

Practice of Epidemiology

Seasonal Influenza Vaccination Coverage Among Adult Populations in the United States, 2005–2011

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The most effective strategy for preventing influenza is annual vaccination. We analyzed 2005–2011 data from the National Health Interview Survey (NHIS), using Kaplan-Meier survival analysis to estimate cumulative proportions of persons reporting influenza vaccination in the 2004–2005 through 2010–2011 seasons for persons aged ≥ 18 , 18–49, 50–64, and ≥ 65 years, persons with high-risk conditions, and health-care personnel. We compared vaccination coverage by race/ethnicity within each age and high-risk group. Vaccination coverage among adults aged ≥ 18 years increased from 27.4% during the 2005–2006 influenza season to 38.1% during the 2010–2011 season, with an average increase of 2.2% annually. From the 2005–2006 season to the 2010–2011 season, coverage increased by 10–12 percentage points for all groups except adults aged ≥ 65 years. Coverage for the 2010–2011 season was 70.2% for adults aged ≥ 65 years, 43.7% for adults aged 50–64 years, 36.7% for persons aged 18–49 years with high-risk conditions, and 55.8% for health-care personnel. In most subgroups, coverage during the 2010–2011 season was significantly lower among non-Hispanic blacks and Hispanics than among non-Hispanic whites. Vaccination coverage among adults under age 65 years increased from 2005–2006 through 2010–2011, but substantial racial/ethnic disparities remained in most age groups. Targeted efforts are needed to improve influenza vaccination coverage and reduce disparities.

adults; high-risk conditions; influenza; influenza vaccine; vaccination; vaccination coverage

Abbreviations: BRFSS, Behavioral Risk Factor Surveillance System; CDC, Centers for Disease Control and Prevention; NHIS, National Health Interview Survey.

Influenza is a major cause of morbidity and mortality among adults in the United States (1–4). Annual epidemics of influenza typically occur during the late fall through early spring in the United States. Influenza viruses cause disease among persons in all age groups (1). Rates of serious illness and death are higher among adults aged ≥ 65 years, children younger than 2 years, pregnant women, and persons of any age who have medical conditions that place them at increased risk for influenza complications (1). The burden of influenza illness among healthy adults aged 18–49 years is an important cause of outpatient medical visits and loss of work days (5, 6), and the economic impact of influenza illness is substantial. One national study estimated the annual economic burden of seasonal influenza in the United States to be \$87.1 billion, including \$10.4 billion in direct medical costs (6). Influenza

vaccination has been shown to be a cost-effective tool for reducing morbidity and mortality associated with influenza among adults (5, 7–18).

Since the 2010–2011 influenza season, the Advisory Committee on Immunization Practices of the Centers for Disease Control and Prevention (CDC) has recommended annual influenza vaccination for all persons aged 6 months or older. Prior to 2010, the adult groups recommended for annual vaccination included persons aged 50 years or older, pregnant women, persons aged 18–49 years with medical conditions associated with higher risk of complications from influenza infection, health-care personnel, and close contacts of high-risk persons (19). Beginning in the 2010–2011 season, healthy adults aged 18–49 years who were not close contacts of persons at high risk were added to the list of persons recommended for annual

vaccination; the recommendation for adults aged 18–49 years was the major change made in the recommendations during the study period (1).

The most effective strategy for preventing influenza is annual vaccination. However, vaccination coverage has been suboptimal (1, 20–27). To assess the impact of the current adult influenza vaccination program in the United States and to identify strategies for improving vaccination coverage among adults, we analyzed data from the 2005–2012 National Health Interview Survey (NHIS). We assessed influenza vaccination coverage among adults by age, high-risk status, and racial/ethnic group.

MATERIALS AND METHODS

We estimated national influenza vaccination coverage among US adults using 2005–2011 NHIS data, and preliminary, early-release NHIS data from January–March 2012. The NHIS is a national cross-sectional household survey that is conducted by the CDC (26, 28). The survey samples civilian, noninstitutionalized populations living in the United States at the time of the survey. Face-to-face interviews are conducted weekly throughout the year with a probability sample of households. The NHIS provides estimates of health indicators, health-care utilization and access, and health-related behaviors, and minority racial/ethnic groups (blacks, Hispanics, and others) are oversampled to allow for more precise estimation of health characteristics in these growing minority populations (26, 28). Seasonal influenza vaccination status is assessed by asking respondents whether they have received seasonal influenza vaccine during the past 12 months and in what month and year the vaccine was received.

We defined high-risk individuals as persons who self-reported one or more of the following: ever being told by a physician that they had diabetes, emphysema, coronary heart disease, angina, a heart attack, or another heart condition; being diagnosed with cancer in the past 12 months (excluding nonmelanoma skin cancer) or ever being told by a physician that they had lymphoma, leukemia, or blood cancer; being told by a physician that they had chronic bronchitis or weak or failing kidneys in the past 12 months; or reporting an asthma episode or attack in the past 12 months. Race/ethnicity (self-identified) was defined as non-Hispanic white, non-Hispanic black, Hispanic, or other (including Asian, American Indian/Alaska Native, and multiracial).

Although female respondents were asked whether they were pregnant at the time of the interview, estimates of influenza vaccination among pregnant women were not assessed because of survey limitations. Because pregnancy status was determined at the time of interview, currently pregnant women who were not pregnant during the influenza season could not be distinguished from currently pregnant women who were pregnant during the influenza season, and women not pregnant at the time of the survey but pregnant during the influenza season could not be identified. Starting in 2012, the NHIS began collecting information on influenza vaccination before, during, and after a recent or current pregnancy. Other data sources that more specifically ascertain pregnancy status in relation to vaccination history are available (29–31).

During the 2004–2005 through 2008–2009 seasons, respondents were classified as health-care personnel if they were currently employed in a health-care occupation or in a health-care industry setting, based on standard occupation and industry groupings recoded into categories by the National Center for Health Statistics at the CDC. Health-care occupations included health diagnosis occupations, health assessment and treatment occupations, health technology occupations, and health service occupations. Health-care industry settings included hospitals, nursing or personal-care facilities, and the offices of physicians, dentists, chiropractors, optometrists, and other health-care practitioners. The National Center for Health Statistics categories of health-care personnel are described further by Walker et al. (25). From the 2009–2010 to 2010–2011 seasons, health-care personnel were defined as adults aged ≥ 18 years who reported currently volunteering or working in a hospital, medical clinic, physician's office, dentist's office, nursing home, or some other health-care facility, including part-time and unpaid work in a health-care facility and professional nursing care provided in a private home. The new definition we used in the 2009–2010 to 2010–2011 seasons is comparable to the definition we used in the 2004–2005 through 2008–2009 seasons (the agreement rate between these 2 health-care personnel definitions is approximately 95% based on the 2010–2011 NHIS data).

SUDAAN, version 10.01 (Research Triangle Institute, Research Triangle Park, North Carolina) was used to calculate point estimates and 95% confidence intervals. We assessed influenza vaccination among adult populations and according to race/ethnicity. To better assess influenza vaccination coverage for each season, we estimated results for coverage restricted to persons interviewed during the period September–June and vaccinated during August–May, using the Kaplan-Meier survival analysis procedure. For example, respondents interviewed during the period September 2010–June 2011 were analyzed to estimate influenza vaccination received during August 2010–May 2011. For the 2004–2005 season, estimates were based on interviews conducted during January–June 2005 and vaccination received during August 2004–May 2005 (starting in 2005, the month and year of influenza vaccination were included in the NHIS data), while for the preliminary 2011–2012 season estimates, we used interviews from September 2011–March 2012 and vaccination received during August 2011–February 2012 (interviews conducted during January–March 2012 were based on the 2012 NHIS early-release data). Vaccination status was determined using the reported month and year of the most recent vaccination as of the end of the month prior to interview.

We conducted *t* tests for linear trends in recent years for each subgroup (coverage in the 2004–2005 season was excluded from trend analysis, since a vaccine shortage occurred during the 2004–2005 season and coverage was substantially lowered). Racial/ethnic differences within each target group were assessed with *t* tests. All analyses were weighted to reflect the age, sex, and race/ethnicity of the US noninstitutionalized, civilian population. All *P* values from the *t* tests were 2-tailed, with the significance level set at $\alpha < 0.05$. A new weight variable was created based on how many months of interview data were included in the analyses. Since we restricted the data to persons interviewed during September–June for the 2005–2006 through

2010–2011 seasons and 10 months of interview data were included in the analyses, the new weight variable was defined as final weight \times (12/10), while for the 2004–2005 season, new weight was defined as final weight \times (12/6), and for the 2011–2012 season, new weight was defined as final weight \times (12/7).

Persons who refused to answer the influenza vaccination question or did not know their vaccination status (about 1.6% per season) were excluded from the analysis. Vaccination status was imputed for persons who said they had been vaccinated but did not report their month and year of vaccination (percentage points imputed ranged from 3% to 5% from the 2004–2005 season through the 2011–2012 season). Information was imputed from donor pools matched for week of interview, age group, region of residence, and race/ethnicity.

RESULTS

Sample characteristics of the study population by age and high-risk status are given in Table 1. Overall, during the 2004–2005 through 2011–2012 seasons, the size of the NHIS analytical sample ranged from 14,798 adults to 25,758 adults.

For all age groups and high-risk groups, vaccination coverage was substantially lower during the 2004–2005 season, in which a vaccine supply shortage occurred, than during the 2005–2006 season (Table 2). Influenza vaccination coverage among adults aged ≥ 18 years, 18–64 years, 18–49 years, and 50–64 years increased significantly from 27.4%, 20.0%, 15.2%, and 32.5%, respectively, during the 2005–2006 season to 38.1%, 31.5%, 26.1%, and 43.7%, respectively, during the 2010–2011 season, with annual average increases of 2.2%, 2.3%, 2.2%, and 2.3%, respectively (P -trend < 0.05) (Table 2). The test for linear trend in vaccination coverage from the 2005–2006 through 2010–2011 seasons among adults aged ≥ 65 years was not statistically significant. Among adults aged ≥ 65 years, seasonal vaccination coverage during the 2009–2010 season (66.5%) was significantly lower than coverage during the 2008–2009 (69.6%) and 2010–2011 (70.2%) seasons ($P < 0.05$) (Table 2, Figure 1).

Among adults with high-risk conditions, vaccination coverage for persons aged 18–64 years, 18–49 years, and 50–64 years increased significantly from 33.9%, 24.7%, and 44.3%, respectively, during the 2005–2006 season to 45.6%, 36.7%, and 54.4%, respectively, during the 2010–2011 season, with annual average increases of 2.4%, 2.4%, and 2.1%, respectively (P -trend < 0.05) (Table 2, Figure 1).

Among adults without high-risk conditions, vaccination coverage for persons aged 18–64 years, 18–49 years, and 50–64 years increased significantly from 16.9%, 13.7%, and 27.2%, respectively, during the 2005–2006 season to 28.1%, 24.3%, and 38.8%, respectively, during the 2010–2011 season (P -trend < 0.05) (Table 2). For all years, within each age group, coverage was significantly lower among persons without high-risk conditions than among those with high-risk conditions (Table 2).

Among health-care personnel, coverage increased significantly from the 2005–2006 season to the 2010–2011 season, with an annual average increase of 2.5% (P -trend < 0.05) (Table 2, Figure 1). Vaccination coverage for the 2009–2010 and 2010–2011 seasons among health-care personnel was

60.3% and 55.8%, respectively (Figure 1, Table 2). For the 2010–2011 season, influenza vaccination coverage among health-care personnel was significantly lower for Hispanics and non-Hispanic blacks than for non-Hispanic whites (Table 3).

Table 3 shows influenza vaccination coverage for the 2010–2011 season by race/ethnicity, age group, and high-risk status. Vaccination coverage among most adult subgroups was significantly lower for Hispanics and non-Hispanic blacks than for non-Hispanic whites (Table 3). Coverage during the 2010–2011 season among adults aged 18–64 years with high-risk conditions was similar across racial/ethnic groups.

Preliminary vaccination coverage for the 2011–2012 season is shown in Figure 1. Preliminary vaccination coverage estimates for the 2011–2012 season were similar to estimates for the 2010–2011 season among age and high-risk groups, except for an increase in coverage among health-care personnel from 55.8% (95% confidence interval: 52.8, 58.9) during the 2010–2011 season to 62.4% (95% confidence interval: 58.3, 66.6) during the 2011–2012 season.

DISCUSSION

Our study indicated that influenza vaccination coverage among adults significantly increased over 5 influenza seasons through 2010–2011 but varied by age group and whether respondents reported health conditions associated with risk for complications from influenza infection. Vaccination coverage among all groups recommended for vaccination (including health-care personnel) remains suboptimal. Coverage was lower than the 90% Healthy People 2020 target for persons aged 18–64 years with high-risk conditions, persons aged ≥ 65 years, and health-care personnel (32). Vaccination coverage was substantially lower for all age and high-risk groups during the 2004–2005 season due to the vaccine supply shortage which occurred during that season (33).

Overall, by the 2010–2011 season—the first season in which all adults were recommended for influenza vaccination—vaccination coverage among adults aged ≥ 18 years was 38%, with vaccination estimates steadily increasing from the 2005–2006 season through the 2010–2011 season. Coverage also increased steadily from the 2005–2006 season through the 2010–2011 season among healthy adults aged 18–49 years, the group added in 2010 to those for whom annual vaccination is recommended by the Advisory Committee on Immunization Practices (1). This group was added because of the known significant morbidity and economic impact of influenza in working-age adults (12). In addition, the universal vaccination recommendation also eliminates the need to determine whether a person has 1 or more specific indications for vaccination and emphasizes the importance of preventing influenza among persons of all ages (1). Continuing annual monitoring of vaccination coverage among adults aged ≥ 18 years is important to assess the impact of the vaccination program and to focus efforts on groups with lagging coverage.

Influenza vaccination uptake remains low among adults for whom vaccination has long been recommended, especially adults younger than 65 years who have high-risk medical conditions. In the 2010–2011 season, vaccination coverage among adults aged 18–64 years with high-risk conditions was only

Table 1. Characteristics of National Health Interview Survey Participants Aged ≥ 18 Years During the 2004–2005 Through 2010–2011 Influenza Seasons, by Age Group, High-Risk Status, and Employment in a Health-Care Field

Subgroup and Age Group, years	Influenza Season													
	2004–2005 ^a		2005–2006 ^b		2006–2007 ^b		2007–2008 ^b		2008–2009 ^b		2009–2010 ^b		2010–2011 ^b	
	No. of Persons	Weighted %	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	14,958	100.0	22,959	100.0	20,195	100.0	19,341	100.0	14,798	100.0	25,661	100.0	25,758	100.0
18–64	12,078	83.9	18,570	83.9	16,207	83.8	15,436	83.5	11,826	83.1	20,441	83.0	20,426	82.9
18–49	8,543	60.9	13,204	60.7	11,504	60.3	10,790	59.0	8,227	58.3	14,028	58.0	14,181	57.8
50–64	3,535	23.0	5,366	23.2	4,703	23.5	4,646	24.5	3,599	24.8	6,413	25.0	6,245	25.2
≥ 65	2,907	16.1	4,389	16.1	3,988	16.2	3,905	16.5	2,972	16.9	5,220	17.0	5,332	17.1
Persons with high-risk conditions ^c														
18–64	2,397	100.0	3,548	100.0	2,995	100.0	2,919	100.0	2,410	100.0	4,194	100.0	4,017	100.0
18–49	1,231	54.1	1,859	53.8	1,543	52.8	1,488	53.5	1,213	51.6	2,039	50.6	1,961	50.0
50–64	1,166	45.9	1,689	46.2	1,452	47.2	1,431	46.5	1,197	48.4	2,155	49.4	2,056	50.0
Persons without high-risk conditions														
18–64	9,660	100.0	14,979	100.0	13,177	100.0	12,479	100.0	8,769	100.0	16,208	100.0	15,570	100.0
18–49	7,296	76.9	11,313	76.5	9,943	76.1	9,281	74.6	6,374	72.1	11,962	74.7	11,544	74.2
50–64	2,364	23.1	3,666	23.5	3,234	23.9	3,198	25.4	2,395	27.9	4,246	25.3	4,026	25.8
Health-care personnel ^d (≥ 18 years)	1,020	6.8 ^e	1,638	6.9 ^e	1,484	7.2 ^e	1,490	7.6 ^e	1,185	7.6 ^e	1,860	7.8 ^e	2,112	8.2 ^e

^a Estimates are based on interviews conducted during January–June 2005.^b Estimates are based on interviews conducted during September–June for each influenza season (e.g., the 2005–2006 season included persons interviewed from September 2005 through June 2006).^c 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, coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding nonmelanoma 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.^d During the 2004–2005 through 2008–2009 influenza seasons, adults were classified as health-care personnel if they were aged ≥ 18 years and currently employed in a health-care occupation or in a health-care industry setting, on the basis of standard occupation and industry categories recoded into groups by the National Center for Health Statistics. From the 2009–2010 season to the 2010–2011 season, health-care personnel were defined as adults aged ≥ 18 years who currently volunteered or worked in a hospital, medical clinic, physician's office, dentist's office, nursing home, or some other health-care facility, including part-time and unpaid work in a health-care facility and professional nursing care provided in a private home.^e Percentage of adults aged ≥ 18 years who were health-care personnel.

Table 2. Influenza Vaccination Coverage Among Adults Aged ≥ 18 Years in the National Health Interview Survey During the 2004–2005 Through 2010–2011 Influenza Seasons, by Age Group, High-Risk Status, and Employment in a Health-Care Field

Subgroup and Age Group, years	Influenza Season														Total Change, % ^c	Average Annual Change, % ^d
	2004–2005 ^a		2005–2006 ^b		2006–2007 ^b		2007–2008 ^b		2008–2009 ^b		2009–2010 ^b		2010–2011 ^b			
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI		
All participants																
≥18	20.9	20.1, 21.7	27.4**	26.5, 28.3	30.2**	29.3, 31.1	33.0**	32.0, 33.9	35.2**	34.0, 36.4	36.9**	36.0, 37.9	38.1	37.2, 39.0	10.7	2.2*
18–64	13.1	12.5, 13.8	20.0**	19.2, 20.9	23.0**	22.1, 24.0	25.7**	24.8, 26.7	28.2**	27.0, 29.4	30.8**	29.8, 31.8	31.5	30.6, 32.5	11.5	2.3*
18–49	10.2	9.4, 11.0	15.2**	14.3, 16.1	17.5**	16.6, 18.6	19.3**	18.3, 20.3	22.4**	21.1, 23.8	25.3**	24.3, 26.4	26.1	25.0, 27.2	10.9	2.2*
50–64	21.0	19.6, 22.5	32.5**	30.5, 34.6	36.9**	35.0, 38.8	41.1**	39.1, 43.1	41.9	39.5, 44.3	43.3	41.6, 45.1	43.7	42.1, 45.3	11.2	2.3*
≥65	61.2	59.0, 63.5	66.0**	64.0, 68.0	67.7	65.6, 69.8	69.2	67.1, 71.3	69.6	67.3, 71.9	66.5**	64.5, 68.5	70.2**	68.2, 72.1	4.2	0.9
Persons with high-risk conditions ^e																
18–64	24.8***	22.9, 26.7	33.9***	31.6, 36.4	37.7***	35.2, 40.4	41.8***	39.2, 44.5	41.4***	38.6, 44.4	44.3***	41.8, 46.8	45.6***	43.1, 48.2	11.7	2.4*
18–49	17.6***	15.4, 20.1	24.7***	21.9, 27.9	26.5***	23.3, 30.1	31.9***	28.5, 35.6	31.9***	27.9, 36.2	34.9***	31.8, 38.3	36.7***	33.3, 40.3	12.0	2.4*
50–64	33.2***	30.2, 36.4	44.3***	40.6, 48.2	49.9***	46.2, 53.7	53.5***	50.0, 57.2	51.2***	47.3, 55.2	53.8***	50.4, 57.3	54.4***	51.0, 57.9	10.1	2.1*
Persons without high-risk conditions																
18–64	10.4	9.7, 11.1	16.9**	16.0, 17.8	19.9**	19.0, 20.9	21.9**	20.9, 22.9	24.8**	23.5, 26.2	27.5**	26.4, 28.6	28.1	27.2, 29.1	11.2	2.2*
18–49	8.9	8.1, 9.7	13.7**	12.8, 14.7	16.2**	15.2, 17.3	17.2	16.2, 18.2	20.8**	19.4, 22.3	23.8**	22.7, 24.9	24.3	23.3, 25.4	10.6	2.1*
50–64	15.3	13.8, 17.1	27.2**	25.1, 29.5	31.4**	29.4, 33.5	35.8**	33.4, 38.3	37.2	34.4, 40.2	38.4	36.2, 40.7	38.8	36.9, 40.7	11.6	2.2*
Health-care personnel ^f (≥18 years)	34.5	31.3, 38.0	43.5**	39.9, 47.2	47.1	43.6, 50.7	47.6	44.5, 50.8	53.1**	49.1, 57.3	60.3**	57.1, 63.5	55.8	52.8, 59.0	12.3	2.5*

Abbreviation: CI, confidence interval.

* $P < 0.05$ for overall trend (t test for trend from the 2005–2006 season through the 2010–2011 season).** $P < 0.05$ for comparison with the previous season (t test for comparison between 2 seasons, with the prior season as the reference group—for example, 2005–2006 vs. 2004–2005, 2006–2007 vs. 2005–2006, 2007–2008 vs. 2006–2007, 2008–2009 vs. 2007–2008, 2009–2010 vs. 2008–2009, and 2010–2011 vs. 2009–2010).*** $P < 0.05$ 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).^a Estimates are based on interviews conducted during January–June 2005 and vaccination received during August 2004–May 2005.^b Estimates are based on interviews conducted during September–June and vaccination received during August–May for each influenza season (e.g., the 2005–2006 season included persons interviewed from September 2005 through June 2006 and vaccinated from August 2005 through May 2006).^c Total change from the 2005–2006 season to the 2010–2011 season. Change from the 2004–2005 season was not calculable because a shortage of vaccine occurred during the 2004–2005 season and vaccination coverage was low.^d Average annual change from the 2005–2006 season to the 2010–2011 season.^e 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, coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding nonmelanoma 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.^f During the 2004–2005 through 2008–2009 influenza seasons, adults were classified as health-care personnel if they were aged ≥ 18 years and currently employed in a health-care occupation or in a health-care industry setting, on the basis of standard occupation and industry categories recoded into groups by the National Center for Health Statistics. From the 2009–2010 season to the 2010–2011 season, health-care personnel were defined as adults aged ≥ 18 years who currently volunteered or worked in a hospital, medical clinic, physician's office, dentist's office, nursing home, or some other health-care facility, including part-time and unpaid work in a health-care facility and professional nursing care provided in a private home. If the older definition of health-care personnel (from the 2004–2005 through 2008–2009 seasons) was used, vaccination coverage among health-care personnel during the 2009–2010 and 2010–2011 seasons was 57.5%, and 57.4%, respectively.

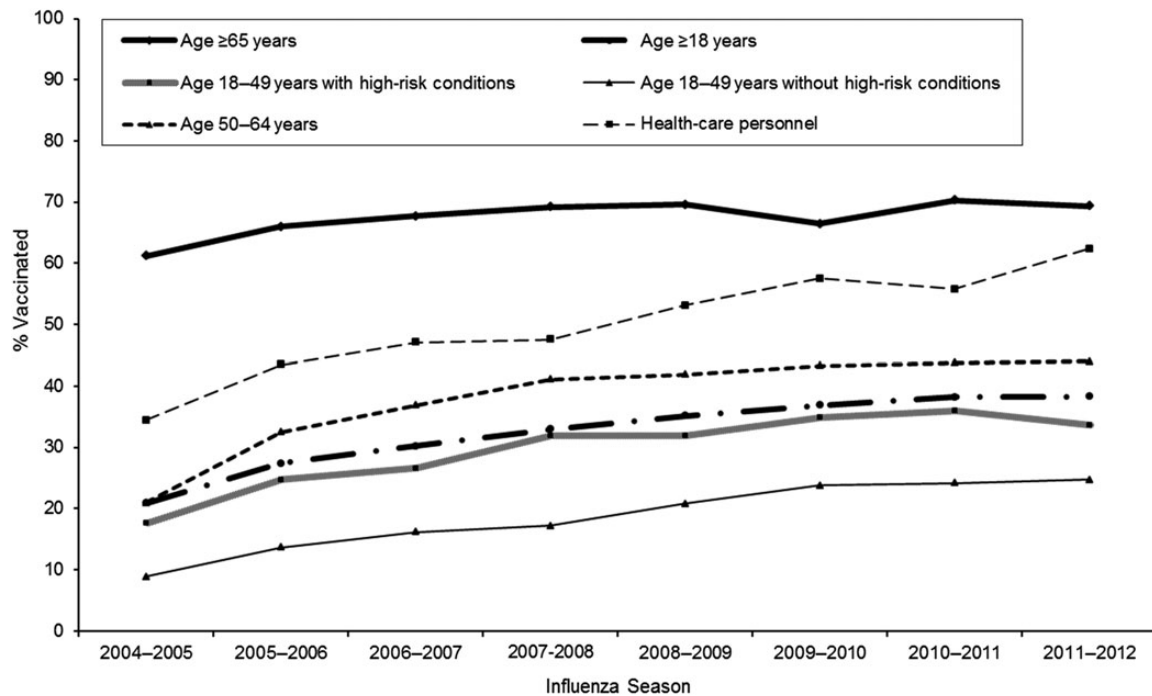


Figure 1. Influenza vaccination coverage among selected US adult populations from the 2004–2005 influenza season to the 2011–2012 influenza season.

45.6%. This is substantially lower than the 90% Healthy People 2020 target for this risk group. The universal influenza vaccination recommendation may help improve vaccination coverage in this age group in future seasons, but continued focus to ensure vaccination among high-risk groups is essential, since they are at the greatest risk of influenza-related hospitalization and death (34, 35). Primary-care physicians, medical subspecialists, and other health-care professionals and vaccination providers, including pharmacists, should work together to ensure that persons at high risk are assessed for their vaccine needs, receive a strong recommendation for vaccination, and are either vaccinated by the recommending provider or referred to another provider if the recommending provider does not provide influenza vaccination services.

Vaccination coverage for adults aged ≥65 years did not significantly increase linearly from the 2005–2006 season (66.0%) through the 2010–2011 season (70.2%), and the preliminary estimate for 2011–2012 was similar to the estimate for 2010–2011. The lack of change in influenza vaccination coverage in this age group indicates that new approaches are needed if increases in influenza vaccination are to occur and reach the 90% Healthy People 2020 target. Reasons for the lack of change in coverage are not well understood. One recent study indicated that the majority (67%) of adults aged ≥65 years who are vaccinated receive their influenza vaccination in a clinical setting, which is significantly higher than the figure for those aged 18–49 years (54%) and 50–64 years (56%) (36). One potential reason for the level coverage in recent years might be related to system or operational factors

affecting the number of persons who can be vaccinated in clinical settings and the failure to implement interventions to promote immunization. An increase in vaccination in alternative settings (e.g., community immunizers, health department clinics, pharmacies, and educational settings) may help improve rates of influenza vaccination; however, people must be motivated to seek out vaccination, and an increase in the proportion of older persons receiving influenza vaccinations in retail settings was not associated with an increase in vaccination coverage (36, 37). A provider's recommendation remains one of the most important determinants of vaccination (36, 37).

Trivalent seasonal influenza vaccination coverage declined during the 2009–2010 season among adults aged ≥65 years. One of the possible reasons is that adults aged ≥65 years were not in the first priority groups for limited doses of the influenza A (H1N1) 2009 monovalent vaccine, although they were included in targeted groups once the supply of vaccine increased (38). Lower coverage in older adults might reflect confusion regarding the influenza A (H1N1) 2009 monovalent vaccine recommendations and the continued strong recommendation to vaccinate all elderly persons with seasonal influenza vaccine.

Influenza vaccination coverage among health-care personnel increased by 12 percentage points from the 2005–2006 season through the 2010–2011 season, although a similar increase was observed for all adults aged 18–64 years. Health-care personnel are exposed to influenza both at work and in the community. Vaccination of this group is especially important given their exposure to many high-risk patients and the

Table 3. Influenza Vaccination Coverage Among Adults Aged ≥ 18 Years in the National Health Interview Survey During the 2010–2011 Influenza Season, by Age Group, High-Risk Status, Employment in a Health-Care Field, and Race/Ethnicity^a

Subgroup and Age Group, years	Race/Ethnicity							
	Non-Hispanic White		Non-Hispanic Black		Hispanic		Other ^b	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI
All participants								
≥ 18	41.1	39.9, 42.3	32.1*	29.5, 34.8	28.8*	27.0, 30.7	37.4	34.0, 41.1
18–64	33.4	32.2, 34.7	28.0*	25.4, 30.9	25.4*	23.6, 27.3	33.1	29.7, 36.8
18–49	26.7	25.3, 28.2	25.2	22.3, 28.3	23.3*	21.3, 25.4	28.4	25.1, 32.1
50–64	46.1	44.2, 48.1	35.1*	30.7, 40.0	34.1*	29.8, 38.8	45.7	37.7, 54.5
≥ 65	72.0	69.9, 74.0	60.5*	54.4, 66.7	64.7	57.1, 72.1	67.2	58.3, 75.9
Persons with high-risk conditions ^c								
18–64	46.4	43.5, 49.5	44.1	37.3, 51.6	42.6	36.9, 48.8	48.1	37.2, 60.5
18–49	34.5	30.4, 39.0	42.1	32.5, 53.2	41.7	34.4, 49.8	33.4	23.4, 46.3
50–64	57.0	52.9, 61.3	46.2*	38.4, 54.8	43.6*	34.7, 53.6	72.8	46.4, 93.4
Persons without high-risk conditions								
18–64	30.2	28.9, 31.5	23.6*	21.1, 26.4	22.1*	20.2, 24.3	30.3	26.9, 34.0
18–49	25.4	24.0, 26.9	22.0*	19.3, 25.0	21.0*	18.9, 23.3	27.5	24.0, 31.3
50–64	41.3	39.0, 43.6	28.8*	23.8, 34.5	28.7*	23.9, 34.2	39.1	30.7, 48.9
Health-care personnel ^d (≥ 18 years)	58.6	54.8, 62.4	43.7*	36.2, 52.1	45.2*	36.5, 54.9	66.8	56.4, 77.0

Abbreviation: CI, confidence interval.

* $P < 0.05$ for race/ethnicity (t test for comparison with non-Hispanic whites).^a Estimates are based on interviews conducted during September 2010–June 2011 and vaccination received during August 2010–May 2011.^b Included Asian, American Indian/Alaska Native, and multiracial.^c 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, coronary heart disease, angina, heart attack, or another heart condition; 2) receiving a diagnosis of cancer during the preceding 12 months (excluding nonmelanoma 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.^d During the 2010–2011 season, health-care personnel were defined as adults aged ≥ 18 years who currently volunteered or worked in a hospital, medical clinic, physician's office, dentist's office, nursing home, or some other health-care facility, including part-time and unpaid work in a health-care facility and professional nursing care provided in a private home.

fact that health-care personnel often work while ill (39–42). Despite annual influenza vaccination's being recommended for health-care personnel by the Advisory Committee on Immunization Practices and numerous medical, nursing, and pharmacy professional organizations and despite being part of the Standards for Adult Immunization Practices (43), vaccination coverage remains suboptimal. Low awareness of the federal recommendations for seasonal influenza vaccination among health-care personnel may have affected vaccination coverage. One study showed that only about 45%–50% of health-care personnel correctly reported being in the target groups recommended to receive annual influenza vaccination (unpublished data and CDC-sponsored population-based Internet panel surveys conducted during the 2010–2011 influenza season). Factors that may increase vaccination coverage among health-care personnel include convenient access to vaccination during all work shifts and at no personal cost, support for vaccination efforts by the leaders of health-care facilities, provision of feedback to health-care personnel on vaccination levels at their workplaces, and education of health-care

personnel emphasizing the effectiveness and safety of influenza vaccine and the importance of their getting vaccinated for patient safety (44). Work-site vaccination could significantly increase seasonal vaccination coverage among health-care personnel; however, one study showed that in one-third of health-care settings, employers did not offer on-site vaccination for health-care personnel (44).

Our study showed that vaccination coverage in most adult subgroups analyzed was significantly higher among non-Hispanic whites than among non-Hispanic blacks and Hispanics. Racial/ethnic disparities in influenza vaccination have been described in previous studies (21, 23–26, 45). Multiple factors probably contribute to these racial/ethnic disparities, including differences in attitudes toward vaccination and preventive care, propensity to seek and accept vaccination, variations in the likelihood that providers will recommend vaccination, and differences in the quality of care received by different racial/ethnic populations (1, 24, 25, 46–51). Broad use of interventions to remove barriers to access and to make the offering of vaccination in health-care and other settings

a routine practice are important components of efforts to reduce these disparities (51, 52). Efforts to reduce disparities may be most important for older adult age groups, given the smaller disparities among adults aged 18–49 years.

The CDC publishes estimates of influenza vaccination coverage from several data sources, including the Behavioral Risk Factor Surveillance System (BRFSS), the National Immunization Survey, Internet panel surveys, and the NHIS (29). For adults, the estimates from the BRFSS provide timely national and state-specific estimates that are available by the time the next influenza vaccination campaign begins. Internet panel surveys provide timely estimates (in-season and rapid post-season) for the general population and the rarer populations of health-care personnel and pregnant women while also providing information on knowledge, attitudes, and behaviors related to influenza vaccination. Estimates from the NHIS are not as timely but may provide more valid national estimates than estimates derived from telephone and Internet panel surveys. The NHIS is a national household survey conducted mostly through face-to-face interviews and has higher response rates (60%–70%) than the BRFSS, which is a telephone survey with lower response rates (50%–60%) (23, 26, 28, 53, 54). For assessing national trends, other advantages of NHIS data include the availability of data on a more complete set of high-risk conditions and longer availability of data for making season-specific estimates using the self-reported month and year of the most recent influenza vaccination (since 2005 for the NHIS, compared with 2008 for the BRFSS).

Thus, the NHIS provides a means of assessing the potential validity of estimates from more timely data sources. Influenza vaccination coverage during the 2010–2011 season based on the BRFSS data was somewhat higher than that based on the NHIS estimates (40.5% vs. 38.1% for adults aged ≥ 18 years, 30.5% vs. 26.1% for adults aged 18–49 years, and 44.5% vs. 43.7 for adults aged 50–64 years) and was lower for adults aged ≥ 65 years (66.6% from the BRFSS vs. 70.2% from the NHIS). While NHIS estimates for adults aged ≥ 65 years appear to have been stable in recent seasons, aside from a dip during 2009–2010, BRFSS estimates for this age group appear to indicate a possible decline, with estimates of 74% for 2008–2009, 67% for 2010–2011, and 65% for 2011–2012 (53). However, both data sources indicate that coverage among older adults is in the range of 65%–70%, with much room for improvement. Ongoing comparisons of NHIS data and other sources of influenza vaccination coverage data are needed; over several seasons, these comparisons will provide a better assessment of the validity of signals in trends and disparities identified from other data sources. Factors that may contribute to the differences in estimated vaccination coverage between the NHIS and other data sources include a more representative sampling frame and higher response rates for the NHIS, differences in survey mode (in-person for the NHIS, telephone or Internet for others), and differences in survey operations and weighting procedures. Starting in 2008, the BRFSS began adding samples of persons in households with only cellular telephone service in each state to the landline telephone sampling frame (55).

The findings in this report are subject to limitations. Influenza vaccination status and high-risk conditions were self-reported and were not validated with medical records. However, self-reported seasonal influenza vaccination status among older

adults has been shown to have relatively high agreement with vaccination status ascertained from medical records, with 5- to 11-percentage-point higher estimates based on self-reported vaccination status compared with estimates based on vaccination status from medical records (56–58). For the 2009–2010 season, when both seasonal vaccine and the influenza A (H1N1) 2009 monovalent vaccine were available, it is possible that some persons may have confused receipt of the influenza A (H1N1) 2009 monovalent vaccine with seasonal influenza vaccination, with a potential for over- or underestimation of coverage for seasonal vaccine in 2009–2010. NHIS response rates were 60%–70%, and it is possible that nonresponse bias may have remained after weighting adjustments.

Influenza vaccination coverage in all groups recommended for vaccination remains suboptimal. Substantial improvement in annual influenza vaccination of recommended groups is needed to maximally reduce the health impact of influenza. Expanded access through greater use of complimentary settings and vaccine providers and better use of evidence-based practices at medical sites (e.g., standing orders and reminder/recall notification) are important to further improve influenza vaccination coverage (43).

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