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Original Contribution

Uptake of Pneumococcal Polysaccharide Vaccination Among Working-age Adults With Underlying Medical Conditions, United States, 2009

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Since 1997, the Advisory Committee on Immunization Practices has recommended the 23-valent pneumococcal polysaccharide vaccine (PPSV23) for nonelderly adults with certain medical conditions. In 2008, the Committee added asthma and cigarette smoking to the list of indications for PPSV23 vaccination. Using data from the 2009 National Health Interview Survey, the authors assessed PPSV23 uptake in people with established and new indications. To identify factors independently associated with receiving PPSV23, they used multivariable logistic regression and predictive marginal analyses. In 2009, a total of 35.2 million adults 18–64 years of age (18.6%) had established PPSV23 indications; adding asthma and smoking to the list of indications increased the high-risk population to 71.6 million people (37.9%). Overall, 26.1% of people with established indications for PPSV23 and 17.4% of people with any indication (those previously established, as well as asthma and smoking) had received the vaccine; overall coverage among persons 50–64 years of age was significantly higher than that among persons 18–49 years of age (34.6% vs. 16.7%; $P < 0.001$) and for all specific indications except cancer. For persons who had asthma or who smoked but had no other indications, rates of coverage were 12.3% and 8.5%, respectively. In persons who had established indications, being older, white, and unemployed and having more physician visits, a prior hospitalization, a regular physician, and health insurance were independently associated with PPSV23 receipt. PPSV23 uptake varies substantially by age and indication but remains low overall, with approximately 59 million unvaccinated high-risk working-age adults. Effective strategies to increase pneumococcal vaccination coverage among at-risk groups are needed.

adult; asthma; pneumococcal vaccines; smoking; vaccination

Abbreviations: ACIP, Advisory Committee on Immunization Practice; CI, confidence interval; IPD, invasive pneumococcal disease; NHIS, National Health Interview Survey; PCV7, 7-valent pneumococcal conjugate vaccine; PCV13, 13-valent pneumococcal conjugate vaccine; PPSV23, 23-valent pneumococcal polysaccharide vaccine.

Infection with *Streptococcus pneumoniae* (pneumococcus) causes substantial morbidity and mortality worldwide (1). In the United States, routine infant vaccination with the 7-valent pneumococcal conjugate vaccine (PCV7) since 2000 has markedly reduced rates of invasive pneumococcal disease (IPD) among nonelderly adults through indirect vaccine effects, that is, ''herd effects.'' Data from the Centers for Disease Control and Prevention's Active Bacterial Core surveillance indicate that the overall rates of IPD among persons 18–49 years of age and 50–64 years of age decreased by 40% and 18%, respectively, from 1998/1999 to 2007 (2). Despite this reduction in disease burden, IPD remains an important cause of illness and death, with an estimated 43,500 cases of IPD and 5,000 IPD-related deaths in persons of all ages in 2009 (3). Approximately 52% of these IPD cases and 47% of deaths occurred in adults who were 18–64 years of age.

Persons who have certain underlying medical conditions have an increased risk of developing IPD or experiencing severe disease and complications (1). Since 1997, the Advisory Committee on Immunization Practice (ACIP) has recommended the 23-valent pneumococcal polysaccharide vaccine (PPSV23) to all adults 65 of age or older and to younger

adults with chronic or immunocompromising medical conditions (1). In 2008, the ACIP added asthma and cigarette smoking as indications for PPSV23 in adults 19–64 years of age based on data that demonstrated a significantly increased risk for IPD in asthmatic adults and cigarette smokers (4). In 2008, the serotypes covered in PPSV23 caused 78% of IPD cases among persons 18–49 years of age and 76% of IPD cases among persons 50–64 years of age (4).

The National Healthy People 2010 and 2020 objectives call for pneumococcal vaccination of at least 60% of persons 18–64 years of age who have underlying medical conditions (5, 6). Despite the long-standing ACIP recommendations, vaccination levels in this group have remained low, ranging from 17% to 35% (6–10). We assessed national PPSV23 coverage among adults 18–64 years of age with underlying medical conditions, including asthma and cigarette smoking. We also evaluated factors associated with receipt of PPSV23 to identify potential strategies to improve vaccination coverage for existing and new adult pneumococcal vaccines.

MATERIALS AND METHODS

We analyzed data from the 2009 National Health Interview Survey (NHIS), an annual household survey conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention (11). The NHIS provides estimates of health indicators, health-care utilization and access, and health-related behaviors for the US resident civilian noninstitutionalized population. The NHIS sample is selected through the use of a complex sampling design that involves stratification, clustering, and multistage sampling with a nonzero probability of selection for each person. Estimates are weighted to the adult civilian population of the United States. Face-to-face interviews are conducted each week throughout the year in a probability sample of households. In the sample adult core, one adult per sampled family was randomly selected and asked to complete the sample adult questionnaire. In 2009, the final response rate for the sample adult core was 65.4% (11). The 2009 sample adult core survey included the following question on pneumococcal vaccination: ''Have you ever had a pneumonia shot? This shot is usually given only once or twice in a person's lifetime and is different from the flu shot. It is also called the pneumococcal vaccine.'' The wording of this question has been constant from 1997 through 2009.

Persons 18–64 years of age with established PPSV23 indications were defined according to the 1997 ACIP recommendations (1) as individuals who reported one or more of the following: ever being told by a physician they had diabetes, emphysema, coronary heart disease, angina, heart attack, or other heart diseases; 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; or being told by a physician that they had liver conditions, chronic bronchitis, or weak or failing kidneys in the past 12 months. Persons with new indications were defined as those who had had an asthma attack in the past 12 months and had no established indications (asthma only) and those who were current smokers and had no established indications (current smoking only) (4).

Data for established indications (determined in 1997) and new indications (determined in 2008) were analyzed separately because the recommendation to vaccinate people with asthma and smokers was first included in the 2009 Adult Immunization Schedule (12). In the 2009 NHIS, a total of 4,215 individuals 18–64 years of age had established indications, 406 individuals had asthma as their only indication, and 3,692 had smoking as their only indication. There were 149 respondents (3.5%) who did not know or refused to reveal their pneumococcal vaccination status in 2009; they were excluded from the analysis.

Statistical analysis

We used SUDAAN statistical software (Research Triangle Institute, Research Triangle Park, North Carolina), a statistical tool for complex sample surveys, to calculate point estimates and 95% confidence intervals (13). All analyses were weighted to reflect the age, sex, and race/ethnicity of the US noninstitutionalized civilian population. In the univariable analysis, we stratified vaccination levels by age group, race/ethnicity, marital status, educational level, employment status, number of physician contacts in the previous year, number of hospitalizations in the previous year, whether they had a regular place of health care, and health insurance status. We used a *t* test to evaluate associations between PPSV23 vaccination status and the above variables. As sample sizes of vaccinated persons with the new indications of asthma and cigarette smoking were very small, thereby making estimates unreliable, factors associated with PPSV23 were evaluated only for established indications using multivariable logistic regression models and predictive marginal analyses. We estimated PPSV23 coverage and adjusted for demographic characteristics and access-to-care variables. Adjusted percentages (i.e., predictive margins) are a type of direct standardization that average the predicted values from the logistic model, controlling for the confounding factors measured in the population (14, 15). These adjusted percentages do not reflect actual vaccine use in the population but allow comparisons across categories of the variables that are included in the models (14, 15). All variables in the univariable analysis were included in the full multivariable model. Variables were determined to be significant at $P < 0.05$. To assess the increase in vaccine coverage among persons with established indications during 1997–2009, we performed a test for linear trend. To assess potential missed opportunities for pneumococcal vaccination among working-age adults with underlying medical conditions that are established PPSV23 indications, we calculated the proportions of persons with indications who did not report receipt of PPSV23 by selected access-to-care characteristics.

RESULTS

Table 1 shows the baseline demographic characteristics of the study population. Of persons 18–64 years of age who had underlying medical conditions, 51.9% were female, 71.7% were white, 56.2% were married, 57.2% were employed, and 52.6% had at least some college education. Additionally, 90.2% had at least one physician

contact, 82.7% had health insurance, 88.9% had a regular physician, and 18.6% had been hospitalized within past year. Persons 18–49 years of age and those 50–64 years of age differed for most sociodemographic characteristics (Table 1).

Established PPSV23 indications

On the basis of a trend analysis, we found that PPSV23 uptake among persons 18–64 years of age with established risk factors increased on average by 1.1% annually, from 12.9% in 1997 to 26.1% in 2009 (test for trend, $P < 0.05$) (Figure 1). During 2009, vaccination coverage levels did not significantly increase according to calendar quarter of the year (25.7%, 25.3%, 26.9%, and 26.3% for quarters 1, 2, 3, and 4, respectively).

Overall in 2009, approximately 35.2 million persons 18–64 years of age (18.6% of the population) reported having an established indication for PPSV23 vaccination. The overall PPSV23 coverage among all persons 18–64 years of age in the population was 11.0% (95% confidence interval (CI): 10.5, 11.5). PPSV23 coverage among persons 18–64 years of age with established indications was 26.1% (95% CI: 24.3, 27.8). Vaccination coverage was significantly lower among persons who were 18–49 years of age (16.7%, 95% CI: 14.5, 19.2) than among persons 50–64 years of age (34.6%, 95% CI: 32.1, 37.3) (Table 2). In 2009, vaccination coverage for persons 18–64 years of age with established indications was 27.7% (95% CI: 25.6, 29.9) for non-Hispanic whites, 24.5% (95% CI: 20.3, 29.2) for non-Hispanic blacks, and 17.3% (95% CI: 13.4, 22.0) for Hispanics (Table 2). PPSV23 coverage was significantly higher among persons who were not employed (34.2%) than among those who were employed (20.0%; $P < 0.05$) (Table 2).

Factors associated with receipt of PPSV23 among persons with established indications

Vaccination coverage significantly increased as the number of physician contacts increased, with an almost 30-percentage-point difference between persons who had no physician visits and those who had 10 or more in the past year (Table 2). Persons who had been hospitalized in the past year were significantly more likely to have received PPSV23 than were those who had not. There was a 19-percentage-point difference in PPSV23 coverage between individuals who had a regular physician for health care and those who did not. PPSV23 coverage was significantly higher among persons with health insurance (28.6%) than among those without health insurance (14.0%; $P < 0.05$) (Table 2). Vaccination coverage was significantly higher among persons 50–64 years of age than among persons 18–49 years of age in most sociodemographic characteristic categories (Table 2).

We conducted multivariate predictive marginal analysis to assess adjusted vaccination coverage rates and identify independent factors associated with pneumococcal vaccination in persons who were 18–64 years of age and had established PPSV23 indications. Adjusted coverage estimates from predictive models were similar to the crude vaccination coverage estimates. Characteristics independently associated with an increased likelihood of receiving PPSV23 among persons 18–64 years of age with established indications were older age, non-Hispanic white race/ethnicity, being unemployed, having more physician visits in the past year, having been hospitalized in the past year, having a regular physician, and having health insurance (Table 3).

PPSV23 coverage among persons 18–64 years of age who had specific indications ranged from 23.3% for persons with cancer to 45.5% for persons with emphysema (Table 4). Additionally, condition-specific vaccination coverage was significantly higher among persons 50–64 years of age than among persons 18–49 years of age (Table 4).

Potential missed opportunities for pneumococcal vaccination were also evaluated. Among persons 18–64 years of age who had established indications and reported never receiving PPSV23, 88.1% had had 1 or more physician contacts in the past 12 months, 15.3% had been hospitalized in past year, 30.6% had visited an emergency department, and 31.6% had received an influenza vaccination; overall, 92.2% reported at least 1 missed opportunity of a type listed above. The frequency of potential missed opportunities varied significantly by racial/ethnic groups for person who had visited the emergency department or been hospitalized. Compared with non-Hispanic whites, a significantly smaller proportion of non-Hispanic blacks who had visited the emergency department and a significantly larger proportion of non-Hispanic blacks who had been hospitalized missed an opportunity for vaccination (Table 5).

New PPSV23 indications: asthma and cigarette smoking

The addition of asthma and smoking to the list of PPSV23 indications in 2008 increased the size of the high-risk target population of persons who were 18–64 years of age to an estimated 71.6 million (37.9%) (Table 4). An estimated 35.5 million persons 18–64 years of age (18.9%) reported having active asthma or currently smoking and having no established indications. Current smokers 18–49 years of age accounted for 25.0 million (70.4%) of the high-risk persons added with the addition of the expanded recommendations (Table 4). Because of the increased denominator, the overall PPSV23 coverage in 2009 among all persons with 1 or more established or new conditions was 17.4% (95% CI: 16.4, 18.5). PPSV23 coverage among persons with active asthma without other indications was 12.3% (95% CI: 9.2, 16.3); coverage was 2.5-fold higher for persons 50–64 years of age than for those 18–49 years of age. Among current smokers without other PPSV23 indications, coverage was 8.5% (95% CI: 7.4, 9.8) (Table 4). Among smokers, coverage was 1.7-fold higher in persons 50–64 years of age than in those 18–49 years of age. Among the 7.7 million people with asthma and 43 million smokers who were 18–64 years of age, 4.4 million (57.1%) and 10.8 million (25.1%) persons, respectively, also had an additional established PPSV23 indication.

DISCUSSION

Analysis of 2009 NHIS data showed that pneumococcal vaccination coverage was low. Of the adults 18–64 years of

Table 1. Characteristics of Participants 18–64 Years of Age With Established 23-Valent Pneumococcal Polysaccharide Vaccine Indications[a], by Demographic and Access-to-Care Variables, in the United States, National Health Interview Survey, 2009

Characteristic	Age, years					
	18–64		18–49		50–64	
	No. of Participants	%	No. of Participants	%	No. of Participants	%
Total	4,215		1,980	48.0	2,235	52.0
Sex						
Male	1,817	48.1	777	45.8	1,040	50.1*
Female	2,398	51.9	1,203	54.2	1,195	49.9
Race/ethnicity						
Non-Hispanic white	2,559	71.7	1,110	68.5	1,449	74.6*
Non-Hispanic black	778	12.9	380	14.0	398	12.0
Hispanic	705	11.9	404	13.7	301	10.3
Other	173	3.5	86	3.8	87	3.1
Marital status						
Married	1,881	56.2	793	48.8	1,088	62.9*
Widowed/divorced/separated	1,233	19.5	422	14.0	811	24.7
Never married	1,096	24.3	763	37.2	333	12.4
Educational level						
Less than high school	784	17.2	355	18.7	429	15.9*
High school graduate	1,196	30.2	527	27.0	669	33.2
Some postsecondary education	2,217	52.6	1,091	54.3	1,126	50.9
Employment status						
Employed	2,313	57.2	1,220	62.7	1,093	52.2*
Unemployed	1,902	42.8	760	37.3	1,142	47.8
Influenza vaccination in the past 12 months						
Yes	1,712	41.6	618	31.7	1,094	50.9*
No	2,456	58.4	1,340	68.3	1,116	49.1
No. of physician contacts within the past year						
0	385	9.8	234	12.5	151	7.2*
1	374	8.6	189	8.8	185	8.5
2–3	846	21.0	415	21.0	431	21.1
4–9	1,396	33.6	623	32.4	773	34.6
≥10	1,161	27.0	495	25.3	666	28.6
Hospitalization within past year						
Yes	835	18.6	369	17.3	466	20.0
No	3,378	81.4	1,610	82.7	1,768	80.0
Had a regular physician						
Yes	3,747	88.9	1,667	84.3	2,080	93.1*
No	443	11.1	299	15.7	144	6.9
Had health insurance						
Yes	3,456	82.7	1,527	77.9	1,929	87.2*
No	754	17.3	450	22.1	304	12.8

*$P < 0.05$ for the difference between persons aged 18–49 years of age and persons aged 50–64 years of age (by chi-squared test).

[a] Persons who reported 1 or more of the following: ever being told by a physician they had diabetes, emphysema, coronary heart disease, angina, 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 they had lymphoma, leukemia, or blood cancer; or in the past 12 months being told by a physician that they had liver conditions, chronic bronchitis, or weak or failing kidneys.

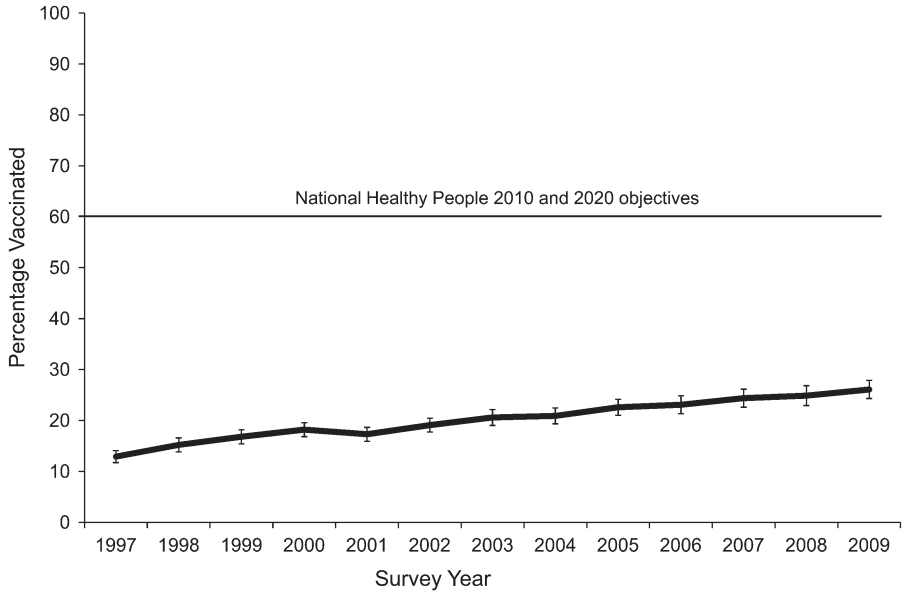

Figure 1. Pneumococcal polysaccharide vaccination coverage among adults 18–64 years of age with established PPSV23 indications, National Health Interview Survey, 1997–2009. Bars, 95% confidence interval.

age who had underlying medical conditions for which the ACIP had recommended PPSV23 vaccination since 1997, 26.1% reported ever receiving the vaccine. Because the addition of asthma and smoking to the list of PPSV23 indications in 2008 increased the population targeted for vaccination substantially and because early uptake among persons with these new indications was low, the overall PPSV23 coverage among all working-age adults with 1 or more conditions for which the ACIP recommended pneumococcal vaccination dropped to 17.4% when those new groups were included. Therefore, about 59 million working-age adults at increased risk for IPD remain unvaccinated; current smokers without other indications accounted for more than half (58.6%) of this at-risk group. As PPSV23 uptake among persons 18–64 years of age with established risk factors has increased on average by only 1.1% annually since 1997, it is unlikely that the Healthy People 2020 objective of 60% PPSV23 uptake (16) will be achieved among this group unless effective strategies and programs to improve pneumococcal vaccination coverage are designed and implemented. As infrastructure and resources to support adult vaccination are lacking, these results also have important programmatic implications for achieving sufficient coverage with new adult pneumococcal vaccines, such as the 13-valent pneumococcal conjugate vaccine (PCV13), which was recently approved by the Food and Drug Administration for use in adults 50 years of age or older (17, 18).

As expected, vaccination coverage among persons 50–64 years of age was significantly higher than among those 18–49 years of age. This result remained unchanged after controlling for other demographic and access-to-care variables. Both the prevalence of PPSV23 indications and the incidence of IPD are known to increase with age (2, 3). In 2007, rates of IPD were 12 and 21 cases per 100,000 population among persons 18–49 years of age and 50–64 years of age, respectively (2, 3). Health-care providers may be more likely to recommend pneumococcal vaccination to adults over 50 years of age because of the greater risk for serious pneumococcal infection.

Vaccination coverage also varied substantially among persons with specific established PPSV23 indications, ranging from 23.3% in persons with cancer to 45.5% in persons with emphysema. The proportion of adult IPD patients 18–64 years of age who had underlying medical conditions increased from 52% during 1998–1999 (before routine childhood PCV7 vaccination) to 59% during 2006–2007, suggesting that nonelderly adults with chronic illnesses may not have benefited as much from the indirect effects of childhood PCV7 vaccination as did relatively healthy adults (2) and further emphasizing the importance of vaccinating working-age adults who have high-risk conditions.

Our study also included the first estimates for PPSV23 uptake among persons with the new ACIP indications of active asthma and current cigarette smoking (4). We found that in 2009, PPSV23 coverage was about 12% for adults with asthma and no other PPSV23 indication and about 9% for cigarette smokers without another PPSV23 indication. As these estimates are for the first year of implementation of the ACIP recommendation, it is too early to assess the full impact of the new recommendation. In addition, some 57.1% of adults with asthma and 25.1% of smokers also had an additional established PPSV23 indication. Our results highlight the need for health-care providers to routinely assess pneumococcal vaccination status and administer the vaccine to both younger patients with chronic illnesses and smokers.

Table 2. Pneumococcal Vaccination Coverage Among Persons 18–64 Years of Age With Established 23-Valent Pneumococcal Polysaccharide Vaccine Indications[a], by Demographic and Access-to-Care Variables, in the United States, National Health Interview Survey, 2009

Characteristic	Age, years					
	18–64		18–49		50–64	
	%	95% CI	%	95% CI	%	95% CI
Total	26.1	24.3, 27.8	16.7	14.5, 19.2	34.6[b]	32.1, 37.3
Sex						
Male[c]	25.4	22.9, 28.0	15.4	12.3, 19.0	33.7[b]	30.0, 37.6
Female	26.7	24.2, 29.3	17.8	14.6, 21.6	35.6[b]	32.1, 39.3
Race/ethnicity						
Non-Hispanic white[c]	27.7	25.6, 29.9	17.2	14.5, 20.4	36.5[b]	33.4, 39.7
Non-Hispanic black	24.5	20.3, 29.2	15.6	11.4, 21.0	33.8[b]	27.1, 41.1
Hispanic	17.3[d]	13.4, 22.0	11.4[d]	8.1, 15.9	24.8[b, d]	17.7, 33.4
Other	28.1	17.7, 41.6	30.6	14.3, 53.8	25.3[b]	17.7, 38.2
Marital status						
Married[c]	26.7	24.3, 29.2	15.1	12.0, 18.8	35.0[b]	31.6, 38.5
Widowed/divorced/separated	29.0	25.5, 32.7	18.0	14.0, 22.9	34.7[b]	30.1, 39.6
Never married	22.3	18.9, 26.0	18.4	14.7, 22.7	32.8[b]	27.0, 39.2
Educational level						
Less than high school[c]	23.1	19.3, 27.5	17.0	12.1, 23.5	29.7[b]	24.4, 35.6
High school graduate	28.7	25.2, 32.4	16.7	12.7, 21.6	37.6[b]	32.7, 42.8
Some postsecondary education	25.6	23.2, 28.1	16.5	13.5, 20.1	34.4[b]	31.0, 38.0
Employment status						
Employed[c]	20.0	17.9, 22.3	14.1	11.6, 17.1	26.5[b]	23.2, 30.2
Unemployed	34.2[d]	31.3, 37.2	21.1[d]	17.2, 25.5	43.5[b, d]	39.7, 47.4
Influenza vaccination in the past 12 months						
Yes[c]	44.3	41.1, 47.6	32.5	27.1, 38.5	51.1[b]	47.4, 54.8
No	12.9[d]	11.4, 14.6	9.3[d]	7.5, 11.4	17.5[b, d]	15.0, 20.4
No. of physician contacts within past year						
0[c]	8.8	5.8, 13.2	4.5	2.3, 8.7	15.7[b]	9.1, 25.8
1	17.5[d]	13.4, 22.4	7.8	4.3, 13.8	26.3[b]	19.8, 34.0
2–3	19.0[d]	18.9, 22.6	13.3	9.5, 18.4	24.2[b, d]	19.3, 30.0
4–9	27.6[d]	24.9, 30.6	16.6[d]	13.2, 20.8	37.1[b, d]	32.9, 41.6
≥10	38.6[d]	34.7, 42.7	28.6[d]	22.7, 35.3	46.8[b, d]	41.8, 51.9
Hospitalization within past year						
Yes[c]	39.9	35.1, 45.0	28.0	21.6, 35.5	49.4[b]	43.0, 55.8
No	22.9[d]	20.9, 24.9	14.3[d]	12.0, 17.0	31.0[b, d]	28.2, 33.9
Had a regular physician						
Yes[c]	28.2	26.3, 30.1	18.7	16.1, 21.7	36.0[b]	33.4, 38.8
No	9.1[d]	6.6, 12.6	5.6[d]	3.6, 9.2	16.1[d]	10.4, 24.1
Had health insurance						
Yes[c]	28.6	26.6, 30.6	18.2	15.5, 21.2	37.1[b]	34.4, 40.0
No	14.0[d]	11.0, 17.6	11.6[d]	7.9, 16.5	17.7[d]	13.0, 23.6

Abbreviation: CI, confidence interval.

[a] Persons who reported 1 or more of the following: ever being told by a physician they had diabetes, emphysema, coronary heart disease, angina, 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 they had lymphoma, leukemia, or blood cancer; or in the past 12 months being told by a physician that they had liver conditions, chronic bronchitis, or weak or failing kidneys.

[b] $P < 0.05$ by *t* test for comparisons of vaccination coverage between persons aged 18–49 years of age and persons aged 50–64 years.

[c] Reference level.

[d] $P < 0.05$ (*t* test for comparisons within each variable with the indicated reference level).

Table 3. Multivariable Logistic Regression and Predictive Marginal Analysis of Pneumococcal Vaccination Among Persons 18–64 Years of Age With Established 23-Valent Pneumococcal Polysaccharide Vaccine Indications[a], by Demographic and Access-to-Care Variables, in the United States, National Health Interview Survey, 2009

Characteristic	Adjusted Vaccination Coverage[b]					
	Persons 18–64 Years of Age		Persons 18–49 Years of Age		Persons 50–64 Years of Age	
	%	95% CI	%	95% CI	%	95% CI
Age, years						
18–49[c]	17.8	15.4, 20.3		N/A		N/A
50–64	33.0*	30.5, 35.5		N/A		N/A
Sex						
Male[c]	25.7	23.2, 28.2	16.5	13.0, 19.9	34.4	30.7, 38.2
Female	26.4	23.9, 28.9	16.7	13.6, 19.9	35.1	31.5, 38.7
Race/ethnicity						
Non-Hispanic white[c]	27.2	25.2, 29.3	16.8	13.9, 19.6	36.8	33.7, 39.8
Non-Hispanic black	23.0	18.9, 27.2	14.7	10.1, 19.4	30.8	24.2, 37.4
Hispanic	20.2*	15.3, 25.1	13.1*	8.4, 17.8	26.*	18.0, 34.9
Other	31.0	19.3, 42.8	34.7	16.9, 52.5	26.3	15.5, 37.1
Marital status						
Married[c]	25.7	23.2, 28.1	15.0	11.8, 18.2	35.0	31.6, 38.4
Widowed/divorced/separated	25.1	21.9, 28.4	16.1	11.8, 20.5	33.9	29.2, 38.6
Never married	28.2	24.3, 32.0	19.1	14.9, 23.4	35.5	29.3, 41.7
Educational level						
Less than high school[c]	23.1	19.2, 27.0	16.8	10.8, 22.9	29.3	23.9, 34.8
High school graduate	27.5	24.3, 30.8	16.3	12.1, 20.4	37.3*	32.6, 41.9
Some postsecondary education	26.2	23.8, 28.5	16.8	13.6, 20.0	34.8*	31.4, 38.2
Employment status						
Employed[c]	21.6	19.4, 23.9	15.2	12.1, 18.3	27.5	23.8, 31.2
Unemployed	31.5*	28.8, 34.9	18.8	15.1, 22.5	42.7*	38.8, 46.6
No. of physician contacts within past year						
0[c]	14.9	9.3, 20.6	6.8	2.3, 11.2	24.3	13.3, 35.2
1	20.8	15.8, 25.9	8.7	3.5, 14.0	30.9	23.2, 38.6
2–3	20.6	17.2, 24.1	14.4*	9.9, 19.0	26.4	20.9, 31.8
4–9	26.9*	24.2, 29.6	16.4*	12.6, 20.1	36.8*	32.5, 41.1
>10	32.6*	28.9, 36.3	23.6*	18.0, 29.2	41.0*	36.1, 45.9
Hospitalization within past year						
Yes[c]	32.6	28.2, 37.0	22.4	16.5, 28.2	41.8	35.4, 48.1
No	24.3*	22.3, 26.4	15.1*	12.5, 17.7	32.8*	29.9, 35.8
Had a regular physician						
Yes[c]	26.8	24.9, 28.6	17.6	15.1, 20.2	35.3	32.6, 37.9
No	17.1*	11.9, 22.3	8.6*	4.5, 12.7	25.8	16.0, 35.5
Had health insurance						
Yes[c]	27.1	25.2, 29.0	16.9	14.3, 19.5	36.5	33.8, 39.2
No	19.1*	14.6, 23.7	15.1	9.4, 20.8	21.1*	14.6, 27.5

Abbreviations: CI, confidence interval; N/A, not applicable.

*$P < 0.05$ (test for comparisons within each variable with the indicated reference level).

[a] Persons who reported 1 or more of the following: ever being told by a physician they had diabetes, emphysema, coronary heart disease, angina, 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 they had lymphoma, leukemia, or blood cancer; or in the past 12 months being told by a physician that they had liver conditions, chronic bronchitis, or weak or failing kidneys.

[b] Adjusted for all variables in the Table.

[c] Reference level.

Table 4. Prevalence of Specific Conditions That Are 23-Valent Pneumococcal Polysaccharide Vaccine Indications and Vaccination Coverage Among Adults 18–64 Years of Age, United States, National Health Interview Survey, 2009

Indication	Age, Years														
	18–64					18–49					50–64				
	Prevalence of Conditions		Population Estimates (Weighted Sample Size), in Millions	Vaccination Coverage		Prevalence of Conditions		Population Estimates (Weighted Sample Size), in Millions	Vaccination Coverage		Prevalence of Conditions		Population Estimates (Weighted Sample Size), in Millions	Vaccination Coverage	
	%	95% CI		%	95% CI	%	95% CI		%	95% CI	%	95% CI		%	95% CI
Lung disease[a]	7.7	7.3, 8.2	14.6	26.9	24.3, 29.8	6.8	6.3, 7.3	9.0	16.5	13.6, 19.8	9.9	9.0, 11.0	5.6	43.6*	39.2, 48.1
Active asthma[b]	4.0	3.7, 4.4	7.7	25.7	22.0, 29.8	4.0	3.7, 4.4	5.4	18.1	14.3, 22.6	4.1	3.5, 4.7	2.3	43.2*	36.5, 50.2
Active asthma only (no other indication)[c]	1.8	1.6, 2.0	3.3	12.3	9.2, 16.3	2.1	1.8, 2.4	2.7	9.7	6.7, 13.9	1.0	0.8, 1.4	0.6	23.8*	14.8, 36.1
Bronchitis	4.0	3.7, 4.4	7.5	31.0	27.4, 34.9	3.2	2.8, 3.6	4.2	19.6	15.5, 24.6	5.8	5.2, 6.5	3.3	45.5*	39.6, 51.5
Emphysema	1.3	1.1, 1.5	2.4	45.5	38.8, 52.3	0.5	0.4, 0.7	0.7	21.6	13.0, 33.9	3.1	2.6, 3.7	1.7	54.9*	46.5, 63.2
Heart disease[d]	8.0	7.6, 8.5	15.2	27.0	24.5, 29.6	5.1	4.6, 5.5	6.7	16.0	12.9, 19.4	15.0	13.9, 16.2	8.5	35.4*	31.7, 39.3
Diabetes mellitus	6.9	6.5, 7.4	13.1	33.2	30.2, 36.4	3.9	3.5, 4.3	5.1	23.1	18.4, 28.5	14.1	13.0, 15.3	8.0	39.8*	35.7, 44.1
Renal disease	1.4	1.2, 1.6	2.6	33.0	26.2, 40.6	1.1	0.9, 1.4	1.5	19.1	12.5, 28.1	2.0	1.6, 2.5	1.1	50.7*	40.1, 61.3
Liver disease	1.4	1.3, 1.7	2.7	26.8	21.2, 33.3	1.0	0.8, 1.2	1.3	11.8	6.9, 19.5	2.5	2.1, 3.0	1.4	40.7*	31.2, 51.0
Cancer	0.8	0.7, 1.0	1.5	23.3	16.8, 31.5	0.5	0.4, 0.6	0.6	17.5	9.1, 31.1	1.6	1.3, 2.0	0.9	27.2	19.0, 37.2
Current smoking[b]	22.7	21.9, 23.6	43.0	12.7	11.5, 13.9	23.6	22.7, 24.6	31.3	9.3	8.1, 10.6	20.6	19.3, 22.0	11.7	21.8*	19.3, 24.5
Current smoking only (no other indication)[e]	17.1	16.4, 17.8	32.2	8.5	7.4, 9.8	18.9	18.1, 19.8	25.0	7.4	6.1, 8.8	12.7	11.6, 13.8	7.2	12.5*	10.1, 15.3
Established indication[f]	18.6	17.9, 19.3	35.2	26.1	24.3, 27.8	12.8	12.1, 13.5	16.9	16.7	14.5, 19.2	32.3	30.8, 33.8	18.3	34.6*	32.1, 37.3
Established indication, current smoking, or asthma[g]	37.9	37.0, 38.8	71.6	17.4	16.4, 18.5	34.3	33.3, 35.3	45.4	11.2	10.0, 12.4	46.3	44.6, 47.9	26.2	28.2*	26.3, 30.2

Abbreviation: CI, confidence interval.

*$P < 0.05$ by *t* test for comparisons of vaccination coverage between persons 18–49 years of age and persons 50–64 years of age.

[a] Persons reported 1 or more of the following: being told by a physician in the past 12 months that they had chronic bronchitis; being told in the past 12 months they had had asthma attack; or ever being told they had emphysema.

[b] Conditions included in the new high-risk definition.

[c] Persons with asthma only who were not current smokers and did not have any of the conditions listed in footnote f.

[d] Persons reporting 1 or more of the following heart conditions: coronary heart disease, angina, heart attack, or another heart condition.

[e] Persons who are current smokers only without asthma or the conditions listed in footnote f.

[f] Persons who reported 1 or more of the following: ever being told by a physician they had diabetes, emphysema, coronary heart disease, angina, 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 they had lymphoma, leukemia, or blood cancer; or in the past 12 months being told by a physician that they had liver conditions, chronic bronchitis, or weak or failing kidneys.

[g] Persons who reported one or more of the conditions listed in footnote g and who were current smokers or had asthma.

Table 5. Proportion of Persons 18–64 Years of Age With Established 23-Valent Pneumococcal Polysaccharide Vaccine Indications Who Reported Never Receiving Pneumococcal Vaccination, by Selected Access-to-Care Characteristics, in the United States, National Health Interview Survey, 2009

Characteristic	Sample	Total		Non-Hispanic White		Non-Hispanic Black		Hispanic	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
No. of doctor visits									
0	320	11.9	10.4, 13.6	11.0	9.2, 13.1	12.7	9.4, 17.1	16.3	12.3, 21.3
1	273	9.1	7.9, 10.5	8.6	7.2, 10.3	7.9	5.6, 11.2	13.0	9.9, 17.0
2–3	641	23.4	21.6, 25.4	24.5	22.1, 27.1	18.9	15.1, 23.4	22.2	18.0, 26.9
4–9	927	32.9	30.6, 35.2	33.6	30.9, 36.5	34.5	28.9, 40.7	27.2	22.9, 32.2
≥10	705	22.7	20.7, 24.8	22.3	19.8, 25.1	25.9	21.7, 30.6	21.4	17.3, 26.0
Hospitalization in past year									
Yes	474	15.3	13.6, 17.2	14.1	12.1, 16.4	21.0*	16.7, 26.1	15.8	12.2, 20.3
No	2,400	84.7	82.8, 86.5	85.9	83.6, 87.9	79.0	73.9, 83.3	84.2	79.7, 87.8
No. of emergency department visits									
0	1,951	69.4	67.2, 71.7	72.3	69.5, 74.9	56.9*	51.3, 62.3	66.8	61.6, 71.6
1	476	16.1	14.2, 18.1	14.2	12.4, 16.7	22.5	18.1, 27.6	18.6	14.4, 23.7
≥2	447	14.5	12.9, 16.2	13.3	11.4, 15.4	20.6	16.6, 25.4	14.6	11.4, 18.5
Influenza vaccination in the past year									
Yes	904	31.6	29.4, 34.0	32.8	30.1, 35.7	27.7	23.8, 32.0	29.2	25.0, 33.9
No	1,971	68.4	66.1, 70.6	67.2	64.3, 70.0	72.3	68.0, 76.2	70.8	66.1, 75.0
At least 1 possible missed opportunity									
Yes[a]	2,510	92.2	90.7, 93.4	92.6	90.8, 94.1	92.7	88.8, 95.3	89.2	84.7, 92.5
No	364	7.8	6.6, 9.3	7.4	5.9, 9.2	7.3	4.7, 11.2	10.8	7.5, 15.3

Abbreviation: CI, confidence interval.

*$P < 0.05$ (chi-squared test for association between race/ethnicity; non-Hispanic white is the reference group).

[a] Persons who reported 1 or more of the following: at least 1 doctor visit, hospitalization in the past year, at least 1 emergency department visit, or influenza vaccination in the past year.

Physician contact and recommendation for vaccination services have been shown to be strongly associated with a patient's decision to get vaccinated (19), but encounters with the health-care system do not guarantee vaccination. Although our findings suggest that recent physician contact or hospitalization was independently associated with PPSV23 vaccination, we also found a substantial proportion of individuals with risk factors who had visited their physicians at least 10 times within the past year and were still not vaccinated. Overall, 92.2% of unvaccinated individuals missed at least 1 potential opportunity to be vaccinated. Nichol and Zimmerman (20) found that a significant proportion of generalists and subspecialists failed to recommend PPSV23 vaccination to their high-risk patients. Recent data also suggest that physician awareness of PPSV23 recommendations may not be optimal and that they may have concerns about the clinical benefit of the vaccine (21). Use of standing-orders programs might help reduce the number of missed opportunities for vaccinating persons who have already accessed the medical system (22–24).

Racial/ethnic disparities persist in rates of pneumococcal vaccination among working-age adults with risk factors; in our study, non-Hispanic whites were significantly more likely to be vaccinated than were Hispanics. These differences remained after controlling for demographic and access-to-care factors. Although studies have consistently reported racial/ethnic differences in PPSV23 receipt among persons 65 years of age or older (25, 26), few data are available about these differences in working-age adults. Edege and Zheng (27) reported notable racial/ethnic disparities in PPSV23 vaccination rates among persons with diabetes mellitus. Unequal access to preventive care and social or cultural values may result in differential acceptance of vaccination (27, 28), but more research is needed to better understand and address the factors associated with racial/ethnic differences among nonelderly at-risk adults.

Vaccination coverage among persons who were unemployed was significantly higher than among those who were employed. This result remained unchanged after controlling for other demographic and access-to-care variables in the subgroup of persons 50–64 years of age but not in the subgroup of persons 18–49 years of age. Of the persons who were unemployed, more than 60% were 50–64 years of age. Persons 50–64 years of age who are unemployed may be more likely to have a medical disability than employed persons.

The 2009 influenza A (H1N1) pandemic highlighted the importance of pneumococcal vaccination and provided an opportunity to improve PPSV23 coverage among at-risk adults. During previous influenza pandemics, secondary bacterial pneumonia was an important cause of illness and death, with pneumococcus reported as the most common cause (29). During the 2009 influenza A (H1N1) pandemic, the ACIP

and Centers for Disease Control and Prevention strongly emphasized the need for vaccination of working-age adults who had PPSV23 indications because of the increased risk of pneumococcal disease and serious complications from influenza, overrepresentation of working-age adults among severe cases of influenza A (H1N1) infection, and low PPSV23 coverage in this group (17). The Centers for Disease Control and Prevention interim guidelines were published in September of 2009 (29), but our data suggest that the recommendations did not impact PPSV23 uptake among at-risk adults, as coverage did not significantly increase by calendar quarter during 2009. The reasons for lack of impact are unclear but may be related to the concerns among clinicians and contradictory evidence regarding the clinical effectiveness of PPSV23 (4, 17, 30).

Several limitations should be considered when interpreting these results. First, information on pneumococcal vaccination was self-reported and may be subject to recall bias (information may not be remembered correctly) and/or misclassification bias (may be confused with influenza or other vaccination). However, potential confusion between pneumococcal and influenza vaccination may be reduced by the clarifying questions included in the NHIS questionnaire (see above). Although to our knowledge, no studies have evaluated the validity of self-reported pneumococcal vaccination among persons 18–64 years of age, previous studies in the United States, Australia, and Spain have found that self-report of pneumococcal vaccination by adults 65 years of age or older was moderately or highly sensitive and moderately specific for pneumococcal vaccination compared with medical record review (31–35). However, 1 study in the United Kingdom reported lower estimates for sensitivity (36).

Second, the NHIS did not collect data on when the PPSV23 was received. Third, we did not know whether individuals received a second dose (were revaccinated) if that was indicated. However, given the low prevalence of conditions for which revaccination is recommended in the NHIS sample and the low coverage for revaccination, the potential influence of revaccination on our results is likely minimal. Fourth, the NHIS does not include information on important special populations at high risk for IPD, such as adults with human immunodeficiency virus infection. Fifth, the response rate of the NHIS adult core survey was relatively low (65.4%); however, the estimates were weighted to reflect differential probabilities of unit nonresponse. Finally, because our sample was limited to noninstitutionalized civilian adults, generalization may not be made beyond this population.

These findings underscore the need for continued monitoring of pneumococcal vaccination coverage among adult at-risk populations. In 2009, an estimated 35 million working-age adults had underlying medical conditions that are established PPSV23 indications, but only about a quarter of those individuals had received the vaccine. With the addition of asthma and cigarette smoking to the list of PPSV23 indications, the target population for pneumococcal vaccination increased to 72 million working-age adults, out of whom 59 million individuals at increased risk for pneumococcal disease were unvaccinated. The potentially preventable pneumococcal disease burden among adults is substantial, but because of limited acceptance among clinicians and lack of evidence of population-level impact on IPD or nonbacteremic pneumonia, increasing PPSV23 coverage among adult populations has been difficult. The experiences from routine PCV7 use among children and immunogenicity studies among adults suggest that the new PCV13 may also be efficacious among adults. In 2008, the serotypes covered by PCV13 caused 53% and 49% of IPD cases among persons 18–49 and 50–64 years of age, respectively (4). As this vaccine was recently approved by the Food and Drug Administration for use in adults 50 years of age or older, our findings might be useful for advisory bodies developing recommendations for the use of PCV13 among at-risk adults and as baseline data for cost-effectiveness analyses of new adult pneumococcal vaccines (37).

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