-43.2)	0.99 (0.96-1.03)
Female	42.2 (41.1-43.4)	Reference
Marital status		
Married	44.3 (43.1-45.4)	1.14 (1.09-1.20)^c
Widowed/divorced/separated	40.8 (39.2-42.4)	1.05 (1.00-1.12)
Never married	38.7 (37.1-40.4)	Reference
Education and race/ethnicity		

Characteristic	Adjusted coverage % (95% CI) ^a	Prevalence ratio (95% CI) ^b
High school or less		
Non-Hispanic White	37.4 (35.7–39.1)	Reference
Non-Hispanic Black	36.6 (33.2–40.1)	0.98 (0.88–1.08)
Hispanic	38.9 (35.8–42.0)	1.04 (0.95–1.14)
Asian	49.0 (40.5–57.5)	1.31 (1.09–1.57)^c
Other	37.8 (30.5–45.7)	1.01 (0.82–1.24)
Some college or college graduate		
Non-Hispanic White	41.4 (40.0–42.8)	Reference
Non-Hispanic Black	38.0 (34.9–41.1)	0.92 (0.84–1.00)^c
Hispanic	37.3 (33.9–40.8)	0.90 (0.82–0.99)^c
Asian	54.4 (48.7–60.1)	1.31 (1.18–1.47)^c
Other	47.5 (40.8–54.3)	1.15 (0.99–1.33)
Above college graduate		
Non-Hispanic White	52.1 (49.6–54.6)	Reference
Non-Hispanic Black	50.2 (42.9–57.4)	0.96 (0.83–1.12)
Hispanic	42.8 (34.4–51.5)	0.82 (0.67–1.01)^c
Asian	54.9 (47.1–62.5)	1.05 (0.91–1.22)
Other	42.4 (30.2–55.5)	0.81 (0.59–1.11)
Employment status		
Employed	40.6 (39.5–41.7)	Reference
Not employed	44.5 (43.1–45.9)	1.10 (1.05–1.14)^c
Poverty level		
At or above poverty	42.3 (41.3–43.3)	1.04 (0.99–1.10)
Below poverty	40.7 (38.6–42.7)	Reference
Region		
Northeast	42.9 (40.7–45.2)	Reference
Midwest	41.7 (40.2–43.2)	0.97 (0.91–1.03)
South	41.8 (40.4–43.3)	0.97 (0.92–1.03)
West	42.3 (40.7–44.0)	0.99 (0.93–1.05)

Characteristic	Adjusted coverage % (95% CI) ^a	Prevalence ratio (95% CI) ^b
US born status and race/ethnicity		
U.S. born		
Non-Hispanic White	42.7 (41.7-43.8)	Reference
Non-Hispanic Black	38.0 (35.7-40.3)	0.89 (0.83-0.95)^c
Hispanic	38.6 (35.8-41.6)	0.90 (0.84-0.98)^c
Asian	53.7 (46.9-60.3)	1.26 (1.11-1.43)^c
Other	41.8 (36.8-47.0)	0.98 (0.86-1.11)
Born outside U.S.-- In U.S. < 10 yrs		
Non-Hispanic White	31.8 (21.7-43.9)	Reference
Non-Hispanic Black	53.1 (42.2-63.7)	1.67 (1.11-2.52)^c
Hispanic	39.1 (31.9-46.8)	1.23 (0.82-1.84)
Asian	41.9 (34.8-49.4)	1.32 (0.88-1.98)
Other	43.2 (19.2-70.9)	1.36 (0.64-2.87)
Born outside U.S.-- In U.S. 10 yrs		
Non-Hispanic White	34.9 (30.4-39.7)	Reference
Non-Hispanic Black	41.8 (33.2-50.9)	1.20 (0.93-1.54)
Hispanic	37.9 (34.6-41.3)	1.09 (0.93-1.27)
Asian	48.4 (43.7-53.1)	1.39 (1.18-1.63)^c
Other	52.3 (37.0-67.1)	1.50 (1.09-2.06)^c
Physician contacts within past year		
None	28.9 (26.9-31.1)	Reference
1	37.2 (35.4-39.0)	1.28 (1.18-1.40)^c
2-3	43.3 (41.8-44.8)	1.50 (1.38-1.62)^c
4-9	47.3 (45.6-49.0)	1.63 (1.50-1.78)^c
10	50.1 (47.9-52.4)	1.73 (1.58-1.89)^c
Hospitalization within past year		
Yes	46.9 (44.4-49.3)	1.13 (1.06-1.19)^c
No	41.6 (40.7-42.6)	Reference

Characteristic		Adjusted coverage % (95% CI) ^a	Prevalence ratio (95% CI) ^b
Usual place for health care			
	Yes	43.3 (42.3-44.2)	1.37 (1.26-1.48) ^c
	No	31.7 (29.2-34.3)	Reference
Health insurance			
	Yes	43.0 (42.0-43.9)	1.39 (1.27-1.53) ^c
	No	30.9 (28.1-33.8)	Reference
Healthcare personnel			
	Yes	65.1 (62.5-67.7)	1.63 (1.56-1.70) ^c
	No	39.9 (39.0-40.8)	Reference
Person with high-risk conditions^d			
	Yes	46.3 (44.7-47.9)	1.14 (1.09-1.18) ^c
	No	40.7 (39.7-41.7)	Reference

Note: Boldface indicates statistical significance (P<0.05).

^a Adjusted coverage, adjusted for all variables included in the table, and interactions including age groups and race/ethnicity, education and race/ethnicity, and the U.S.- born status and race/ethnicity.

^b Adjusted prevalence ratios, adjusted for all variables included in the table, and interactions including age groups and race/ethnicity, education and race/ethnicity, and U.S. born status and race/ethnicity.

^c P< 0.05 by *t* test for comparison within each covariate category with the indicated reference level.

^d Adults categorized as being at high risk for influenza-related complications reported 1 or more of the following: 1) ever being told by a physician that they had diabetes, emphysema, chronic obstructive pulmonary disease (COPD, starting from the 2012-13 season), coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding non-melanoma skin cancer) or ever being told by a physician that they had lymphoma, leukemia, or blood cancer; 3) being told by a physician that they had chronic bronchitis or weak or failing kidneys during the preceding 12 months; or 4) reporting an asthma episode or attack during the preceding 12 months.