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Use of Outpatient Cardiac Rehabilitation Among Heart Attack Survivors — 20 States and the District of Columbia, 2013 and Four States, 2015

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Heart disease is the leading cause of death in the United States (*1*). Each year, approximately 790,000 adults have a myocardial infarction (heart attack), including 210,000 that are recurrent heart attacks (*2*). Cardiac rehabilitation (rehab) includes exercise counseling and training, education for heart-healthy living, and counseling to reduce stress. Cardiac rehab provides patients with education regarding the causes of heart attacks and tools to initiate positive behavior change, and extends patients' medical management after a heart attack to prevent future negative sequelae (*3*). A systematic review has shown that after a heart attack, patients using cardiac rehab were 53% (95% confidence interval [CI] = 41%–62%) less likely to die from any cause and 57% (95% CI = 21%–77%) less likely to experience cardiac-related mortality than were those who did not use cardiac rehab (*3*). However, even with long-standing national recommendations encouraging use of cardiac rehab (*4*), the intervention has been underutilized. An analysis of 2005 Behavioral Risk Factor Surveillance System (BRFSS) data found that only 34.7% of adults who reported a history of a heart attack also reported subsequent use of cardiac rehab (*5*). To update these estimates, CDC used the most recent BRFSS data from 2013 and 2015 to assess the use of cardiac rehab among adults following a heart attack. Overall use of cardiac rehab was 33.7% in 20 states and the District of Columbia (DC) in 2013 and 35.5% in four states in 2015. Cardiac rehab use was underutilized overall and differences were evident by sex, age, race/ethnicity, level of education, cardiovascular risk status, and by state. Increasing use of cardiac rehab after a heart attack should be encouraged by health systems and supported by the public health community.

The BRFSS is a telephone survey, conducted annually by all U.S states, with guidance and support from CDC (https://www.cdc.gov/brfss). The survey includes a core component and optional modules. Participants with history of a heart attack are identified by an affirmative response to the question, "Has a doctor, nurse, or other health professional ever told you that you had a heart attack, also called a myocardial infarction?" In 2013, 20 states* and DC, and in 2015, four states† included the cardiovascular health module, which contained questions about using cardiac rehab after a heart attack. The median response rates for the BRFSS were 46.4% and 47.2% for 2013 and 2015, respectively.

Participants identified as heart attack survivors were asked: "After you left the hospital following your heart attack, did you go to any kind of outpatient rehabilitation?" Demographic characteristics included age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic other, or Hispanic), highest level of education achieved (less than high school, high school graduate, some college, or college graduate) and having

* Arizona, Arkansas, Florida, Georgia, Hawaii, Iowa, Maine, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, North Dakota, Oklahoma, Oregon, South Carolina, Tennessee, Washington, and Wisconsin.
† Georgia, Iowa, Maine, and Oregon.

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any kind of health insurance. Selected self-reported cardiovascular disease (CVD) risk factors included hypertension, high blood cholesterol, diabetes, obesity, and current smoking.[§] Each respondent was categorized based on their number of CVD risk factors (0, 1, 2, 3, 4, or 5). Among heart attack survivors, the crude and adjusted percentage of cardiac rehab use was assessed overall and by state of residence in 2013 and 2015, as well as by demographic characteristics and CVD risk in 2013. P-values were obtained by Wald F test and $p<0.05$ were used to identify statistically significant differences among subgroups. The BRFSS's complex sample design was accounted for using statistical software with BRFSS respondent sampling weights and design variables.

In 2013, a total of 166,913 participants who completed the cardiovascular health module from 20 states and DC, among whom, 4.8% (95% CI = 4.6–5.0) were heart attack survivors. In 2015, a total of 20,776 participants from four states completed the module, 4.3% (3.9–4.7) of whom were heart attack survivors. Overall, 33.7% (95% CI = 31.8–35.6) of heart attack survivors in 2013 and 35.5% (95% CI = 31.0–40.3) in 2015 reported use of cardiac rehab after leaving the hospital following their heart attack.

In 2013, among 9,490 heart attack survivors, older adults, men, non-Hispanic whites, persons with college or higher education, and those with two, three, or four (of five) CVD risk factors were more likely to receive cardiac rehab than were younger persons, women, non-Hispanic blacks, Hispanics, persons with less than a college education, and persons with fewer than two or with five out of five CVD risk factors (relative to those with two, three of four; $p<0.05$) (Table 1).

In 2013, the adjusted percentage of cardiac rehab use ranged from 20.7% in Hawaii to 58.6% in Minnesota (Table 2). Among the four states that used the cardiac rehab module in 2015, both the crude and adjusted percentages of cardiac rehab use were lowest in Georgia and highest in Iowa. Among the four states that used the module in both 2013 and 2015, the overall adjusted percentage of cardiac rehab use was 35.6% (95% CI = 32.1–39.3) in 2013 and 35.5% (95% CI = 31.0–40.3) in 2015 ($p = 0.8075$).

Discussion

In this analysis, approximately 1 in 3 heart attack survivors reported receiving cardiac rehab after suffering a heart attack. These estimates highlight missed opportunities to access an evidenced-based intervention that has been documented to improve patient survival, quality of life, functional status,

[§] Hypertension was defined by answering "yes" to the question, "Have you ever been told by a doctor, nurse, or other health professional that you have high blood pressure?" (persons who answered yes only during pregnancy were not included); high blood cholesterol was defined by answering "yes" to the question, "Have you ever been told by a doctor, nurse, or other health professional that your blood cholesterol is high?"; diabetes was defined by answering "yes" to the question, "Have you ever been told by a doctor that you have diabetes?"; obesity was ascertained by asking, "About how much do you weigh without shoes?" and "About how tall are you without shoes?," and based on the answers, calculating body mass index (kg/m2); obesity was defined as body mass index ≥30; current smoking was defined by answering "every day" or "some days" to the question, "Do you now smoke cigarettes every day, some days, or not at all?"

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TABLE 1. Crude and adjusted percentages* of adults who survived a heart attack and received cardiac rehabilitation, by descriptive characteristics — Behavioral Risk Factor Surveillance System, 20 U.S. states and the District of Columbia, 2013

Characteristics	No.	Crude % (95% CI)	p-value	Adjusted %* (95% CI)	p-value
Total	**9,490**	**33.7 (31.8–35.6)**	**<0.001**	**33.7 (31.8–35.6)**	**<0.001**
Sex			<0.001	—	<0.001
Men	5,197	36.9 (34.4–39.5)		36.4 (33.9–39.0)	
Women	4,293	28.2 (25.7–30.8)		28.8 (26.4–31.4)	
Age group (yrs)			<0.001	—	<0.001
18–64	3,197	26.9 (24.3–29.7)		28.6 (26.0–31.3)	
≥65	6,293	39.6 (37.2–42.1)		37.9 (35.3–40.5)	
Race/Ethnicity			<0.001	—	<0.001
White, non-Hispanic	7,756	37.0 (35.0–38.9)		35.4 (33.5–37.4)	
Black, non-Hispanic	873	21.9 (17.4–27.3)		25.3 (20.4–31.0)	
Hispanic	617	23.2 (17.5–30.0)		24.5 (18.4–31.8)	
Other, non-Hispanic	244	25.7 (15.9–38.8)		33.3 (22.4–46.3)	
Education			<0.001	—	<0.001
Less than high school	1,483	21.8 (17.7–26.6)		23.3 (19.4–27.6)	
High school diploma	3,297	36.2 (33.3–39.3)		36.1 (33.1–39.2)	
Some college	2,649	33.6 (30.5–36.8)		33.0 (29.9–36.2)	
College graduate	2,061	48.3 (44.1–52.4)		46.4 (42.5–50.4)	
Insurance			<0.001	—	0.0197
Yes	8,899	35.3 (33.4–37.3)		34.4 (32.5–36.5)	
No	591	18.6 (13.7–24.8)		25.2 (19.0–32.5)	
No. of cardiovascular risk factors†			0.0108	—	0.0074
0	557	32.3 (25.5–40.0)		32.3 (25.8–39.6)	
1	1,719	27.9 (23.8–32.4)		27.2 (23.5–31.3)	
2	2,987	36.7 (33.1–40.4)		35.4 (32.0–39.0)	
3	2,671	35.2 (32.0–38.5)		35.1 (32.1–38.2)	
4	1,380	34.1 (29.6–38.8)		37.1 (32.8–41.7)	
5	176	21.3 (13.6–31.8)		25.7 (16.8–37.2)	

Abbreviation: CI = confidence interval.
* Adjusted for age, sex, race/ethnicity, education, insurance status, and CVD risk.
† Hypertension, high cholesterol, diabetes, obesity, and current smoker.

and cardiovascular risk profile following a significant health event, as well as reduce risk for a recurrent heart attack and psychological disorders (*3*,*6*).

Outpatient cardiac rehab has historically been underutilized (*5*), and the findings from this report demonstrate that this continues to be the case in all groups. No subgroup examined had utilization rates exceeding 50% and no state had utilization rates above 61%. Even with low percentages of rehab use, disparities in its use were apparent. Younger adults, females, blacks, Hispanics, adults without health insurance, and those with fewer than two or with five out of five CVD risk factors (relative to those with two, three, or four) were less likely to use cardiac rehab than were their counterparts. Threefold differences in cardiac rehab use were observed at the state level. The continued underutilization of cardiac rehab overall and among the aforementioned subgroups has been shown to be related to multiple factors, including lack of patient knowledge, awareness, and perceived importance of rehab; accessibility to rehab program sites; lack of health insurance coverage or high out-of-pocket costs for these services; and low referral rates from health care professionals (*4*).

In concert with *Healthy People 2020* objectives (*7*), the U.S. Department of Health and Human Service's Million Hearts initiative (https://millionhearts.hhs.gov/index.html), aims to increase cardiac rehab use among heart attack survivors across the United States (*8*). The Million Hearts Cardiac Rehabilitation Collaborative,¶ a group of over 30 organizations and agencies, has developed an action plan to increase use of cardiac rehab to over 70%. The roadmap for this action plan includes interventions that increase the referral to cardiac rehab (e.g., through electronic medical record-based referral), enrollment in rehab (e.g., via patient interaction with a cardiac rehab staff member liaison at hospital discharge), and adherence to cardiac rehab services (e.g., by minimizing patient copayments). Meeting the Million

¶ The Million Hearts Cardiac Rehabilitation Collaborative (CRC), is an outgrowth of the Million Hearts Cardiac Rehabilitation Leadership Summit held in November 2015 in Washington, DC, with representatives from over 30 organizations and agencies as well as CR graduates and their families. Represented organizations include the American Association of Cardiovascular and Pulmonary Rehabilitation, American Heart Association, American College of Cardiology, American Association of Nurse Practitioners, American College of Physicians, American Hospital Association, Heart Failure Society of America, Preventive Cardiovascular Nurses Association, Blue Cross Blue Shield Association, National Medical Association, Patient-Centered Outcomes Research Institute, America's Essential Hospitals, Mended Hearts, WomenHeart, and Visiting Nurse Services of NY, and MedStar Health. The CRC has grown to include additional clinical specialist and patient advocacy groups as well as representatives from CR programs and health systems across the country. The CRC meets quarterly by phone to drive progress on their aim of achieving at least 70% participation among those eligible by 2022.

Hearts goal of increasing use of cardiac rehab among patients with a qualifying condition to ≥70% in 5 years would save an estimated 25,000 lives and prevent 180,000 hospitalizations annually in the United States (*9*).

The findings in this report are subject to at least four limitations. First, BRFSS data are self-reported and are limited by recall bias, which could lead to underestimation of either heart attacks or use of cardiac rehab. Second, the survey does not provide information about why survey respondents did not participate in cardiac rehab, or whether those who did had attended the recommended number of cardiac rehab sessions. Third, since state participation in using the rehab module of the BRFSS was low (40% in 2013 and 8% in 2015) and inconsistent over time, these findings do not provide nationally representative estimates. Finally, with relatively few respondents reporting a history of heart attack (183 [DC] to 2,288 [Florida]), state-level confidence intervals were wide and might account for nonsignificant differences in cardiac rehab use for some characteristics.

Health system interventions to promote cardiac rehab referral and use, supported by access to affordable rehab programs within the community, should be prioritized to improve outcomes and prevent recurrent events. Given that overall cardiac rehab use was low, improvement in referral is needed; however, populations with lower use of cardiac rehab, such as women, those with lower levels of education, and minority populations should be further assessed to determine barriers to the use of cardiac rehab. Some strategies that might improve use of cardiac rehab include higher payment for rehab by insurers, eliminating or reducing copays for patients, extending cardiac rehab clinic hours to improve access, as well as providing standardized referrals coupled with linkage to cardiac rehab staff member liaisons at hospital discharge or by primary care providers and cardiologists. In addition, patients who have experienced a heart attack should be made aware of the availability of alternative models of cardiac rehab, such as telehealth and home-based rehab, to reduce the barriers related to transportation and responsibilities at home or work (*4*,*6*,*9*,*10*).

TABLE 2. Number and crude and adjusted percentages* of adults who survived a heart attack and received cardiac rehabilitation, by state — Behavioral Risk Factor Surveillance System, 20 U.S. states and the District of Columbia (DC) (2013) and 4 U.S. states (2015)

		Crude		Adjusted*	
States†	No.	% (95% CI)	p-value	% (95% CI)	p-value
2013 (20 states and DC)			<0.001	—	<0.001
Total	**9,490**	**33.7 (31.8–35.6)**		**33.7 (31.8–35.6)**	
Hawaii	263	19.7 (13.6–27.8)		20.7 (13.9–29.6)	
Oklahoma	288	20.8 (15.7–27.0)		20.9 (15.6–27.2)	
Oregon	225	26.9 (20.5–34.4)		24.9 (19.2–31.7)	
Arizona	230	23.5 (15.1–34.6)		25.0 (17.7–34.2)	
Tennessee	392	25.0 (19.9–30.9)		27.2 (21.9–33.2)	
Washington	550	31.2 (26.3–36.5)		29.4 (24.8–34.5)	
DC	183	23.6 (16.1–33.2)		29.5 (20.0–41.1)	
Mississippi	458	27.8 (21.9–34.6)		29.5 (23.6–36.3)	
Florida	2,288	30.4 (25.7–35.5)		29.9 (25.8–34.4)	
Georgia	375	28.6 (23.2–35.1)		30.1 (24.5–36.3)	
North Carolina	227	29.1 (22.3–37.0)		31.2 (24.3–39.0)	
Arkansas	345	30.0 (23.6–37.3)		31.5 (25.0–38.9)	
Missouri	470	36.6 (30.3–43.4)		36.3 (30.1–43.0)	
South Carolina	569	37.7 (32.4–43.3)		38.3 (33.1–43.8)	
Massachusetts	195	46.5 (36.0–57.4)		42.9 (33.4–53.0)	
Maine	286	48.6 (41.3–56.0)		46.1 (38.7–53.7)	
North Dakota	392	51.7 (45.3–58.0)		47.2 (41.1–53.3)	
Nebraska	456	51.4 (44.2–58.5)		49.0 (42.3–55.8)	
Iowa	464	54.6 (48.9–60.2)		51.4 (45.7–57.0)	
Wisconsin	266	56.3 (45.9–66.1)		53.3 (44.0–62.4)	
Minnesota	568	60.9(52.4–68.8)		58.6 (49.9–66.7)	
2015 (four states)			<0.001	—	<0.001
Total	**1,006**	**35.5 (31.0–40.3)**		**35.5 (31.0–40.3)**	
Georgia	229	26.3 (19.9–34.0)		27.9 (21.5–35.5)	
Oregon	206	35.5 (27.6–44.3)		32.2 (24.6–40.9)	
Maine	294	45.0 (37.8–52.4)		44.4 (36.9–52.1)	
Iowa	277	59.4 (52.0–66.5)		57.5(49.6–65.0)	

Abbreviation: CI = confidence interval.
* Adjusted for age, sex, race/ethnicity, education, insurance status and CVD risk.
† States are listed in ascending order of adjusted percentage of receiving cardiac rehabilitation in 2013 and 2015.

Summary

What is already known about this topic?

Each year, approximately 210,000 heart attacks are recurrent events. Outpatient cardiac rehabilitation among heart attack survivors helps to reduce these recurrences and improve health outcomes. Thus, national guidelines and recommendations encourage the use of cardiac rehabilitation.

What is added by this report?

This report used the most recent Behavioral Risk Factor Surveillance System data from 2013 (20 states) and 2015 (four states) to assess the use of cardiac rehabilitation among adults following a heart attack. In 2013, only one third of heart attack survivors used cardiac rehabilitation, and its use varied by sex, race/ethnicity, education, insurance status, cardiovascular risk status and by state. The percentage of use of cardiac rehabilitation did not change significantly from 2013 to 2015 among the four states observed during both years.

What are the implications for public health practice?

The percentage of heart attack survivors using cardiac rehabilitation is suboptimal. Strategies that increase the use of cardiac rehabilitation among all heart attack survivors, including lowering out-of-pocket payment, improving access, standardizing referrals, and providing education to enhance awareness, with special focus among populations who are most underserved, has the potential to substantially improve health outcomes of heart attack survivors.

Conflict of Interest

No conflicts of interest were reported.

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National, Regional, State, and Selected Local Area Vaccination Coverage Among Adolescents Aged 13–17 Years — United States, 2016

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The Advisory Committee on Immunization Practices (ACIP) recommends that adolescents routinely receive tetanus, diphtheria, and acellular pertussis vaccine (Tdap), meningococcal conjugate vaccine (MenACWY), and human papillomavirus (HPV) vaccine (*1*) at age 11–12 years. ACIP also recommends catch-up vaccination with hepatitis B vaccine, measles, mumps, and rubella (MMR) vaccine, and varicella vaccine for adolescents who are not up to date with childhood vaccinations. ACIP recommends a booster dose of MenACWY at age 16 years (*1*). In December 2016, ACIP updated HPV vaccine recommendations to include a 2-dose schedule for immunocompetent adolescents initiating the vaccination series before their 15th birthday (*2*). To estimate adolescent vaccination coverage in the United States, CDC analyzed data from the 2016 National Immunization Survey–Teen (NIS-Teen) for 20,475 adolescents aged 13–17 years.* During 2015–2016, coverage increased for ≥1 dose of Tdap (from 86.4% to 88.0%) and for each HPV vaccine dose (from 56.1% to 60.4% for ≥1 dose). Among adolescents aged 17 years, coverage with ≥2 doses of MenACWY increased from 33.3% to 39.1%. In 2016, 43.4% of adolescents (49.5% of females; 37.5% of males) were up to date with the HPV vaccination series, applying the updated HPV vaccine recommendations retrospectively.† Coverage with ≥1 HPV vaccine dose varied by metropolitan statistical area (MSA) status and was lowest (50.4%) among adolescents living in non-MSA areas and highest (65.9%) among those living in MSA central cities.§ Adolescent vaccination coverage continues to improve overall; however, substantial opportunities exist to further increase HPV-associated cancer prevention.

NIS-Teen is an annual survey that collects data on vaccines received by adolescents aged 13–17 years in the 50 states, the District of Columbia, selected local areas, and territories.¶ NIS-Teen is conducted among parents and guardians of eligible adolescents identified using a random-digit–dialed sample of landline and cellular telephone numbers.** Parents and guardians are interviewed for information on the sociodemographic characteristics of the adolescent and household, and contact information for the child's vaccination providers. If more than one age-eligible adolescent lives in the household, one adolescent is randomly selected for participation. With parental/guardian consent, health care providers identified during the interview are mailed a questionnaire requesting the vaccination history from the adolescent's medical record.†† This report

* Eligible participants were born during January 1998–February 2004. Tetanus, diphtheria, and acellular pertussis vaccine (Tdap) represents coverage with ≥1 Tdap dose at age ≥10 years. Meningococcal conjugate vaccine (MenACWY) represents coverage with the quadrivalent meningococcal conjugate vaccine or meningococcal-unknown type vaccine. Coverage with meningococcal type B vaccine is not included in 2016 National Immunization Survey–Teen (NIS-Teen) vaccination coverage estimates. Human papillomavirus (HPV) vaccination coverage includes receipt of any HPV vaccine and does not distinguish between nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV) vaccines. Some adolescents might have received more than the 2 or 3 recommended HPV vaccine doses. Estimates for hepatitis B and measles, mumps, and rubella vaccines represent coverage based on the catch-up schedule for adolescents who are not up to date with these vaccinations. Except as noted, coverage estimates for ≥1 and ≥2 varicella vaccine doses were obtained among adolescents with no history of varicella disease. Influenza vaccination coverage data are not included in this report but are available online at https://www.cdc.gov/flu/fluvaxview/index.htm.

† Most of the vaccination data for adolescents surveyed in the 2016 NIS-Teen were collected before publication of the 2-dose HPV schedule. However, the HPV up-to-date status of these adolescents was assessed to estimate what proportion would not need further HPV vaccination doses under the updated schedule. Adolescents were considered to be up to date with HPV vaccination if they had received ≥3 doses, or if each of the following applied: 1) they had received 2 doses; 2) the first dose was received before their 15th birthday; and 3) the difference between dates of first and second doses was ≥5 months minus 4 days, the absolute minimum interval between the first and second doses (https://www.cdc.gov/vaccines/programs/iis/cdsi.html).

§ Metropolitan statistical area (MSA) status was determined based on household-reported county of residence, and was grouped into three categories: MSA central city, MSA non-central city, and non-MSA. MSA and central city were as defined by the U.S. Census Bureau (https://www.census.gov/geo/reference/gtc/gtc_cbsa.html). Non-MSA areas include urban populations not located within an MSA as well as completely rural areas.

¶ Local areas that received federal Section 317 immunization funds were sampled separately: Chicago, Illinois; New York, New York; Philadelphia County, Pennsylvania; Bexar County, Texas; and Houston, Texas. Two local areas were oversampled: El Paso County, Texas and Dallas County, Texas. Three territories were sampled separately in 2016: Guam, Puerto Rico, and the U.S. Virgin Islands.

** All identified cellular-telephone households were eligible for interview. Sampling weights were adjusted for dual-frame (landline and cellular telephone), nonresponse, noncoverage, and overlapping samples of mixed telephone users. A description of NIS-Teen dual-frame survey methodology and its effect on reported vaccination estimates is available at https://www.cdc.gov/vaccines/imz-managers/coverage/nis/child/dual-frame-sampling.html.

†† For the telephone samples for the states and local areas, the overall Council of American Survey Research Organizations (CASRO) response rate was 32.7% (55.5% for the landline sample and 29.5% for the cellular telephone sample). For adolescents with completed interviews, 48.4% had adequate provider data (53.9% landline sample, 47.4% cell sample). Among completed interviews with adequate provider data, 23% (4,684) were from the landline sample and 77% (15,791) were from the cellular telephone sample. For territories, the overall CASRO response rates were 31.5% for Guam, 33.2% for Puerto Rico, and 44.4% for the U.S. Virgin Islands. The CASRO response rate is the product of three other rates: 1) the resolution rate (the proportion of telephone numbers that can be identified as either for business or residence); 2) the screening rate (the proportion of qualified households that complete the screening process); and 3) the cooperation rate (the proportion of contacted eligible households for which a completed interview is obtained).

presents vaccination coverage estimates for 20,475 adolescents (9,661 females and 10,814 males) aged 13–17 years with adequate provider data.[§§] NIS-Teen methodology, including methods for weighting and synthesizing provider-reported vaccination histories, has been described (https://www.cdc.gov/vaccines/imz-managers/nis/downloads/NIS-PUF15-DUG.pdf). T-tests were used for statistical comparison of weighted data to account for the complex survey design. Weighted linear regression by survey year was used to estimate annual percentage point increases. Differences were considered statistically significant for p-values <0.05.

National Vaccination Coverage

In 2016, ≥1-dose HPV vaccination coverage among teens was 60.4% (65.1% for females; 56.0% for males), and 43.4% were up to date with the recommended HPV vaccination series (49.5% for females; 37.5% for males) (Table 1). During 2015–2016, HPV vaccination coverage increased for ≥1 dose by 4.3 percentage points overall (6.2 for males), for ≥2 doses by 3.8 percentage points (2.8 for females; 4.6 for males), and for ≥3 doses by 2.2 percentage points (3.4 for males) (Table 1) (Figure 1). Also during 2015–2016, coverage with ≥1 Tdap dose increased by 1.6 percentage points to 88.0%; among adolescents without a history of varicella disease, coverage with ≥2 varicella vaccine doses increased by 2.5 percentage points to 85.6%; and among persons aged 17 years, coverage with ≥2 MenACWY doses increased by 5.8 percentage points to 39.1% (Table 1) (Figure 1).

Vaccination Coverage by Selected Characteristics

Tdap and MenACWY coverage was similar for each age group. For HPV vaccination (≥1-dose, ≥2-dose, and ≥3-dose coverage, and up-to-date status) coverage was higher overall and by sex, for persons aged 17 years (e.g., ≥1-dose coverage was 65.4% versus 53.5% at age 13 years), except for HPV up-to-date status among males, which was highest among males aged 16 years (Table 1). Among adolescents aged 13 years, HPV vaccination coverage was similar for females and males; among adolescents aged 17 years, HPV vaccination coverage was 14–23 percentage points higher among females than among males (Table 1).

Differences in vaccination coverage by race/ethnicity in 2016 were similar to patterns observed in previous years (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/47510) (*3*). Coverage with Tdap, MenACWY, MMR vaccine, hepatitis B vaccine, and ≥2 doses of varicella vaccine did not differ by poverty status[¶¶] (Table 2); however, HPV coverage, overall and by sex, was higher among adolescents living below the federal poverty level than among those living at or above the poverty level (e.g., overall, 12.9 percentage points and 8.4 percentage points higher for ≥1-dose coverage and up-to-date status, respectively). HPV coverage, overall and by sex, was 13–17 percentage points lower for adolescents living in non-MSA areas and 5–8 percentage points lower among those living in MSA non-central city areas than among those living in MSA central cities (Table 2). Coverage with ≥1 MenACWY dose and ≥2 varicella vaccine doses were 9.5 percentage points and 4.5 percentage points, respectively, lower among adolescents living in non-MSA areas than among those living in MSA central cities. Adolescents living in non-MSA areas were more likely to have all reported vaccination providers from public facilities (30.4%) than were those living in MSA non-central cities (10.3%) or MSA central cities (14.4%) (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/47510).

State, Local, and Territorial Vaccination Coverage

Vaccination coverage varied by state (Table 3). For example, coverage with ≥1 Tdap dose ranged from 77.5% in South Carolina to 96.7% in Massachusetts, and ≥1-dose MenACWY coverage ranged from 54.2% in Wyoming to 96.4% in Rhode Island. Among females, ≥1-dose HPV vaccination coverage ranged from 47.8% in Mississippi to 90.1% in Rhode Island (Table 3) (Figure 2); among males, ≥1-dose HPV coverage ranged from 36.9% in Indiana and Wyoming to 87.8% in Rhode Island (Table 3) (Figure 3). HPV up-to-date estimates among females ranged from 30.8% in South Carolina to 73.0% in Rhode Island, and among males, from 19.9% in Wyoming to 68.7% in Rhode Island. During 2013–2016, ≥1-dose HPV vaccination coverage increased an average of 5.0 percentage points per year nationally; among states, local areas, and territories, the greatest statistically significant average annual increases were in New York City (7.7 percentage points), Nevada (7.6), Maryland (7.4), Guam (7.3), New York (7.2), and Alaska (7.1) (Supplementary Table 3, https://stacks.cdc.gov/view/cdc/47510).

Discussion

In 2016, adolescent vaccination coverage in the United States was sustained and continued to improve in several areas: compared with 2015, coverage with Tdap, ≥2 doses of varicella

[§§] Adolescents from Guam (242 females and 293 males), Puerto Rico (197 females and 208 males), and the U.S. Virgin Islands (201 females and 227 males) were excluded from the national estimates.

[¶¶] Adolescents were classified as below the federal poverty level if their total family income was less than the federal poverty level specified for the applicable family size and number of children aged <18 years. All others were classified as at or above the poverty level. Poverty status was unknown for 724 adolescents. https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

TABLE 1. Estimated vaccination coverage with selected vaccines and doses among adolescents aged 13–17* years, by age at interview — National Immunization Survey–Teen, United States, 2016

	% (95% CI)†						
	Age (yrs)					Total	
	13	14	15	16	17	2016	2015
Vaccine	(n = 4,209)	(n = 4,256)	(n = 4,113)	(n = 4,190)	(n = 3,707)	(N = 20,475)	(N = 21,875)
Tdap§ ≥1 dose	87.6 (85.4–89.6)	88.5 (86.3–90.4)	87.9 (85.5–89.9)	89.2 (87.5–90.7)	86.8 (84.4–88.9)	88.0 (87.1–88.9)¶	86.4 (85.4–87.3)
MenACWY**							
≥1 dose	81.7 (79.2–83.9)	83.3 (81.1–85.4)	80.4 (77.8–82.8)	82.3 (80.1–84.3)	83.5 (81.3–85.5)	82.2 (81.2–83.2)	81.3 (80.2–82.3)
≥2 doses††	—	—	—	—	39.1 (36.1–42.1)	39.1 (36.1–42.1)¶	33.3 (30.7–36.0)
HPV§§ vaccine							
All adolescents							
≥1 dose	53.5 (50.8–56.2)	59.2 (56.3–62.0)¶	62.0 (59.1–64.7)¶	61.9 (59.4–64.4)¶	65.4 (62.5–68.1)¶	60.4 (59.2–61.6)¶	56.1 (54.9–57.4)
≥2 doses	40.6 (37.9–43.4)	47.2 (44.2–50.2)¶	50.3 (47.4–53.3)¶	52.4 (49.8–55.0)¶	55.1 (52.1–58.1)¶	49.2 (47.9–50.4)¶	45.4 (44.2–46.7)
≥3 doses	27.0 (24.5–29.6)	34.9 (32.0–38.0)¶	37.6 (34.9–40.4)¶	42.9 (40.3–45.5)¶	43.1 (40.1–46.1)¶	37.1 (35.9–38.4)¶	34.9 (33.7–36.1)
HPV UTD***	33.7 (31.1–36.5)	42.5 (39.5–45.6)¶	45.4 (42.5–48.3)¶	47.6 (45.0–50.3)¶	47.3 (44.3–50.3)¶	43.4 (42.1–44.7)	NA
Females							
≥1 dose	54.7 (50.9–58.4)	62.7 (58.5–66.7)¶¶	68.4 (64.2–72.2)¶¶	66.8 (63.3–70.2)¶¶	72.7 (68.9–76.2)¶¶	65.1 (63.3–66.8)	62.8 (61.0–64.5)
≥2 doses	42.9 (39.1–46.8)	50.2 (45.7–54.6)¶¶	57.4 (52.8–61.8)¶¶	59.3 (55.7–62.9)¶¶	65.1 (61.0–69.0)¶¶	55.0 (53.1–56.8)¶	52.2 (50.3–54.0)
≥3 doses	28.8 (25.2–32.6)	38.4 (34.1–42.9)¶¶	43.7 (39.4–48.2)¶¶	50.0 (46.3–53.8)¶¶	54.2 (49.7–58.6)¶¶	43.0 (41.1–44.9)	41.9 (40.1–43.7)
HPV UTD	36.1 (32.4–40.0)	46.1 (41.6–50.5)¶¶	52.4 (47.8–56.9)¶¶	54.2 (50.5–57.9)¶¶	59.0 (54.6–63.3)¶¶	49.5 (47.6–51.4)	NA
Males							
≥1 dose	52.4 (48.5–56.3)	56.0 (52.0–59.9)	55.4 (51.7–59.0)	57.3 (53.7–60.8)	58.6 (54.6–62.6)¶¶	56.0 (54.3–57.7)¶	49.8 (48.0–51.6)
≥2 doses	38.4 (34.6–42.3)	44.5 (40.4–48.6)¶¶	43.1 (39.5–46.7)	45.9 (42.3–49.5)¶¶	45.9 (41.8–50.0)¶¶	43.6 (41.9–45.3)¶	39.0 (37.3–40.8)
≥3 doses	25.2 (21.9–28.8)	31.8 (27.9–36.0)¶¶	31.3 (28.1–34.7)¶¶	36.2 (32.8–39.8)¶¶	32.8 (29.3–36.6)¶¶	31.5 (30.0–33.2)¶	28.1 (26.6–29.7)
HPV UTD	31.4 (27.9–35.3)	39.3 (35.2–43.5)¶¶	38.2 (34.7–41.7)¶¶	41.4 (37.9–45.0)¶¶	36.6 (32.9–40.4)	37.5 (35.8–39.2)	NA
MMR vaccine ≥2 doses	90.7 (88.6–92.4)	91.9 (90.3–93.3)	91.4 (89.7–92.8)	91.1 (89.7–92.3)	89.4 (87.2–91.2)	90.9 (90.1–91.6)	90.7 (89.9–91.4)
Hepatitis B vaccine ≥3 doses	91.7 (89.7–93.3)	92.5 (91.0–93.8)	91.3 (89.5–92.8)	91.2 (89.8–92.5)	90.3 (88.2–92.0)	91.4 (90.7–92.1)	91.1 (90.2–91.9)
Varicella							
History of varicella†††	10.2 (8.8–11.8)	12.4 (10.8–14.2)	14.8 (13.0–16.9)¶¶	17.9 (16.0–20.1)¶¶	20.5 (18.1–23.2)¶¶	15.2 (14.3–16.1)¶	17.8 (16.8–18.9)
No history of varicella disease							
≥1 dose vaccine	95.0 (93.0–96.5)	96.2 (95.0–97.0)	94.8 (92.4–96.4)	94.9 (93.5–95.9)	94.0 (92.1–95.5)	95.0 (94.2–95.6)	94.9 (94.1–95.6)
≥2 doses vaccine	89.3 (87.0–91.2)	87.5 (85.2–89.6)	84.3 (81.5–86.8)¶¶	83.5 (81.4–85.5)¶¶	82.7 (80.2–84.9)¶¶	85.6 (84.5–86.6)¶	83.1 (82.0–84.2)
History of varicella or received ≥2 doses varicella vaccine	90.4 (88.3–92.1)	89.1 (87.0–90.9)	86.7 (84.2–88.8)¶¶	86.5 (84.7–88.1)¶¶	86.2 (84.2–88.0)¶¶	87.8 (86.9–88.6)¶	86.1 (85.2–87.0)

Abbreviations: CI = confidence interval; HPV = human papillomavirus; MenACWY = quadrivalent meningococcal conjugate vaccine; MMR = measles, mumps, and rubella; NA = not applicable – the update to the HPV recommendation occurred in December 2016; the new criteria was only applied retrospectively to the most current data year in which the recommendation was published; NIS-Teen = National Immunization Survey–Teen; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine; UTD = up to date.

* Adolescents (N = 20,475) in the 2016 NIS-Teen were born during January 1998–February 2004.

† Estimates with 95% CI half-widths >10 might not be reliable.

§ Includes percentages receiving Tdap vaccine at age ≥10 years.

¶ Statistically significant difference (p<0.05) compared with 2015 NIS-Teen estimates.

** Includes percentages receiving MenACWY or meningococcal-unknown type vaccine.

†† ACIP recommends a booster dose at age 16 years. Estimates are provided for ≥2 doses of MenACWY or meningococcal-unknown type vaccine. Calculated only among adolescents who were aged 17 years at time of interview. Does not include adolescents who received 1 dose of MenACWY vaccine at age ≥16 years.

§§ HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV). For ≥1, ≥2, and ≥3 dose measures, percentages are reported among females and males combined (N = 20,475) and for females only (n = 9,661) and males only (n = 10,814).

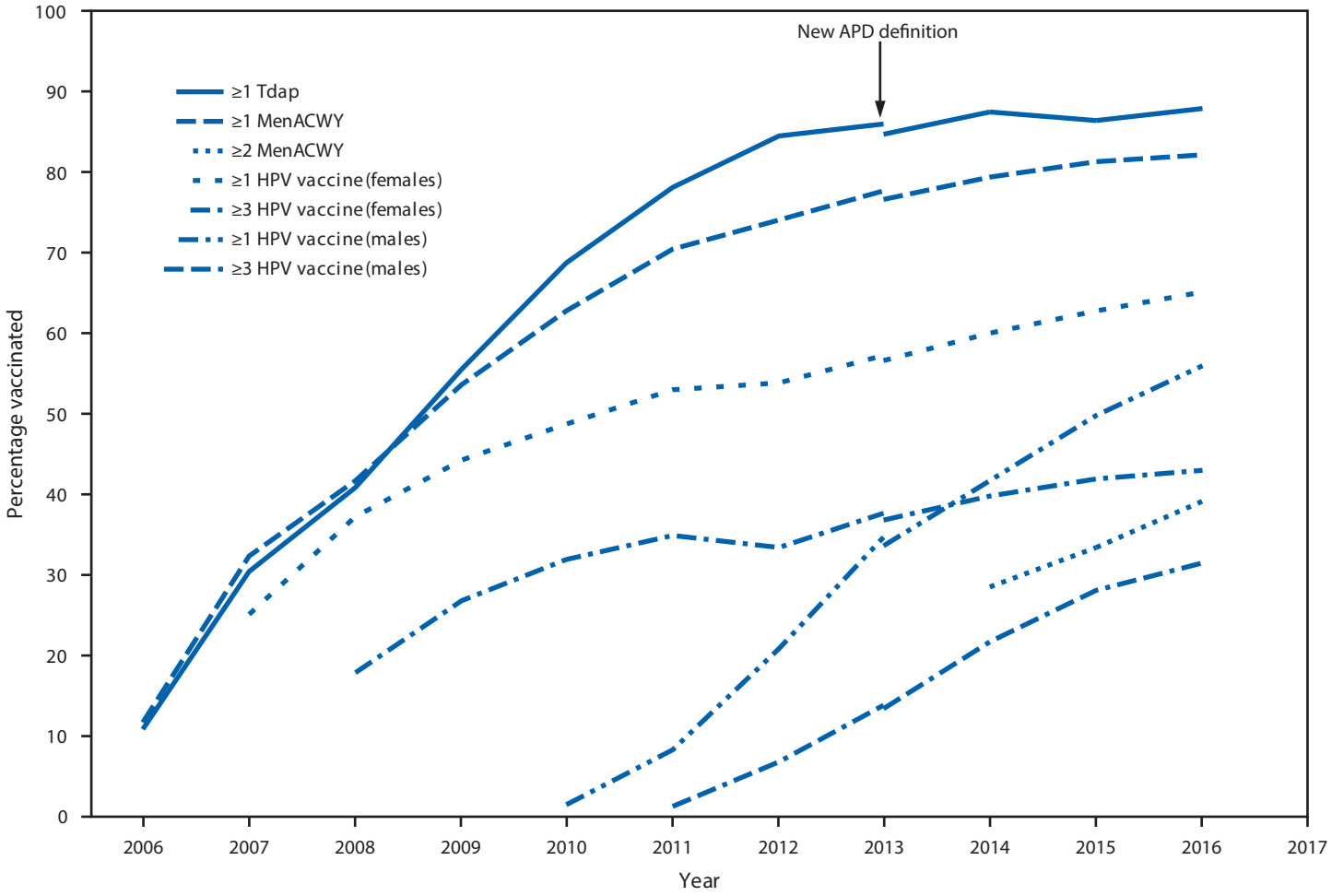
¶¶ Statistically significant difference (p<0.05) in estimated vaccination coverage by age: reference group was adolescents aged 13 years.

*** HPV UTD includes those who received ≥3 doses, and those who received 2 doses when the first HPV vaccine dose was initiated before age 15 years and the time between the first and second dose was at least 5 months minus 4 days.

††† By parent/guardian report or provider records.

vaccine, ≥2 doses of MenACWY, and each dose of HPV vaccine increased. Since HPV vaccine was introduced for females in 2006 and for males in 2011, coverage has increased gradually among females and more rapidly among males. During 2015–2016, increases in coverage with each HPV dose, ranging from 3.4 to 6.2 percentage points occurred among males, whereas only a 2.8 percentage point increase in ≥2-dose HPV coverage occurred among females. Coverage with ≥1-dose HPV vaccine among males continues to approach that among females, particularly for adolescents aged 13 years, suggesting that HPV vaccination of both female and male adolescents has been integrated into vaccination practices. Although HPV

FIGURE 1. Estimated vaccination coverage with selected vaccines and doses* among adolescents aged 13-17 years, by survey year — National Immunization Survey-Teen (NIS-Teen), United States, 2006–2016†



Abbreviations: ACIP = Advisory Committee on Immunization Practices; APD = adequate provider data; HPV = human papillomavirus; MenACWY = quadrivalent meningococcal conjugate vaccine; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine.

* ≥1 dose Tdap at or after age 10 years; ≥1 MenACWY: ≥1 dose MenACWY or meningococcal-unknown type vaccine; ≥2 MenACWY: ≥2 doses MenACWY or meningococcal-unknown type vaccine, calculated only among adolescents aged 17 years at time of interview. Does not include adolescents who received their first and only dose of MenACWY at or after age 16 years; HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV) or bivalent (2vHPV). ACIP recommends 9vHPV, 4vHPV or 2vHPV for females and 9vHPV or 4vHPV for males. The routine ACIP recommendation was made for females in 2006 and for males in 2011.

† NIS-Teen implemented a revised APD definition in 2014, and retrospectively applied the revised APD definition to 2013 data. Estimates using different APD definitions might not be directly comparable.

vaccination initiation (receipt of ≥1 HPV vaccine dose) continues to increase, coverage remains 22–28 percentage points lower than those for Tdap and ≥1-dose MenACWY. These gaps indicate substantial opportunity for improving HPV vaccination practices.

Disparities in adolescent vaccination coverage were found by MSA status: HPV vaccination initiation among adolescents living outside MSA central cities was 16 percentage points lower than among those living in MSA central cities. Although adolescents living in non-MSA areas had substantially lower HPV and MenACWY vaccination coverage compared with those living in MSA central cities, Tdap coverage in these groups was similar. Reasons for these disparities are not well understood. Potential contributing factors might include differences in parental acceptance of certain vaccines and provider participation in, and adolescents' eligibility for, the Vaccines for Children program.*** The disproportionately lower number of pediatric primary care providers found in non-MSA areas than in MSA central city areas (*4*,*5*) might partially explain

*** Children aged ≤18 years who are Medicaid-eligible, uninsured, or American Indian/Alaska Native (as defined by the Indian Health Care Improvement Act) are eligible to receive vaccines from providers through the Vaccines for Children (VFC) program. Children categorized as "underinsured" (because their health plans do not include coverage for recommended vaccinations) are eligible to receive VFC vaccines if they are served by a rural health clinic or federally qualified health center or under an approved deputization agreement. https://www.cdc.gov/vaccines/programs/vfc/providers/eligibility.html.

TABLE 2. Estimated vaccination coverage with selected vaccines and doses among adolescents aged 13–17 years,* by poverty level† and metropolitan statistical area (MSA)§ — National Immunization Survey–Teen, United States, 2016.

	% (95% CI)¶							
	Poverty status			MSA				
Vaccine	Below poverty level (n = 3,461)	At or above poverty level (n = 16,290)	Difference (n = 19,751)	Non-MSA (n = 4,248)	MSA non-central city (n = 8,248)	MSA central city (n = 7,979)	Difference between non-MSA and MSA central city (n = 12,227)	Difference between MSA non-central city and central city (n = 16,227)
Tdap** ≥1 dose	86.7 (84.6 to 88.6)	88.4 (87.3 to 89.4)	-1.7 (-3.9 to 0.5)	87.7 (86.0 to 89.3)	87.8 (86.3 to 89.2)	88.4 (86.9 to 89.7)	-0.6 (-2.8 to 1.5)	-0.6 (-2.6 to 1.5)
MenACWY††								
≥1 dose	82.9 (80.5 to 85.0)	82.0 (80.8 to 83.1)	0.9 (-1.7 to 3.4)	74.1 (71.8 to 76.2)	83.3 (81.8 to 84.7)	83.5 (81.8 to 85.1)	-9.5 (-12.2 to -6.7) §§	-0.2 (-2.5 to 2.0)
≥2 doses¶¶	36.4 (29.5 to 43.9)	39.1 (35.9 to 42.4)	-2.7 (-10.7 to 5.2)	31.6 (26.0 to 37.8)	43.0 (38.5 to 47.6)	37.1 (32.5 to 42.0)	-5.5 (-13.2 to 2.1)	5.9 (-0.7 to 12.5)
HPV*** vaccine coverage								
All adolescents								
≥1 dose	70.2 (67.4 to 72.8)	57.3 (55.9 to 58.7)	12.9 (9.8 to 15.9)§§	50.4 (47.8 to 53.0)	58.5 (56.6 to 60.3)	65.9 (64.0 to 67.9)	-15.6 (-18.8 to -12.3)§§	-7.5 (-10.1 to -4.8)§§
≥2 doses	55.9 (52.9 to 58.9)	47.1 (45.7 to 48.6)	8.8 (5.4 to 12.1)§§	38.5 (36.0 to 41.0)	48.0 (46.1 to 49.9)	54.0 (51.8 to 56.1)	-15.5 (-18.8 to -12.2)§§	-6.0 (-8.9 to -3.2)§§
≥3 doses	41.9 (38.9 to 44.9)	36.2 (34.8 to 37.6)	5.7 (2.3 to 9.0)§§	28.6 (26.4 to 31.0)	36.0 (34.2 to 37.8)	41.3 (39.1 to 43.4)	-12.6 (-15.8 to -9.5)§§	-5.3 (-8.1 to -2.5) §§
HPV UTD†††	50.1 (47.0 to 53.1)	41.7 (40.3 to 43.1)	8.4 (5.0 to 11.7)§§	33.3 (30.9 to 35.8)	42.1 (40.2 to 43.9)	48.1 (46.0 to 50.3)	-14.8 (-18.1 to -11.5)§§	-6.1 (-8.9 to -3.2) §§
Females								
≥1 dose	74.8 (71.0 to 78.2)	62.0 (60.0 to 63.9)	12.8 (8.7 to 16.8)§§	56.2 (52.5 to 59.9)	62.6 (60.0 to 65.2)	70.9 (68.1 to 73.5)	-14.6 (-19.2 to -10.0)§§	-8.2 (-12.0 to -4.4)§§
≥2 doses	63.8 (59.7 to 67.7)	52.8 (50.7 to 54.8)	11.0 (6.5 to 15.6)§§	45.3 (41.5 to 49.1)	53.2 (50.4 to 55.9)	60.3 (57.2 to 63.3)	-15.0 (-19.8 to -10.1)§§	-7.1 (-11.2 to -2.9)§§
≥3 doses	48.0 (43.7 to 52.3)	42.4 (40.3 to 44.5)	5.6 (0.8 to 10.4)§§	34.1 (30.7 to 37.7)	41.5 (38.8 to 44.2)	47.7 (44.5 to 50.9)	-13.5 (-18.3 to -8.7)§§	-6.2 (-10.4 to -2.0)§§
HPV UTD	58.1 (53.9 to 62.2)	47.9 (45.8 to 50.0)	10.2 (5.5 to 14.8)§§	39.4 (35.7 to 43.2)	47.4 (44.6 to 50.2)	55.5 (52.3 to 58.6)	-16.1 (-21.0 to -11.2)§§	-8.1 (-12.3 to -3.9)§§
Males								
≥1 dose	65.8 (61.7 to 69.6)	52.8 (50.9 to 54.7)	13.0 (8.6 to 17.4)§§	44.8 (41.2 to 48.4)	54.4 (51.8 to 56.9)	61.4 (58.5 to 64.1)	-16.5 (-21.1 to -12.0)§§	-7.0 (-10.8 to -3.2)§§
≥2 doses	48.4 (44.2 to 52.7)	41.8 (39.9 to 43.7)	6.6 (1.9 to 11.3)§§	32.0 (28.8 to 35.3)	42.8 (40.3 to 45.4)	48.2 (45.3 to 51.1)	-16.2 (-20.6 to -11.8)§§	-5.4 (-9.3 to -1.5)§§
≥3 doses	36.0 (32.0 to 40.3)	30.3 (28.6 to 32.1)	5.7 (1.2 to 10.3)§§	23.4 (20.6 to 26.4)	30.5 (28.3 to 32.9)	35.3 (32.6 to 38.2)	-12.0 (-16.0 to -7.9)§§	-4.8 (-8.4 to -1.2)§§
HPV UTD	42.5 (38.3 to 46.7)	35.8 (34.0 to 37.6)	6.7 (2.0 to 11.3)§§	27.6 (24.6 to 30.8)	36.8 (34.4 to 39.3)	41.3 (38.5 to 44.2)	-13.8 (-18.0 to -9.5)§§	-4.5 (-8.3 to -0.7)§§
≥2 MMR vaccine doses	90.5 (89.0 to 91.9)	91.1 (90.2 to 92.0)	-0.6 (-2.3 to 1.1)	90.3 (88.5 to 91.8)	90.9 (89.8 to 92.0)	91.1 (89.8 to 92.2)	-0.8 (-2.8 to 1.2)	-0.1 (-1.8 to 1.5)
≥3 Hepatitis B doses	90.2 (88.5 to 91.7)	91.9 (91.1 to 92.7)	-1.7 (-3.5 to 0.0)	91.1 (89.3 to 92.5)	92.0 (90.8 to 92.9)	90.9 (89.6 to 92.0)	0.2 (-1.8 to 2.2)	1.1 (-0.5 to 2.7)
Varicella								
History of varicella§§§	18.0 (15.8 to 20.5)	14.3 (13.3 to 15.3)	3.8 (1.3 to 6.3)§§	21.7 (19.4 to 24.1)	13.7 (12.5 to 15.0)	14.7 (13.3 to 16.4)	6.9 (4.1 to 9.7) §§	-1.0 (-3.0 to 0.9)
Among adolescents with no history of varicella disease								
≥1 dose vaccine	95.2 (93.8 to 96.3)	95.1 (94.3 to 95.9)	0.0 (-1.4 to 1.5)	94.5 (92.7 to 95.8)	95.0 (93.8 to 96.0)	95.1 (93.9 to 96.0)	-0.6 (-2.5 to 1.3)	0.0 (-1.6 to 1.5)
≥2 doses vaccine	85.0 (82.5 to 87.2)	85.9 (84.8 to 87.0)	-1.0 (-3.5 to 1.6)	81.7 (79.2 to 83.9)	86.0 (84.4 to 87.5)	86.2 (84.5 to 87.8)	-4.5 (-7.4 to -1.7) §§	-0.2 (-2.4 to 2.1)
History of varicella or received ≥2 doses varicella vaccine	87.7 (85.6 to 89.5)	88.0 (87.0 to 88.9)	-0.2 (-2.4 to 1.9)	85.6 (83.6 to 87.4)	87.9 (86.6 to 89.2)	88.2 (86.7 to 89.6)	-2.6 (-5.0 to -0.2) §§	-0.3 (-2.2 to 1.7)

Abbreviations: CI = confidence interval; HPV = human papillomavirus; MenACWY = quadrivalent meningococcal conjugate vaccine; MMR = measles, mumps, and rubella; NIS-Teen = National Immunization Survey–Teen; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine; UTD = up to date.

* Adolescents (N = 20,475) in the 2016 NIS-Teen were born during January 1998–February 2004.

† Adolescents were classified as below poverty level if their total family income was less than the federal poverty level specified for the applicable family size and number of children aged <18 years. All others were classified as at or above the poverty level (https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html). Poverty status was unknown for 724 adolescents.

§ MSA status was determined based on household-reported county of residence, and was grouped into three categories: MSA central city, MSA non-central city, and non-MSA. MSA and central city were as defined by the U.S. Census Bureau (https://www.census.gov/geo/reference/gtc/gtc_cbsa.html). Non-MSA areas include urban populations not located within an MSA as well as completely rural areas.

¶ Estimates with 95% CI half-widths >10 might not be reliable.

** Includes percentages receiving Tdap vaccine at age ≥10 years.

†† Includes percentages receiving MenACWY and meningococcal-unknown type vaccine.

§§ Statistically significant difference (p<0.05) in estimated vaccination coverage by poverty level or metropolitan statistical area; referent groups were adolescents living at or above poverty level and MSA central city, respectively.

¶¶ ≥2 doses of MenACWY or meningococcal-unknown type vaccine. Calculated only among adolescents aged 17 years at time of interview. Does not include adolescents who received 1 dose of MenACWY vaccine at age ≥16 years.

*** HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV). For ≥1-, ≥2-, and ≥3-dose measures, percentages are reported among females and males combined (n = 20,475) and for females only (n = 9,661) and males only (n = 10,814).

††† HPV UTD includes those with ≥3 doses, and those with 2 doses when the first HPV vaccine dose was initiated before age 15 years and time between the first and second dose was at least 5 months minus 4 days.

§§§ By parent/guardian report or provider records.

TABLE 3. Estimated vaccination coverage with selected vaccines and doses* among adolescents aged 13–17 years,† by HHS region, state, selected local area, or territory — National Immunization Survey–Teen, United States, 2016

Region, state, local area	% (95% CI)§							
	All adolescents (N = 20,475)				Females (n = 9,661)		Males (n = 10,814)	
	≥1 Tdap¶	≥1 MenACWY**	≥1 HPV††	HPV UTD§§	≥1 HPV††	HPV UTD§§	≥1 HPV††	HPV UTD§§
U.S. overall	**88.0 (87.1–88.9)** ¶¶	**82.2 (81.2–83.2)**	**60.4 (59.2–61.6)** ¶¶	**43.4 (42.1–44.7)**	**65.1 (63.3–66.8)**	**49.5 (47.6–51.4)**	**56.0 (54.3–57.7)** ¶¶	**37.5 (35.8–39.2)**
Region I	**94.8 (93.4–96.0)** ¶¶	**90.8 (88.7–92.6)**	**69.9 (66.7–72.9)**	**55.0 (51.7–58.3)**	**74.9 (70.7–78.7)**	**61.0 (56.2–65.5)**	**65.1 (60.5–69.5)**	**49.3 (44.7–54.0)**
Connecticut	93.9 (89.6–96.5)	93.9 (89.9–96.4)	62.2 (55.8–68.2)	49.0 (42.7–55.3)	68.9 (60.3–76.4)	56.9 (48.1–65.3)	55.8 (46.6–64.6)	41.5 (32.8–50.7)
Maine	87.5 (83.1–90.9)	83.5 (78.1–87.8)	70.0 (63.9–75.4)	56.0 (49.8–62.1)	73.1 (64.4–80.3)	64.3 (55.5–72.3)	67.1 (58.4–74.8)	48.2 (39.6–56.9)
Massachusetts	96.7 (94.4–98.0) ¶¶	90.4 (86.2–93.5)	71.4 (65.7–76.5)	56.6 (50.6–62.5)	77.6 (69.7–83.9)	62.0 (53.3–70.1)	65.5 (57.1–72.9)	51.4 (43.1–59.6)
New Hampshire	95.3 (91.5–97.5)	88.0 (83.1–91.6)	69.9 (63.7–75.5)	51.2 (44.6–57.8)	70.6 (61.9–78.1)	56.5 (47.3–65.2)	69.3 (60.1–77.1)	46.3 (36.9–55.9)
Rhode Island	95.4 (92.5–97.2)	96.4 (93.2–98.1)	88.9 (84.7–92.1)	70.8 (64.4–76.4)	90.1 (83.4–94.2)	73.0 (63.5–80.8)	87.8 (81.7–92.1)	68.7 (59.8–76.4)
Vermont	93.8 (90.4–96.1)	86.4 (82.0–89.9)	70.3 (64.6–75.5)	55.7 (49.9–61.3)	71.2 (62.4–78.6)	58.4 (49.7–66.7)	69.5 (61.8–76.3)	53.1 (45.2–60.7)
Region II	**90.8 (88.4–92.7)**	**90.0 (87.6–92.0)**	**67.2 (63.8–70.5)** ¶¶	**51.4 (47.7–55.1)**	**72.0 (67.2–76.4)** ¶¶	**57.6 (52.3–62.8)**	**62.7 (57.6–67.4)**	**45.5 (40.5–50.7)**
New Jersey	89.9 (85.5–93.1)	91.7 (87.9–94.4)	58.5 (52.4–64.3)	42.8 (37.0–48.8)	66.0 (57.8–73.4)	50.1 (41.8–58.5)	51.2 (42.7–59.7)	35.8 (28.2–44.1)
New York	91.1 (88.2–93.4)	89.2 (86.0–91.8)	71.5 (67.3–75.4) ¶¶	55.7 (51.0–60.2)	75.0 (69.0–80.1) ¶¶	61.3 (54.6–67.6)	68.2 (62.1–73.8)	50.3 (43.9–56.7)
NY–City of New York	88.9 (84.1–92.3)	89.6 (84.4–93.2)	76.8 (70.8–81.9)	61.7 (54.9–68.1)	81.9 (73.8–87.9) ¶¶	69.9 (60.5–77.8)	71.9 (62.9–79.5)	53.9 (44.2–63.2)
NY–Rest of state	92.6 (88.6–95.3)	89.0 (84.5–92.3)	68.1 (62.3–73.5) ¶¶	51.8 (45.6–58.0)	70.5 (62.0–77.8)	55.8 (46.7–64.5)	65.9 (57.6–73.3) ¶¶	48.0 (39.7–56.4)
Region III	**88.9 (86.6–90.8)**	**84.7 (81.9–87.1)**	**61.2 (57.9–64.4)**	**46.9 (43.6–50.2)**	**65.0 (60.2–69.5)**	**51.9 (47.1–56.6)**	**57.6 (53.0–62.0)**	**42.1 (37.7–46.6)**
Delaware	87.5 (83.0–91.0)	87.3 (82.4–91.0)	70.7 (64.9–75.8)	56.9 (50.7–62.8)	78.3 (70.5–84.5)	66.8 (58.4–74.3)	63.3 (54.7–71.1)	47.3 (38.8–55.9)
District of Columbia	86.5 (81.5–90.3)	86.9 (81.3–91.0)	79.2 (73.5–84.0)	62.0 (55.3–68.2)	80.7 (72.2–87.0)	65.1 (55.4–73.7)	77.7 (69.5–84.3)	58.8 (49.4–67.6)
Maryland	85.0 (79.7–89.2)	84.8 (79.0–89.3)	64.5 (58.1–70.5)	48.1 (41.6–54.6)	69.0 (59.9–76.8)	51.8 (42.6–60.9)	60.2 (51.0–68.7)	44.5 (35.6–53.7)
Pennsylvania	92.0 (88.9–94.2)	92.7 (89.6–94.9)	64.4 (59.3–69.2)	51.0 (45.9–56.1)	72.0 (65.1–78.1)	58.0 (50.6–65.1)	57.2 (49.9–64.1)	44.4 (37.5–51.5)
PA–Philadelphia	89.8 (85.4–93.0)	91.2 (87.1–94.1)	80.7 (75.4–85.0)	68.4 (62.5–73.8)	88.2 (81.2–92.8)	76.2 (67.8–83.0)	73.7 (65.7–80.3)	61.1 (52.8–68.9)
PA–Rest of state	92.3 (88.7–94.7)	92.9 (89.3–95.3)	62.3 (56.6–67.6)	48.7 (43.0–54.5)	69.9 (62.1–76.7)	55.6 (47.4–63.6)	54.9 (46.8–62.8)	42.1 (34.5–50.2)
Virginia	87.1 (81.0–91.5)	71.5 (63.9–78.1)	53.6 (46.0–61.0)	39.2 (32.1–46.8)	50.7 (39.6–61.6)	41.1 (30.8–52.3)	56.4 (46.2–66.0) ¶¶	37.4 (28.0–47.9)
West Virginia	89.7 (85.3–92.9)	89.0 (84.5–92.3)	54.2 (47.5–60.8)	41.2 (34.7–47.9)	58.5 (48.8–67.6)	49.7 (40.2–59.3)	50.0 (40.9–59.2)	33.0 (24.9–42.2)
Region IV	**88.9 (87.1–90.5)**	**77.7 (75.4–79.9)**	**55.8 (53.1–58.5)** ¶¶	**38.7 (36.1–41.4)**	**59.6 (55.7–63.3)**	**44.8 (40.9–48.7)**	**52.3 (48.5–56.0)** ¶¶	**32.9 (29.3–36.6)**
Alabama	91.7 (87.8–94.4)	72.4 (66.4–77.7)	51.7 (45.3–58.0)	35.4 (29.5–41.7)	54.2 (45.1–63.1)	46.5 (37.4–55.7)	49.2 (40.5–58.1)	24.7 (17.9–32.9)
Florida	89.7 (84.5–93.3)	76.3 (70.2–81.5)	55.9 (49.2–62.5)	40.4 (34.0–47.1)	58.4 (48.6–67.6)	46.4 (36.9–56.2)	53.5 (44.4–62.5)	34.5 (26.3–43.8)
Georgia	92.8 (88.3–95.6)	91.4 (87.1–94.4)	67.3 (60.9–73.2) ¶¶	45.6 (39.2–52.2)	77.0 (68.9–83.5) ¶¶	55.4 (46.2–64.2)	58.0 (48.5–67.0)	36.2 (27.8–45.6)
Kentucky	89.0 (84.6–92.2)	85.9 (81.2–89.6) ¶¶	48.0 (41.7–54.4)	34.0 (28.0–40.5)	54.8 (45.6–63.7)	39.7 (30.9–49.3)	41.6 (33.2–50.5)	28.5 (21.0–37.3)
Mississippi	82.0 (76.5–86.5)	57.4 (51.0–63.5)	45.6 (39.4–52.0)	29.1 (23.6–35.2)	47.8 (38.7–57.0)	33.9 (25.6–43.3)	43.6 (35.1–52.4)	24.5 (17.8–32.7)
North Carolina	89.1 (84.5–92.5)	75.7 (69.7–80.9)	57.5 (51.0–63.8)	41.2 (35.0–47.7)	57.9 (48.8–66.5)	46.9 (38.1–56.0)	57.1 (47.8–66.0)	35.7 (27.3–45.1)
South Carolina	77.5 (70.7–83.1)	68.9 (61.9–75.2)	44.2 (37.4–51.3)	29.1 (23.3–35.6)	50.5 (40.2–60.7)	30.8 (22.5–40.6)	38.2 (29.7–47.5)	27.4 (20.0–36.4)
Tennessee	89.3 (84.1–92.9) ¶¶	76.3 (70.0–81.7)	55.3 (48.5–61.9)	36.0 (29.7–42.8)	55.3 (45.4–64.7)	36.9 (28.1–46.6)	55.3 (46.1–64.3) ¶¶	35.2 (26.5–44.9)
Region V	**91.2 (89.5–92.6)** ¶¶	**85.9 (84.0–87.7)**	**58.4 (55.8–61.0)** ¶¶	**43.4 (40.8–46.1)**	**63.4 (59.7–67.0)**	**49.2 (45.4–53.0)**	**53.7 (49.9–57.4)** ¶¶	**38.0 (34.4–41.7)**
Illinois	91.0 (87.9–93.3)	83.9 (79.9–87.3)	63.5 (58.6–68.1) ¶¶	47.8 (42.9–52.7)	68.5 (61.7–74.5)	52.6 (45.6–59.5)	58.7 (51.8–65.3) ¶¶	43.2 (36.6–50.1)
IL–City of Chicago	84.2 (75.2–90.3)	91.1 (84.6–95.0) ¶¶	73.1 (63.2–81.2)	55.7 (45.6–65.3)	79.7 (66.0–88.8)	65.3 (51.5–76.9)	66.8 (52.0–79.0)	46.4 (32.8–60.6)
IL–Rest of state	92.5 (89.2–94.8)	82.3 (77.6–86.3)	61.4 (55.8–66.6) ¶¶	46.1 (40.6–51.7)	66.0 (58.2–73.0)	49.8 (41.8–57.7)	56.9 (49.2–64.4) ¶¶	42.6 (35.2–50.3)
Indiana	89.5 (84.6–92.9)	88.0 (82.7–91.8)	45.2 (38.9–51.7)	33.9 (28.0–40.2)	53.9 (44.5–63.1)	43.5 (34.3–53.0)	36.9 (29.0–45.5)	24.7 (18.1–32.8)
Michigan	93.6 (89.4–96.2) ¶¶	95.0 (91.8–97.0)	61.3 (54.2–67.9)	44.8 (37.9–51.9)	70.5 (60.9–78.7)	55.4 (45.5–65.0)	52.5 (42.6–62.2)	34.6 (26.1–44.3)
Minnesota	89.7 (85.0–93.1)	85.2 (80.1–89.1)	59.1 (53.0–65.0)	44.1 (38.1–50.3)	58.1 (49.0–66.7)	46.4 (37.7–55.3)	60.1 (51.6–68.0)	42.0 (33.9–50.6)
Ohio	90.8 (85.6–94.3)	79.6 (73.4–84.7)	56.2 (49.5–62.8)	41.8 (35.3–48.6)	57.6 (48.1–66.5)	42.5 (33.7–51.9)	55.0 (45.2–64.3)	41.1 (31.9–51.0)
Wisconsin	91.6 (87.2–94.5)	85.6 (80.7–89.4)	61.9 (55.5–67.9)	45.5 (39.2–52.0)	68.1 (58.6–76.2)	53.6 (44.1–63.0)	56.0 (47.3–64.4)	37.8 (29.7–46.5)

See table footnotes on the next page.

this difference in vaccination coverage, because nonpediatric providers might be less familiar with adolescent vaccination recommendations. Because Tdap coverage is substantially higher than ≥1-dose HPV coverage, even in non-MSA areas, lack of access to any vaccination services is unlikely the underlying cause of lower HPV vaccine initiation. A better understanding of reasons for variations in HPV vaccine initiation by MSA status is needed to identify appropriate, targeted strategies to improve HPV vaccination coverage. CDC has published a series of reports in an effort to better understand health disparities between rural and urban areas (https://www.cdc.gov/ruralhealth/caseforruralhealth.html).

Variation in adolescent vaccination coverage among state and local areas might reflect differences in adolescent health care delivery, the prevalence of factors associated with lower vaccination coverage, and immunization program emphasis on, and effectiveness of, adolescent vaccination activities. Immunization programs in several state and local jurisdictions (e.g., Alaska, Maryland, Nevada, New York, and New York City), although not necessarily having the highest HPV vaccination coverage in the nation, have experienced annual increases in coverage that exceed the national average over a 4-year period. Activities contributing to this success, as reported by these immunization programs, include enhancing provider education, assessing vaccination coverage levels in health care provider offices and providing feedback to the practices, conducting media campaigns, engaging community partners, and experiencing a "spillover" effect from middle school vaccination requirements for Tdap and MenACWY vaccines.

TABLE 3. (*Continued*) Estimated vaccination coverage with selected vaccines and doses* among adolescents aged 13–17 years,† by HHS region, state, selected local area, or territory — National Immunization Survey–Teen, United States, 2016

Region, state, local area	% (95% CI)§							
	All adolescents (N = 20,475)				Females (n = 9,661)		Males (n = 10,814)	
	≥1 Tdap¶	≥1 MenACWY**	≥1 HPV††	HPV UTD§§	≥1 HPV††	HPV UTD§§	≥1 HPV††	HPV UTD§§
Region VI	**86.7 (84.6–88.5)**	**84.9 (82.8–86.8)**	**52.0 (49.3–54.8)**	**35.0 (32.5–37.7)**	**57.3 (53.2–61.2)**	**41.3 (37.4–45.4)**	**47.0 (43.3–50.8)**	**28.9 (25.8–32.3)**
Arkansas	91.0 (87.1–93.8)	89.1 (84.9–92.2) ¶¶	54.4 (48.1–60.5)	34.5 (28.9–40.7)	53.3 (43.8–62.6)	35.5 (27.1–45.0)	55.4 (47.3–63.3)	33.6 (26.3–41.7)
Louisiana	93.7 (89.8–96.2)	90.9 (86.9–93.8)	60.5 (54.4–66.3)	41.8 (35.8–48.1)	69.9 (61.1–77.4)	50.8 (41.7–59.8)	51.5 (43.1–59.9)	33.2 (25.7–41.7)
New Mexico	84.3 (79.2–88.4)	77.8 (72.5–82.4)	60.5 (54.4–66.3)	42.9 (37.0–49.0)	63.1 (54.4–71.1)	49.0 (40.4–57.7)	57.9 (49.3–66.1)	37.0 (29.3–45.3)
Oklahoma	89.6 (84.2–93.3)	73.6 (66.6–79.6)	56.9 (49.5–63.9)	39.2 (32.4–46.4)	63.8 (53.0–73.4)	43.6 (33.6–54.1)	50.3 (40.3–60.2)	35.0 (26.1–45.2)
Texas	85.0 (82.1–87.5)	85.5 (82.6–88.0) ***	49.3 (45.6–53.0)	32.9 (29.6–36.5)	54.5 (49.0–59.8)	39.7 (34.4–45.1)	44.3 (39.4–49.4)	26.5 (22.5–30.9)
TX–Bexar County	85.4 (80.1–89.5)	87.2 (81.8–91.2)	53.4 (46.7–59.9)	39.2 (33.0–45.8)	58.3 (48.6–67.5)	45.2 (35.8–55.0)	48.5 (39.7–57.4)	33.3 (25.6–42.1)
TX–City of Houston	86.2 (77.9–91.7)	82.9 (73.8–89.3)	62.6 (53.6–70.9)	46.4 (37.6–55.3)	59.4 (45.7–71.8)	44.2 (31.8–57.3)	65.9 (54.2–75.9)	48.6 (36.8–60.5)
TX–Dallas County	83.0 (76.7–87.9)	87.7 (82.0–91.8)	45.7 (38.5–53.1)	23.9 (18.8–30.0)	48.8 (37.9–59.8)	24.3 (16.8–33.6)	42.7 (33.4–52.5)	23.6 (16.9–32.0)
TX–El Paso County	83.4 (76.6–88.6)	91.6 (86.5–94.8) ¶¶	79.8 (73.6–84.9) ¶¶	66.0 (59.0–72.4)	78.4 (68.4–85.9)	69.0 (58.9–77.6)	81.1 (73.0–87.2) ¶¶	63.2 (53.2–72.1)
TX–Rest of state	85.2 (81.4–88.3)	85.0 (81.2–88.2) ***	46.8 (42.0–51.6)	30.7 (26.4–35.4)	53.3 (46.2–60.2)	39.2 (32.5–46.4)	40.6 (34.2–47.2)	22.5 (17.7–28.3)
Region VII	**86.2 (83.6–88.4)**	**70.8 (67.4–74.0)**	**55.3 (51.8–58.8)**	**39.3 (36.0–42.8)**	**60.7 (55.7–65.5)**	**43.7 (38.8–48.7)**	**50.2 (45.3–55.1)**	**35.2 (30.6–40.0)**
Iowa	89.2 (85.0–92.2)	74.9 (69.4–79.7)	60.7 (54.8–66.3)	45.5 (39.7–51.5)	64.4 (55.9–72.2)	47.4 (39.0–55.9)	57.2 (48.9–65.1)	43.8 (35.8–52.0)
Kansas	87.3 (82.1–91.2)	69.7 (63.5–75.3)	51.8 (45.2–58.3)	35.6 (29.6–42.1)	62.4 (53.1–70.9)	45.6 (36.6–54.9)	41.7 (32.9–51.0)	26.0 (18.7–35.0)
Missouri	83.9 (78.7–88.0)	66.2 (59.6–72.2)	51.6 (45.0–58.1)	35.8 (29.8–42.4)	55.0 (45.7–64.0)	38.5 (29.8–48.0)	48.3 (39.1–57.5)	33.3 (25.2–42.5)
Nebraska	86.8 (81.5–90.8)	80.2 (74.6–84.8)	63.7 (57.2–69.8)	45.9 (39.4–52.5)	69.4 (59.8–77.6)	50.6 (41.1–60.0)	58.3 (49.3–66.8)	41.3 (32.6–50.6)
Region VIII	**85.9 (83.1–88.3)**	**75.4 (72.1–78.4)**	**57.4 (53.6–61.0)**	**40.6 (36.9–44.4)**	**64.1 (58.6–69.3)**	**48.1 (42.6–53.7)**	**50.9 (45.7–56.1)**	**33.5 (28.6–38.7)**
Colorado	87.5 (82.1–91.4) ***	77.5 (71.3–82.7) ***	63.5 (56.5–69.9)	48.0 (41.0–55.0)	68.3 (57.9–77.1)	52.1 (41.9–62.2)	58.8 (49.2–67.8)	44.0 (34.7–53.7)
Montana	85.7 (80.4–89.7)	67.6 (61.3–73.3)	55.3 (48.9–61.5)	39.9 (33.8–46.4)	68.2 (59.6–75.7) ¶¶	52.5 (43.6–61.2)	43.0 (34.5–51.9)	27.9 (20.8–36.4)
North Dakota	92.0 (87.5–94.9)	92.0 (87.5–94.9)	67.6 (60.9–73.5)	52.7 (46.0–59.3)	68.3 (58.2–76.9)	60.2 (50.1–69.5)	66.9 (57.9–74.7)	45.5 (36.6–54.6)
South Dakota	79.4 (73.1–84.5)	65.7 (59.1–71.7) ¶¶	55.9 (49.2–62.3) ¶¶	38.6 (32.4–45.2)	61.7 (51.8–70.8)	47.3 (37.8–57.1)	50.4 (41.5–59.3)	30.5 (23.0–39.2)
Utah	83.9 (78.5–88.2)	76.6 (70.5–81.7)	49.7 (43.1–56.2)	30.5 (24.9–36.9)	58.8 (49.2–67.8)	41.3 (32.4–50.7)	40.9 (32.4–50.1)	20.3 (13.9–28.7)
Wyoming	86.7 (81.7–90.5)	54.2 (48.1–60.1)	43.4 (37.5–49.5)	26.7 (21.7–32.3)	50.4 (41.5–59.3)	33.9 (26.1–42.7)	36.9 (29.2–45.3)	19.9 (14.1–27.3)
Region IX	**82.7 (77.9–86.6)**	**80.3 (75.5–84.4)**	**70.6 (65.6–75.2) ¶¶**	**48.0 (42.5–53.5)**	**75.3 (68.0–81.4)**	**55.8 (47.5–63.8)**	**66.1 (59.1–72.5)**	**40.5 (33.6–47.7)**
Arizona	84.3 (78.7–88.6)	85.2 (79.7–89.3)	63.1 (56.6–69.2)	44.1 (37.5–51.0)	65.4 (56.1–73.6)	46.6 (37.2–56.2)	60.9 (51.6–69.5)	41.7 (32.7–51.3)
California	82.1 (75.9–86.9)	79.7 (73.5–84.8)	72.6 (66.1–78.2) ¶¶	49.1 (42.2–56.0)	78.0 (68.5–85.3)	58.3 (47.6–68.2)	67.3 (58.4–75.2)	40.3 (31.8–49.4)
Hawaii	82.2 (76.5–86.7)	75.8 (69.7–81.1)	64.8 (58.3–70.8)	54.0 (47.5–60.3)	71.7 (62.3–79.5)	61.5 (52.0–70.2)	58.3 (49.2–66.8)	46.9 (38.2–55.7)
Nevada	87.1 (81.8–91.0)	78.7 (72.8–83.7)	64.9 (58.5–70.8)	39.9 (33.7–46.5)	64.6 (55.6–72.7)	43.0 (34.2–52.3)	65.1 (55.9–73.3) ¶¶	37.0 (28.4–46.5)
Region X	**85.5 (82.3–88.1)**	**75.0 (71.3–78.4)**	**62.6 (58.8–66.3) ¶¶**	**46.7 (42.8–50.7)**	**66.5 (61.1–71.5)**	**51.7 (46.0–57.4)**	**58.9 (53.5–64.1) ¶¶**	**41.9 (36.6–47.4)**
Alaska	79.4 (74.1–83.9) ¶¶	67.0 (61.1–72.4) ¶¶	61.1 (55.0–66.9) ¶¶	43.3 (37.2–49.6)	61.9 (53.0–70.0)	47.8 (39.0–56.8)	60.3 (51.7–68.4) ¶¶	39.1 (30.9–48.0)
Idaho	87.5 (83.0–90.9)	86.5 (81.4–90.4)	57.2 (50.9–63.3)	36.5 (30.8–42.6)	59.8 (50.7–68.4)	43.4 (34.9–52.3)	54.7 (46.0–63.1)	30.0 (22.7–38.4)
Oregon	83.2 (77.0–88.0)	70.5 (64.2–76.2)	61.7 (55.2–67.9)	47.5 (41.0–54.0)	62.6 (52.7–71.6)	50.3 (40.7–59.9)	60.9 (52.1–69.0)	44.7 (36.1–53.7)
Washington	86.8 (81.5–90.7)	75.1 (68.9–80.5)	64.8 (58.5–70.6) ¶¶	49.5 (43.0–55.9)	70.9 (62.4–78.3)	55.2 (45.8–64.2)	58.9 (49.9–67.3)	44.0 (35.4–52.9)
Range†††	(77.5 – 96.7)	(54.2 – 96.4)	(43.4 – 88.9)	(26.7 – 70.8)	(47.8 – 90.1)	(30.8 – 73.0)	(36.9 – 87.8)	(19.9 – 68.7)
Territory								
Guam	77.5 (72.9–81.6)	77.1 (72.6–81.1)	67.4 (62.4–72.1)	44.2 (39.0–49.5)	76.9 (70.0–82.5)	55.8 (48.0–63.4)	58.5 (51.4–65.3)	33.2 (27.0–40.1)
Puerto Rico	91.2 (87.5–93.9) ¶¶	89.2 (85.0–92.3)	75.8 (70.2–80.6)	52.8 (46.4–59.0)	80.8 (72.7–86.9)	61.9 (52.8–70.3)	71.1 (62.9–78.1)	44.1 (35.7–53.0)
U.S. Virgin Islands	78.9 (73.7–83.2)	61.3 (55.5–66.7)	41.9 (36.2–47.7)	22.6 (17.9–28.1)	43.8 (35.6–52.4)	26.6 (19.5–35.0)	40.1 (32.5–48.1)	19.0 (13.2–26.4)

Abbreviations: CI = confidence interval; HHS = U.S. Department of Health and Human Services; HPV = human papillomavirus; MenACWY = quadrivalent meningococcal conjugate vaccine; NIS-Teen = National Immunization Survey–Teen; Tdap = tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine; UTD = up to date.

* Estimates for additional measures, including MMR, hepatitis B, and varicella vaccines are available at https://www.cdc.gov/vaccines/vaxview/teenvaxview.

† Adolescents (N = 20,475) in the 2016 NIS-Teen were born during January 1998—February 2004.

§ Estimates with 95% CI half-widths >10 might not be reliable.

¶ ≥1 dose Tdap vaccine at age ≥10 years.

** ≥1 dose of MenACWY or meningococcal-unknown type vaccine.

†† HPV vaccine, nine-valent (9vHPV), quadrivalent (4vHPV), or bivalent (2vHPV). For ≥1-, ≥2-, and ≥3-dose measures, percentages are reported among females and males combined (N = 20,475) and for females only (n = 9,661) and males only (n = 10,814).

§§ HPV UTD includes those with ≥3 doses, and those with 2 doses when the first HPV vaccine dose was initiated before age 15 years and time between the first and second dose was at least 5 months minus 4 days.

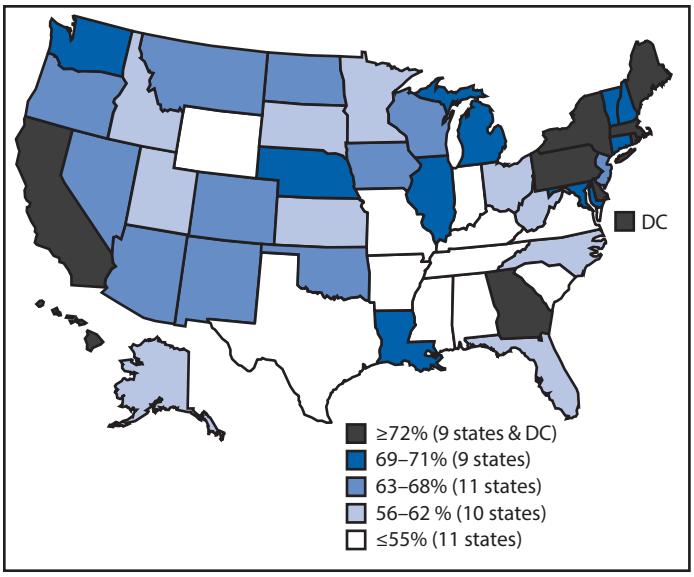
¶¶ Statistically significant (p<0.05) percentage point increase from 2015.

*** Statistically significant (p<0.05) percentage point decrease from 2015.

††† Range excludes selected local areas and territories.

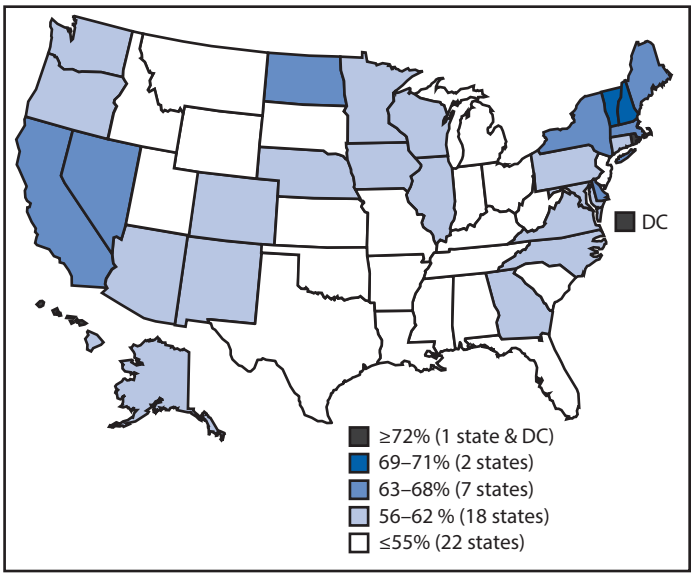
At the end of 2016, the recommended HPV vaccination schedule was changed from a 3-dose to a 2-dose series for immunocompetent adolescents initiating the series before their 15th birthday. Three doses are recommended for persons initiating the series at ages 15 through 26 years and for immunocompromised persons (*2*). The recommendation allows for 1 fewer dose and one fewer visit to a health care provider, which might encourage providers to promote, and parents to accept, vaccination at the recommended age of 11–12 years. Although it is too early to assess the direct impact of the revised recommendation on vaccination practices, when applied retrospectively, the HPV up-to-date coverage was 6.3 percentage points higher than the ≥3-dose HPV coverage.

FIGURE 2. Estimated vaccination coverage* of ≥1 dose of human papillomavirus vaccine† among female adolescents aged 13–17 years§,¶ — National Immunization Survey – Teen, United States, 2016



Abbreviation: DC = District of Columbia.
* National coverage = 65%.
† The Advisory Committee on Immunization Practices recommends nine-valent, quadrivalent, or bivalent HPV vaccine for females.
§ Sample size = 9,661.
¶ Includes female adolescents born during January 1998–February 2004.

FIGURE 3. Estimated vaccination coverage* of ≥1 dose of human papillomavirus vaccine† among male adolescents aged 13–17 years§,¶ — National Immunization Survey – Teen, United States, 2016



Abbreviation: DC = District of Columbia.
* National coverage = 56%.
† The Advisory Committee on Immunization Practices recommends nine-valent or quadrivalent HPV vaccine for males.
§ Sample size = 10,814.
¶ Includes male adolescents born during January 1998–February 2004.

Each year in the United States, an estimated 31,500 newly diagnosed cancers in men and women are attributable to HPV; approximately 90% of these could be prevented by receipt of the nine-valent HPV vaccine (https://www.cdc.gov/cancer/hpv/statistics/cases.htm). Although it is too early to observe the impact of HPV vaccination on HPV-associated cancers, impact on infection with HPV types targeted by the vaccine and other endpoints have been reported (*6*–*8*). Data from the 2007–2010 National Health and Nutrition Examination Surveys indicate that, compared with 2003–2006 (before HPV vaccine introduction), prevalence of HPV types targeted by the quadrivalent HPV vaccine††† in cervicovaginal specimens had decreased 56% (from 11.5% to 5.0%) among females aged 14–19 years (*6*). By 2011–2014, prevalence had declined 71% (from 11.5% to 3.3%) among females aged 14–19 years and 61% (from 18.5% to 7.2%) among females aged 20–24 years (*7*). Evidence of vaccine impact among males also exists (*8*).

The findings in this report are subject to at least five limitations. First, the overall household response rate was 32.7% (55.5% for the landline and 29.5% for the cell phone samples), and only 53.9% of landline-completed and 47.4% of cell phone–completed interviews had adequate provider data. Second, bias in estimates might remain even after adjustment for household and provider nonresponse and phoneless households.¶¶¶ Weights have been adjusted for the increasing number of cell phone–only households over time. Nonresponse bias might change, which could affect comparisons of estimates between survey years. Third, estimates stratified by state/local area might be unreliable because of small sample sizes. Fourth, multiple statistical tests were conducted, and a small number might be significant because of chance alone. Finally, ≥2-dose MenACWY coverage likely underestimates the proportion of adolescents who receive ≥2 MenACWY doses. Adolescents might receive a booster dose of MenACWY after age 17 years (*1*); because NIS-Teen includes adolescents aged 13–17 years, receipt of MenACWY at age ≥18 years cannot be captured in coverage estimates.

Adolescent vaccination coverage can be increased, and the gap between HPV vaccination coverage and coverage with Tdap and ≥1-dose MenACWY can be closed with increased implementation of effective strategies. Providers should use every visit to review vaccination histories, provide strong

††† Most HPV vaccine used in the United States before licensure of the nine-valent vaccine at the end of 2014 was quadrivalent HPV vaccine.

¶¶¶ In a sensitivity analysis of 2012 NIS-Teen data including adjustments for incomplete sample frame, nonresponse bias, and incomplete ascertainment of vaccination status, estimates of Tdap, ≥1-dose meningococcal conjugate, and ≥1-dose HPV vaccination coverage were estimated to be lower than actual values by 1–3 percentage points. https://www.cdc.gov/vaccines/imz-managers/nis/downloads/NIS-teen-puf15-dug.pdf.

Summary

What is already known about this topic?

To protect against vaccine-preventable diseases, including human papillomavirus (HPV)–associated cancers, diphtheria, pertussis, tetanus, and meningococcal disease, routine immunization of adolescents aged 11–12 years is recommended by the Advisory Committee on Immunization Practices (ACIP). Since HPV vaccine introduction in 2006 for females and 2011 for males, coverage has increased gradually for females and more rapidly for males, although coverage has not reached the tetanus, diphtheria and acellular pertussis vaccine (Tdap) and quadrivalent meningococcal conjugate vaccine (MenACWY) coverage.

What is added by this report?

In December 2016, ACIP updated HPV vaccination recommendations to include a 2-dose schedule for immunocompetent adolescents initiating the vaccine series before their 15th birthday; 3 doses are recommended for persons who initiate the series at age 15–26 years and for immunocompromised persons. A new HPV up-to-date measure was added to the 2016 National Immunization Survey–Teen to account for the revised HPV vaccination schedule. HPV up-to-date estimates were 49.5% for females and 37.5% for males and 6.0–6.5 percentage points higher than ≥3-dose adolescent HPV coverage. HPV up-to-date vaccination coverage was 15 percentage points lower among adolescents living in nonmetropolitan statistical areas (MSAs) than among adolescents living in MSA central cities.

What are the implications for public health care?

Adolescent vaccination coverage continues to improve, but opportunity remains to increase HPV-associated cancer prevention. A better understanding of reasons for differences in HPV vaccination by MSA status might identify appropriate strategies to improve coverage. Protection against vaccine-preventable diseases will be increased if clinicians consistently recommend and simultaneously administer Tdap, MenACWY, and HPV vaccines at age 11–12 years.

clinical recommendations for HPV and other recommended vaccines, and implement systems to eliminate or minimize missed opportunities (e.g., standing orders, provider reminders, patient reminder or recall, and use of immunization information systems) (https://www.thecommunityguide.org/topic/vaccination). Resources for clinicians to facilitate effective communication with parents and adolescents regarding HPV and other recommended vaccines are available at https://www.cdc.gov/hpv/hcp/index.html. Provider-based performance measurement could also facilitate increased adolescent vaccination coverage, including the Assessment, Feedback, Incentives, and eXchange program implemented by state and local immunization programs with individual providers (https://www.cdc.gov/vaccines/programs/afix/index.html), and the 2018 updated Healthcare Effectiveness Data and Information Set composite measure for health plans, assessing receipt of Tdap, MenACWY, and HPV vaccines by age 13 years (http://www.ncqa.org/hedis-quality-measurement/hedis-measures/hedis-2018). Protection against vaccine-preventable diseases will be increased if clinicians consistently recommend and simultaneously administer Tdap, MenACWY, and HPV vaccines at age 11–12 years.

Conflict of Interest

No conflicts of interest were reported.

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HIV Testing Among Transgender Women and Men — 27 States and Guam, 2014–2015

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Transgender persons are at high risk for human immunodeficiency virus (HIV) infection; in a recent analysis of the results of over nine million CDC funded HIV tests, transgender women* had the highest percentage of confirmed positive results (2.7%) of any gender category (*1*). Transgender men,† particularly those who have sex with cisgender§ men, are also at high risk for infection (*2*). HIV testing is critical for detecting and treating persons who are infected and delivering preventive services to those who are uninfected. CDC recommends that persons at high risk for HIV infection be screened for HIV at least annually, although transgender persons are not specified in the current recommendations. CDC analyzed data from the Behavioral Risk Factor Surveillance System (BRFSS) to describe HIV testing among transgender women and men and two cisgender comparison groups in 27 states and Guam. After adjusting for demographic characteristics, transgender women and men had a lower prevalence of ever testing and past year testing for HIV (35.6% and 31.6% ever, and 10.0% and 10.2% past year, respectively) compared with cisgender gay and bisexual men (61.8% ever and 21.6% past year) and instead reported testing at levels comparable to cisgender heterosexual men and women (35.2% ever, and 8.6% past year). This finding suggests that transgender women and men might not be sufficiently reached by current HIV testing measures. Tailoring HIV testing activities to overcome the unique barriers faced by transgender women and men might increase rates of testing among these populations.

BRFSS is an annual, state-based, random-digit–dialed cellular and landline telephone survey of the noninstitutionalized U.S. adult population.¶ Gender identity was uniformly assessed in an optional module used by 20 jurisdictions** in 2014 and 22 jurisdictions†† in 2015. Fourteen jurisdictions participated in the module during both years, six participated only in 2014, and eight participated only in 2015, for a total of 28. Jurisdiction-specific response rates ranged from 33.0% to 59.2%§§ and 34.4% to 57.6%¶¶ in 2014 and 2015, respectively. Transgender respondents were defined as those who answered affirmative to the question if they considered themselves to be transgender. Those who answered affirmative were asked to identify as male-to-female (defined as transgender women in this report), female-to-male (defined as transgender men in this report), or gender nonconforming. Because of small sample size, responses from gender nonconforming persons (n = 272) were not included in this analysis.

Pooled data collected in 2014 and 2015 were used to compare demographic characteristics and HIV testing among transgender and cisgender respondents. Cisgender men who reported sexual orientations of gay or bisexual represent a group at high risk for HIV infection (*3*). Cisgender men and women who reported an orientation of straight (hereafter referred to as cisgender heterosexual men and women) represent a group at lower risk for infection (*4*). The proportion of respondents who reported ever and past year HIV testing was calculated, and unadjusted prevalence ratios and 95% confidence intervals were estimated to identify characteristics associated with ever testing among transgender women and men. Multivariable logistic regression models compared self-reported prevalence of ever and past year testing among transgender women and men with cisgender gay and bisexual men while adjusting for characteristics associated with testing in univariate models ($p<0.10$). All estimates were weighted to account for the complex multistage sampling design; because only 14 of 28 jurisdictions participated in the optional module during both years of data collection, weights for these 14 jurisdictions were averaged across the 2-year period to account for varying levels of participation over time. Estimates with relative standard error ≥30% were not reported.

During 2014–2015, 28 jurisdictions collected data on gender identity, resulting in a total sample of 732 transgender women, 451 transgender men, 3,798 cisgender gay and bisexual men, and 301,524 cisgender heterosexual men and women (Table 1). The unadjusted prevalence of ever testing for HIV was 37.5% among transgender women, 36.6% among transgender men, 66.2% among cisgender gay and bisexual men, and 35.2% among cisgender

* Persons assigned male sex at birth who identify as woman, transgender woman, or another transfeminine identity.
† Persons assigned female sex at birth who identify as man, transgender man, or another transmasculine identity.
§ Persons whose sex assigned at birth is the same as their gender identity or expression.
¶ https://www.cdc.gov/brfss/.
** Delaware, Guam, Hawaii, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Minnesota, Montana, Nevada, New York, Ohio, Pennsylvania, Vermont, Virginia, Wisconsin, and Wyoming.
†† Colorado, Connecticut, Delaware, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Maryland, Massachusetts, Minnesota, Missouri, Nevada, New York, Ohio, Pennsylvania, Texas, Virginia, West Virginia, and Wisconsin.
§§ https://www.cdc.gov/brfss/annual_data/2014/pdf/2014_dqr.pdf.
¶¶ https://www.cdc.gov/brfss/annual_data/2015/pdf/2015-sdqr.pdf.

TABLE 1. Selected demographic characteristics and HIV testing behaviors among transgender and cisgender respondents[*] — Behavioral Risk Factor Surveillance System, 27 states and Guam,[†] 2014–2015

Characteristic	Transgender women		Transgender men		Cisgender gay and bisexual men[§]		Cisgender heterosexual men and women[¶]	
	No.	%** (95% CI)	No.	%** (95% CI)	No.	%** (95% CI)	No.	%** (95% CI)
Total	**732**	**100 —**	**451**	**100 (—)**	**3,798**	**100 (—)**	**301,524**	**100 (—)**
Race/Ethnicity								
White, non-Hispanic	527	60.6 (52.8–67.9)	309	49.2 (37.9–60.6)	2,929	67.1 (63.7–70.3)	242,370	71.1 (70.7–71.5)
Black, non-Hispanic	67	13.3 (9.3–18.7)	43	11.4 (6.6–18.9)	233	11.8 (9.7–14.5)	21,166	12.0 (11.7–12.3)
Hispanic or Latino	46	13.2 (8.1–21.0)	48	29.0 (18.6–42.2)	250	12.8 (10.2–15.8)	14,320	11.0 (10.7–11.4)
Other, non-Hispanic	77	12.9 (7.9–20.2)	42	—††	338	8.3 (6.9–10.1)	19,890	5.9 (5.7–6.1)
Age group (yrs)								
18–24	55	14.2 (9.9–19.8)	30	15.6 (8.7–26.4)	434	21.9 (19.0–25.1)	14,166	11.7 (11.4–12.0)
25–44	146	29.1 (22.3–37.0)	98	45.2 (33.7–57.2)	893	33.4 (30.5–36.5)	60,098	31.5 (31.1–31.9)
45–64	322	40.3 (33.6–47.4)	185	25.0 (18.3–33.1)	1,582	33.9 (31.2–36.7)	122,321	36.2 (35.9–36.6)
≥65	209	16.4 (12.6–21.1)	138	14.2 (10.0–19.8)	889	10.8 (9.5–12.3)	104,939	20.6 (20.4–20.8)
Education								
<High school	90	22.0 (15.8–29.9)	72	34.4 (23.5–47.1)	180	10.4 (8.2–12.9)	19,081	12.2 (11.9–12.5)
High school	292	38.5 (32.0–45.4)	169	40.6 (29.9–52.2)	813	25.4 (22.5–28.5)	86,020	29.7 (29.4–30.1)
Some college	205	24.2 (18.6–30.9)	116	15.1 (10.2–21.8)	996	31.5 (28.6–34.5)	82,460	31.1 (30.7–31.5)
College or above	142	15.3 (11.3–20.4)	92	10.0 (6.5–15.0)	1,801	32.8 (30.2–35.5)	113,289	27.0 (26.7–27.3)
Annual household income								
<$25,000	240	40.1 (33.0–47.6)	149	30.4 (21.7–40.8)	950	25.5 (22.9–28.3)	64,039	22.3 (21.9–22.6)
$25,000–$49,999	169	20.9 (15.6–27.4)	118	29.4 (19.7–41.4)	886	21.7 (19.2–24.4)	66,938	21.3 (21.0–21.7)
≥$50,000	232	29.5 (23.8–35.9)	120	24.4 (15.0–37.0)	1,604	40.1 (37.2–43.1)	128,546	42.8 (42.4–43.1)
Missing	91	9.6 (6.4–14.0)	64	15.8 (10.0–24.1)	358	12.8 (10.4–15.6)	42,001	13.7 (13.4–13.9)
Has health insurance								
Yes	649	80.7 (72.7–86.8)	394	70.6 (57.1–81.2)	3,446	88.2 (86.1–90.1)	280,774	88.8 (88.5–89.1)
No	73	19.3 (13.2–27.4)	54	29.5 (18.8–42.9)	338	11.8 (9.9–13.9)	19,804	11.2 (10.9–11.5)
Marital status								
Married or unmarried couple	383	52.2 (45.0–59.2)	219	53.1 (41.8–64.1)	1,302	33.2 (30.5–36.1)	172,305	57.3 (56.9–57.7)
Separated/widowed/ divorced	184	19.7 (15.0–25.5)	138	18.5 (12.4–26.8)	551	10.6 (8.9–12.6)	85,996	20.5 (20.2–20.8)
Never married	161	28.1 (22.3–34.7)	90	28.4 (19.7–39.0)	1,918	56.2 (53.1–59.2)	41,852	22.2 (21.8–22.5)
Geographic region								
Northeast	111	21.5 (16.7–27.2)	48	16.3 (10.7–24.0)	904	30.3 (27.8–33.0)	50,129	25.6 (25.3–25.8)
Midwest	309	36.2 (29.9–43.0)	206	34.5 (24.9–45.5)	1,358	29.2 (26.6–31.9)	122,255	33.0 (32.7–33.2)
South	186	37.1 (29.8–45.0)	133	42.4 (31.1–54.6)	907	32.0 (28.7–35.4)	77,703	33.8 (33.5–34.1)
West	114	5.3 (3.9–7.2)	58	6.8 (4.2–10.7)	595	8.5 (7.4–9.8)	49,389	7.7 (7.6–7.8)
County of residence								
Metropolitan	484	77.3 (71.3–82.4)	304	80.3 (71.7–86.8)	3,020	87.4 (85.2–89.3)	210,875	81.5 (81.3–81.7)
Nonmetropolitan	236	22.7 (17.6–28.7)	141	19.7 (13.2–28.3)	744	12.6 (10.7–14.8)	88,601	18.5 (18.3–18.7)
Ever received diagnosis of depressive disorder								
Yes	149	21.9 (16.8–28.1)	116	22.6 (15.2–32.1)	1,156	30.9 (28.0–34.0)	56,693	18.0 (17.7–18.3)
No	577	78.1 (71.9–83.2)	331	77.4 (67.9–84.8)	2,619	69.1 (66.0–72.1)	243,693	82.0 (81.7–82.3)
Ever tested for HIV								
Yes	225	37.5 (30.8–44.6)	137	36.6 (27.0–47.4)	2,506	66.2 (63.3–69.1)	80,241	35.2 (34.8–35.5)
No	499	62.6 (55.4–69.2)	302	63.4 (52.6–73.0)	1,247	33.8 (30.9–36.7)	211,990	64.8 (64.5–65.2)
Tested for HIV in past 12 months								
Yes	65	11.7 (7.9–16.9)	29	12.4 (6.8–21.5)	895	27.5 (24.9–30.3)	15,118	8.6 (8.4–8.9)
No	667	88.3 (83.1–92.1)	422	87.6 (78.5–93.2)	2,903	72.5 (69.7–75.1)	286,406	91.4 (91.1–91.6)
Setting of last HIV test								
Private doctor/HMO/clinic	136	58.9 (47.4–69.6)	91	61.4 (44.9–75.6)	1,651	65.1 (61.4–68.7)	53,626	69.6 (69.0–70.3)
Hospital (inpatient and ED)	34	14.5 (8.1–24.5)	25	13.5 (7.5–23.1)	222	9.2 (7.4–11.4)	9,498	12.0 (11.6–12.5)
Other[§§]	51	26.7 (17.9–37.8)	20	—††	605	25.6 (22.3–29.3)	15,606	18.4 (17.8–18.9)

Abbreviations: CI = confidence interval; ED = emergency department; HIV = human immunodeficiency virus; HMO = health maintenance organization.

* Chi-square tests were conducted to assess differences in demographic characteristics and HIV testing behaviors between gender identity categories; all p ≤0.01 (data not shown).

† Data were collected in the following jurisdictions: Colorado (2015), Connecticut (2015), Delaware, Georgia (2015), Guam (2014). Hawaii, Idaho, Illinois (2015), Indiana, Iowa, Kansas, Kentucky (2014), Louisiana (2014), Maryland, Massachusetts (2015), Minnesota, Missouri (2015), Montana (2014), Nevada, New York, Ohio, Pennsylvania, Texas (2015), Vermont (2014), Virginia, West Virginia (2015), Wisconsin, and Wyoming (2014).

¶ Includes cisgender men and women who reported a sexual orientation of straight.

** Weighted column percent excludes missing values and responses of don't know, not sure, or not asked unless otherwise noted.

†† Estimate suppressed because relative standard error of the estimate was ≥30%.

§§ Includes counseling and testing sites, correctional facilities, drug treatment facilities, at home, or somewhere else.

heterosexual men and women. The unadjusted prevalence of past year testing was 11.7% among transgender women, 12.4% among transgender men, 27.5% among cisgender gay and bisexual men, and 8.6% among cisgender heterosexual men and women.

Black transgender women (62.6%) and men (66.9%) had a higher prevalence of ever testing than their white counterparts (33.2% and 30.7%, respectively). Among transgender women, the highest prevalence of ever testing (68.5%) was reported by those who had ever received a diagnosis of a depressive disorder (Table 2). After adjusting for demographic characteristics, transgender women and men had a lower prevalence of ever testing and past year testing for HIV (35.6% and 31.6% ever, and 10.0% and 10.2% past year, respectively) compared with cisgender gay and bisexual men (61.8% ever, and 21.6% past year) and reported testing at levels comparable with those of cisgender heterosexual men and women (35.2% ever, and 8.6% past year) (Table 3).

TABLE 2. Prevalence of ever testing for HIV by demographic characteristics among transgender women and men — Behavioral Risk Factor Surveillance System, 27 states and Guam,* 2014–2015

Characteristic	Transgender women		Transgender men	
	% Ever tested† (95% CI)	PR (95% CI)	% Ever tested† (95% CI)	PR (95% CI)
Race/Ethnicity				
White, non-Hispanic	33.2 (25.7–41.6)	Ref	30.7 (21.9–41.2)	Ref
Black, non-Hispanic	62.6 (45.2–77.3)	1.9 (1.3–2.7)	66.9 (42.8–84.6)	2.2 (1.4–3.4)
Hispanic or Latino	—§	1.0 (0.5–2.0)	—§	1.3 (0.7–2.6)
Other, non-Hispanic	—§	0.9 (0.4–1.9)	—§	0.5 (0.1–2.2)
Age group (yrs)				
18–24	34.7 (19.9–53.2)	0.6 (0.4–1.1)	53.6 (25.6–79.6)	1.3 (0.6–2.8)
25–44	54.4 (38.1–69.9)	Ref	40.2 (23.4–59.6)	Ref
45–64	35.1 (25.8–45.7)	0.6 (0.4–1.0)	36.2 (23.9–50.6)	0.9 (0.5–1.7)
≥65	14.7 (8.1–25.2)	0.3 (0.1–0.5)	—§	0.2 (0.1–0.4)
Education				
<High school	36.4 (21.4–54.6)	1.0 (0.6–1.7)	—§	0.9 (0.4–1.9)
High school	37.6 (27.5–49.0)	Ref	38.0 (23.0–55.8)	Ref
Some college	39.3 (26.9–53.2)	1.0 (0.7–1.6)	28.4 (17.4–42.7)	0.8 (0.4–1.4)
College or above	35.1 (22.1–50.9)	0.9 (0.6–1.6)	58.9 (40.9–74.8)	1.6 (0.9–2.7)
Annual household income				
<$25,000	41.8 (30.4–54.1)	1.2 (0.7–2.0)	51.5 (34.4–68.2)	1.6 (0.8–3.0)
$25,000–$49,999	35.4 (21.8–51.9)	Ref	32.8 (17.3–53.1)	Ref
≥$50,000	32.1 (21.8–44.5)	0.9 (0.5–1.6)	—§	0.7 (0.3–1.7)
Has health insurance				
Yes	36.4 (29.5–43.9)	Ref	39.1 (28.7–50.7)	Ref
No	40.2 (22.3–61.1)	1.1 (0.6–1.9)	—§	0.8 (0.4–1.7)
Marital status				
Married or unmarried couple	31.3 (22.4–41.8)	Ref	25.0 (15.1–38.5)	Ref
Separated/widowed/divorced	44.0 (30.6–58.4)	1.4 (0.9–2.2)	47.8 (28.2–68.1)	1.9 (1.0–3.7)
Never married	44.5 (32.5–57.2)	1.4 (0.9–2.2)	49.9 (31.6–68.3)	2.0 (1.1–3.7)
Geographic region				
Northeast	33.4 (22.3–46.6)	Ref	38.5 (20.9–59.8)	Ref
Midwest	35.7 (25.9–46.8)	1.1 (0.7–1.7)	36.6 (21.1–55.5)	1.0 (0.5–2.0)
South	41.2 (28.3–55.6)	1.2 (0.8–2.0)	35.5 (20.6–53.8)	0.9 (0.5–1.9)
West	39.8 (27.0–54.1)	1.2 (0.7–2.0)	39.9 (20.7–62.8)	1.0 (0.5–2.2)
County of residence				
Metropolitan	35.9 (28.5–44.1)	Ref	40.4 (28.6–53.4)	Ref
Nonmetropolitan	42.7 (29.7–56.8)	1.2 (0.8–1.8)	—§	0.5 (0.3–1.1)
Ever received diagnosis of depressive disorder				
Yes	68.5 (54.7–79.6)	2.4 (1.8–3.3)	40.4 (23.9–59.4)	1.2 (0.7–2.1)
No	28.5 (21.8–36.4)	Ref	34.9 (23.8–47.9)	Ref

Abbreviations: CI = confidence interval; HIV = human immunodeficiency virus; PR = prevalence ratio; Ref = reference category.

* Data were collected in the following jurisdictions: Colorado (2015), Connecticut (2015), Delaware, Georgia (2015), Guam (2014), Hawaii, Idaho, Illinois (2015), Indiana, Iowa, Kansas, Kentucky (2014), Louisiana (2014), Maryland, Massachusetts (2015), Minnesota, Missouri (2015), Montana (2014), Nevada, New York, Ohio, Pennsylvania, Texas (2015), Vermont (2014), Virginia, West Virginia (2015), Wisconsin, and Wyoming (2014).

† Percentage is weighted and excludes missing values and responses of don't know, not sure, not asked.

§ Estimate suppressed because relative standard error of the estimate was ≥30%.

TABLE 3. Prevalence of ever testing and testing in past 12 months for HIV, by gender identity category — Behavioral Risk Factor Surveillance System, 27 states and Guam,* 2014–2015

Gender identity category	Ever tested for HIV		Tested in past 12 months for HIV	
	Adjusted prevalence¶ (95% CI)	aPR¶ (95% CI)	Adjusted prevalence¶ (95% CI)	aPR¶ (95% CI)
Transgender women	35.6 (29.2–42.6)	0.6 (0.5–0.7)	10.0 (6.5–15.0)	0.5 (0.3–0.7)
Transgender men	31.6 (22.5–42.4)	0.5 (0.4–0.7)	10.2 (5.8–17.5)	0.5 (0.3–0.8)
Cisgender gay and bisexual men†	61.8 (59.0–64.6)	Ref	21.6 (19.4–24.0)	Ref
Cisgender heterosexual men and women§	35.2 (34.8–35.6)	0.6 (0.5–0.6)	8.6 (8.4–8.9)	0.4 (0.4–0.5)

Abbreviations: aPR = adjusted prevalence ratio; CI = confidence interval; HIV = human immunodeficiency virus; Ref = reference category.

* Data were collected in the following jurisdictions: Colorado (2015), Connecticut (2015), Delaware, Georgia (2015), Guam (2014), Hawaii, Idaho, Illinois (2015), Indiana, Iowa, Kansas, Kentucky (2014), Louisiana (2014), Maryland, Massachusetts (2015), Minnesota, Missouri (2015), Montana (2014), Nevada, New York, Ohio, Pennsylvania, Texas (2015), Vermont (2014), Virginia, West Virginia (2015), Wisconsin, and Wyoming (2014).

† Includes cisgender men who reported a sexual orientation of gay or bisexual.

§ Includes cisgender men and women who reported a sexual orientation of straight.

¶ Adjusted for: race/ethnicity, age, education, annual household income, health insurance, marital status, geographic region, metropolitan county of residence, ever diagnosed with depressive disorder.

Discussion

Despite the high risk for HIV infection previously reported among transgender populations, nearly two thirds of transgender women and men in the sample reported never testing for HIV, which is consistent with evidence suggesting that many HIV-infected transgender women are not aware of their status (*5*). The prevalences of ever and past year testing among transgender women and men were comparable to those among cisgender heterosexual men and women, a group at much lower risk for infection. Transgender women and men reported a substantially lower prevalence of ever and past year testing than did cisgender gay and bisexual men. These findings indicate that current self-reported HIV testing levels among transgender women and men are inconsistent with their HIV risk profiles. Innovative, tailored approaches might be needed to reach transgender persons who are not being reached by existing HIV prevention strategies that focus on other key populations, such as gay, bisexual, and other men who have sex with men.***

Black transgender women and men were more likely than their white counterparts to report ever testing, which might reflect success of expanded testing measures focused among black communities (*6*) or might be a response to racial/ethnic disparities in HIV infection reported among transgender women (*1*,*5*). Transgender women who ever received a diagnosis of depressive disorder were more likely than those who had not to report ever testing; this is consistent with previous findings in the U.S. general population (*7*). However, few other differences in testing prevalence across demographic subgroups were identified, indicating widespread opportunities for improvement of testing measures aimed toward all transgender women and men who are at risk for HIV infection. Such measures should account for the unique barriers to testing that many transgender persons might face, such as HIV stigma within the transgender community (*8*), gender identity stigma in health care settings (*9*), and socioeconomic marginalization (*10*).

The findings in this report are subject to at least four limitations. First, the proportion of transgender respondents was small (<1%), which reduced the precision of HIV testing estimates. Second, BRFSS transgender data are only representative of transgender persons in the 28 jurisdictions that participated in the optional module and therefore cannot be generalized to the entire U.S. transgender population. Third, the measure of gender identity might incorrectly classify transgender respondents who self-identify simply as man or woman rather than transgender man or woman, which would potentially underestimate the number of transgender persons in the sample. Finally, because BRFSS does not ask questions about HIV status or sexual risk behaviors, the analytic sample might have included respondents who are already living with HIV infection or who are not at risk for HIV infection and therefore would be less likely to have tested for HIV in the past year or at all.

The findings of this analysis indicate suboptimal rates of HIV testing among transgender women and men. The population-based estimates in this report can serve as a baseline for future monitoring of testing trends among transgender persons. Intensified and expanded use of culturally appropriate recruitment methods by public health officials might enhance activities to reach transgender women and men and increase the rates of testing. CDC is currently working to enhance the capacity of community-based organizations to provide targeted HIV testing in addition to other prevention and support services to transgender persons who are at risk for or have newly diagnosed HIV. These programs and other innovative approaches are needed to improve delivery of HIV testing and other prevention services to transgender persons.

*** https://effectiveinterventions.cdc.gov/en.

Summary

What is already known about this topic?

Transgender persons are at high risk for HIV infection. CDC recommends that persons at high risk for HIV infection be screened for HIV at least annually, but transgender persons are not specified in the current recommendations, and current nationwide HIV testing rates for transgender persons are unknown.

What is added by this report?

This analysis of 2014 and 2015 Behavioral Risk Factor Surveillance System data showed that transgender women and men self-reported a lower prevalence of HIV testing (both ever and in the past year) compared with gay and bisexual men whose gender identities match their sex assignments at birth (cisgender). Transgender women and men self-reported testing at levels similar to cisgender heterosexual men and women.

What are the implications for public health practice?

Transgender women and men reported current HIV testing levels that were inconsistent with their HIV risk profiles. Innovative, tailored approaches might be needed to reach transgender persons who are not being reached by existing HIV prevention strategies that focus on other key populations, such as gay, bisexual, and other men who have sex with men.

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Conflict of Interest

No conflicts of interest were reported.

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CDC Grand Rounds: Newborn Screening for Hearing Loss and Critical Congenital Heart Disease

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Newborn screening is a public health program that benefits 4 million U.S. infants every year by enabling early detection of serious conditions, thus affording the opportunity for timely intervention to optimize outcomes (*1*). States and other U.S. jurisdictions decide whether and how to regulate newborn screening practices. Most newborn screening is done through laboratory analyses of dried bloodspot specimens collected from newborns. Point-of-care newborn screening is typically performed before discharge from the birthing facility. The Recommended Uniform Screening Panel includes two point-of-care conditions for newborn screening: hearing loss and critical congenital heart disease (CCHD). The objectives of point-of-care screening for these two conditions are early identification and intervention to improve neurodevelopment, most notably language and related skills among infants with permanent hearing loss, and to prevent death or severe disability resulting from delayed diagnosis of CCHD. Universal screening for hearing loss using otoacoustic emissions or automated auditory brainstem response was endorsed by the Joint Committee on Infant Hearing in 2000 and 2007* and was incorporated in the first Recommended Uniform Screening Panel in 2005. Screening for CCHD using pulse oximetry was recommended by the Advisory Committee on Heritable Disorders in Newborns and Children in 2010 based on an evidence review† and was added to the Recommended Uniform Screening Panel in 2011.§

Universal Screening for Hearing Loss

Permanent hearing loss present at birth affects approximately 1.6 of every 1,000 infants in the United States (*2*). Early hearing detection and intervention (EHDI) programs at the state and federal levels promote a "1-3-6" plan that includes 1) screening all infants at age ≤1 month, 2) performing diagnostic audiologic evaluation of infants who do not pass screening at age ≤3 months, and 3) providing appropriate intervention for children with diagnosed hearing loss at age ≤6 months. Children with permanent hearing loss who receive intervention services before age 3–6 months have significantly better language development than do children who do not receive services (*3*). Similarly, early diagnosis of hearing loss, starting with newborn screening, has been shown to reduce deficits in receptive and expressive language that occur in unscreened children who subsequently receive a clinical diagnosis of hearing loss (*4*).

Universal newborn hearing screening also can yield long-term economic benefits (*5*). A prospective British cohort study that tracked groups of children with permanent bilateral hearing loss who were either screened soon after birth or later in infancy found that at school age, children in the newborn screening cohort had significantly better receptive language and substantially lower educational costs (*6*). Extrapolating from those data, a U.S. study estimated potential averted special education costs of approximately $200 million per year, which would largely offset the cost of hearing screening (*7*).

Statewide newborn hearing screening programs began to be established in the 1990s. By the early 2000s, all states had established publicly funded EHDI programs that provide 1) technical assistance to providers, 2) support for families, and 3) data tracking to ensure receipt of services in accordance with the 1-3-6 goals. State EHDI programs receive technical assistance and funding from CDC or the Health Resources and Services Administration (HRSA). CDC provides funding to states to develop and implement data systems that help ensure that infants receive recommended screening, diagnosis, and intervention services. CDC also conducts an annual survey to assess progress toward achieving EHDI goals. In addition, CDC supports evaluation and research on long-term clinical outcomes and program effectiveness. HRSA provides funding and technical assistance to states to support quality improvement activities, family engagement, and activities to reduce loss to follow-up of infants who do not pass the newborn hearing screening.

National EHDI data¶ have demonstrated improvements in the number of infants meeting the 1-3-6 goals. From 2000 to 2014, the percentage of newborns who had documented newborn hearing screening increased from 52% to >97%, and the number of documented diagnoses of hearing loss following screening increased sixfold, from 855 in 2000 to 6,163 in 2014. Although almost all U.S. infants now undergo hearing screening soon after birth, infants who fail to pass screening do

* http://www.asha.org/policy/PS2007-00281/.
† https://www.hrsa.gov/advisorycommittees/mchbadvisory/heritabledisorders/nominatecondition/reviews/cyanoticheart.pdf.
§ https://www.hrsa.gov/advisorycommittees/mchbadvisory/heritabledisorders/recommendations/correspondence/cyanoticheartsecre09212011.pdf.
¶ https://www.cdc.gov/ncbddd/hearingloss/ehdi-data.html.

not necessarily receive timely diagnostic evaluations or timely intervention services once they receive a diagnosis of permanent hearing loss. Therefore, EHDI programs focus on increasing the percentage of infants who meet the 3-month diagnostic evaluation and 6-month early intervention goals. Since 2005, states have reported aggregated data through the CDC Hearing Screening and Follow-up Survey on the numbers of infants successfully receiving those recommended services (*2*). From 2005 to 2014, the percentage of infants who failed newborn hearing screening and who were documented by their state EHDI program as having received a completed diagnostic evaluation increased from 30% to 58%. Among infants with confirmation of hearing loss, documented enrollment in early intervention during the same period increased from 58% to 65%. There have also been reductions in the number of infants lost to follow-up/lost to documentation (failure to report the results from hearing screening, rescreening, diagnostic services, or treatment services to the state EHDI program and the medical home), both overall and in selected states (*2*). For example, just 4.6% of infants who did not pass newborn hearing screening in Massachusetts in 2014 were lost to follow-up/lost to documentation, and 85% of infants with diagnosed hearing loss were documented to have received intervention services.

Further progress in the timely provision of newborn hearing screening, diagnostic, and intervention services as well as improved standardization of data are possible through state-based EHDI Information Systems (EHDI-IS). These EHDI-IS support the early identification of hearing loss and receipt of intervention by enabling state programs to document and track those infants not passing the newborn hearing screening and in need of follow-up services. CDC provides technical assistance and funding to maintain and strengthen these systems. To improve the completeness and accuracy of reported data, CDC collaborated with state EHDI programs to develop a set of Functional Standards for EHDI-IS.** These standards specify technical and functional requirements for EHDI-IS and list data items considered important for tracking and surveillance by EHDI programs.

Screening for Critical Congenital Heart Disease

CCHD includes 12 structural heart disorders that prevent the heart from pumping blood normally to the body, resulting in a high likelihood of low blood oxygen saturation.†† CCHD screening relies on noninvasive pulse oximetry; diagnosis of CCHD requires evaluation by a specialist. CCHD occurs in approximately two of every 1000 births.§§ Infants with undetected CCHD who are discharged from a birth hospital are at risk for developing serious complications that could result in emergency readmission or death within the first few days or weeks of life. Although many cases of CCHD are detected prenatally or through clinical examination, infants who appear normal might be discharged home and subsequently undergo life-threatening crises. It has been estimated that before the introduction of newborn screening for CCHD, 70–100 infants died each year in the United States from late-diagnosed CCHD (*8*). The cost of pulse oximetry screening is estimated to be $10–$15 per infant (*9*). Using conservative estimates of averted deaths and hospitalization costs, an economic analysis calculated that CCHD screening appears cost-effective relative to other services (*10*).

Newborn screening for CCHD has been implemented more recently than newborn hearing screening; the first state policies were adopted in 2011 (*11*). As of 2016, 48 states had laws or policies on CCHD screening. In contrast to long-established EHDI programs, CCHD screening programs are in the early stages of development, and no federal funding is available to support state CCHD screening activities. There is no national collection or analysis of CCHD screening data, and among states, data collection procedures differ. A HRSA-funded newborn screening technical assistance center has built a data repository and begun to collect information from states on newborns with CCHD who were identified by screening and had not received a prenatal or clinical diagnosis.

Many states have birth defects surveillance programs that collect information on children with various types of major birth defects, and some states with birth defects surveillance programs might have the capability to evaluate effectiveness of CCHD screening (*12*). New Jersey was the first state to implement mandatory statewide CCHD screening in all its birthing facilities on August 31, 2011 (*13*). One day after the requirement to screen all infants was implemented, a baby who did not pass CCHD screening was determined to have CCHD and underwent life-saving surgery with a successful outcome. Upon implementation in 2011, New Jersey assessed screening coverage through aggregate quarterly reports from all birthing facilities and collected information on all failed screens through a CCHD screening module built into the New Jersey Birth Defects Registry (NJBDR). The module captures clinical information needed to evaluate the unique contribution of screening to early identification of CCHD. Data from this module are reviewed monthly by NJBDR staff members, and follow-up with hospitals for clarification is conducted as needed. Confirmed records are then entered into a separate NJBDR analytic database. New Jersey now collects individual-level CCHD screening data on all live births through its electronic birth certificate and continues to ascertain detailed information on infants who fail the screen

** https://www.cdc.gov/ncbddd/hearingloss/ehdi-is-functional-standards-.html.
†† https://www.cdc.gov/ncbddd/heartdefects/hcp.html.
§§ https://ghr.nlm.nih.gov/condition/critical-congenital-heart-disease.pdf.

through its CCHD module in the NJBDR. New Jersey's high rate of screening coverage and successful ongoing use of the NJBDR have been achieved through employment of extensive education and training efforts. The key to the success of the New Jersey CCHD screening program has been collaboration among the NJBDR, hospitals, community partners, and the Office of Vital Statistics and Registry. More complete reporting of CCHD screening on all infants and linkage with birth defects surveillance systems are important for ensuring that all infants are screened, optimizing the screening algorithm and quantifying the contribution to improved health (*12*).

Universal CCHD screening continues to evolve. States have implemented various screening algorithms that are being evaluated for specific settings, such as births at high elevation or infants in neonatal intensive care units. Evaluation of the impact of CCHD screening on deaths from CCHD is also under way, using administrative data found in national linked infant birth and death records. Improved data collection will be crucial to assess the effectiveness and guide optimization of CCHD screening (*14*).

Challenges and New Directions in Point-of-Care Newborn Screening in the United States

EHDI is a mature point-of-care screening program that has demonstrated health and economic benefits. Lessons learned from EHDI can be applied to both CCHD screening and point-of-care newborn screening for other conditions that might be included in the Recommended Uniform Screening Panel in the future. The interface between public health and hospitals, health care providers, and families in point-of-care screening presents both challenges and opportunities across conditions (*15*). As demonstrated by EHDI, the data tracking and follow-up capacity of public health agencies can facilitate early identification of affected infants and ongoing coordination between families and clinical care systems. By promoting screening, timely diagnosis, and follow-up based on standardized data systems, public health workers and agencies can play critical roles in enabling children with permanent hearing loss or CCHD to be healthy and reach their full potential.

Conflict of Interest

Scott D. Grosse reports participation in a study tour to China during May 3-10, 2017, organized by the Newborn Foundation, a nonprofit entity that promotes newborn pulse oximetry screening. Marci K. Sontag reports grants from Health Resources and Services Administration, grants from the National Heart Lung and Blood Institute, grants from the Cystic Fibrosis Foundation, and grants from the Gerber Foundation. No other conflicts of interest were reported.

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Notes from the Field

Fatal Pneumonic Tularemia Associated with Dog Exposure — Arizona, June 2016

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On June 15, 2016, Arizona public health officials were notified of a presumptive positive *Francisella tularensis* blood culture result from a woman aged 73 years with pulmonary sarcoidosis who had recently died from respiratory failure. She had been taking amoxicillin for a dental infection. She was evaluated on June 6 for 4 days of fever, myalgia, anorexia, and diarrhea. Because of suspected colitis she was advised to discontinue amoxicillin; she declined hospital admission. Two days later, she was hospitalized for shortness of breath and confusion. Chest radiography revealed a right lower lobe pneumonia and an effusion. This was treated with cefepime and intravenous doxycycline. On June 8, her stool tested positive for *Clostridium difficile* toxin A/B by polymerase chain reaction, requiring treatment with metronidazole and vancomycin. Her condition deteriorated, and she died on June 11. Tularemia was not suspected as cause of illness until June 17 when a blood culture collected on June 6 was confirmed as *F. tularensis*, a Tier 1 select agent; no laboratory exposures occurred.

The patient lived in a semirural area of northern Arizona, did not engage in outdoor activities, and had no known history of insect bites, exposure to animal carcasses or untreated water. She traveled to Hawaii May 16–26, returning approximately 11 days before illness onset. Postmortem exam revealed no bites, abscesses, or lymphadenopathy.

The patient's dog was noted to be lethargic and anorexic in late May, 3 days after being found with a rabbit carcass in its mouth. The patient and dog had frequent close contact. Serum from the dog, obtained approximately 3 weeks after its illness and the patient's death, had a *F. tularensis*-specific titer of 1:256. An assessment of the property on June 23 revealed numerous rabbits and one squirrel carcass with *F. tularensis* DNA detected in its liver and spleen. Genotyping of *F. tularensis* from squirrel and human samples showed both infections were attributable to an A.II strain.

Approximately 125 human tularemia cases are reported in the United States annually. Humans are infected through arthropod bites, contact with infectious tissues, inhalation, or ingestion (*1*). Symptoms commonly begin 3–5 days after exposure and can include fever, skin lesions, lymphadenopathy, difficulty breathing, and diarrhea (*1*).

Two *F. tularensis* subspecies, *tularensis* (Type A) and *holarctica* (Type B), cause human tularemia (*1*,*2*). Distinct clades within Type A (A.I and A.II) are associated with different virulence in humans and laboratory animals (*2*,*3*). A.II strains are localized to the western United States and associated with milder illness than are A.I strains (*2*,*3*).

Based on the patient's respiratory symptoms, radiographic findings, and lack of alternative exposure history, exposure likely occurred at her property through inhalation of *F. tularensis*, potentially via close contact with her dog. The dog might have transmitted infectious material through oral secretions after mouthing an infected carcass or brought infectious material on its fur into contact with the patient. Human illness linked to dogs has been documented (*3*).

The role of pulmonary sarcoidosis in this patient's illness is unclear, but it might have contributed to the severe outcome of infection with an A.II strain (*4*). Concurrent infection with *C. difficile* might also have exacerbated the clinical course of tularemia. Diagnosis of tularemia is challenging because symptoms are nonspecific and exposure history is often unclear. Thorough ascertainment of animal exposures, including nature of contact, might refine clinical suspicion for specific zoonoses. Preventing exposure and implementing early, appropriate therapy can reduce morbidity and mortality. Additional information is available at https://www.cdc.gov/tularemia.

Conflict of Interest

No conflicts of interest were reported.

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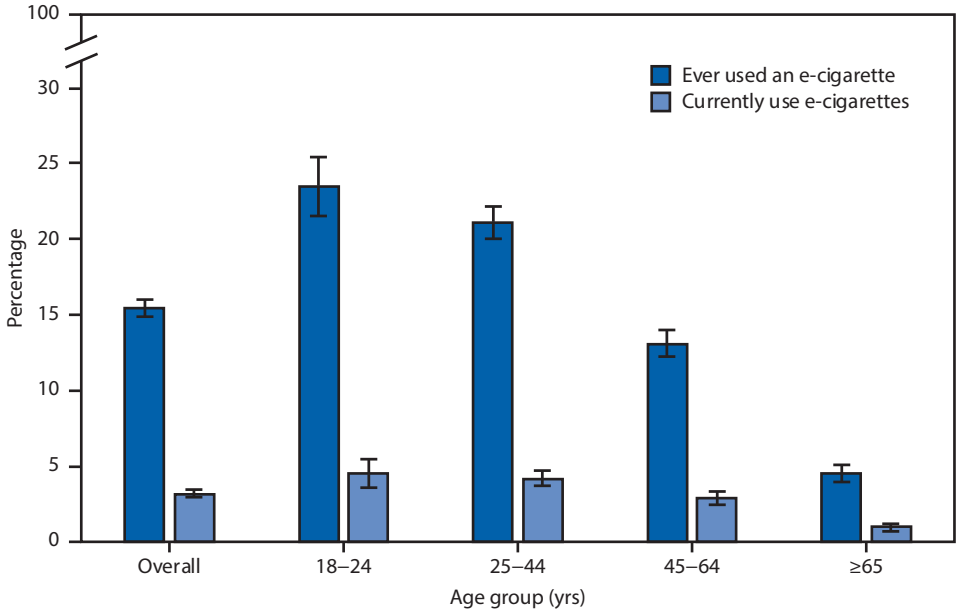
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Who Ever Used an E-cigarette† and Percentage Who Currently Use E-cigarettes,§ by Age Group — National Health Interview Survey, United States, 2016¶



* With 95% confidence intervals indicated with error bars.
† Based on the response of "yes" to the survey question "Have you ever used an e-cigarette, even one time?"
§ Based on a response of "every day" or "some days" to the question "Do you now use e-cigarettes every day, some days or not at all?"
¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population and are derived from the National Health Interview Survey Sample Adult component.

Overall, 15.4% of adults aged ≥18 years had ever used an e-cigarette, and 3.2% currently used e-cigarettes in 2016. Adults aged 18–24 years were the most likely to have ever used an e-cigarette (23.5%); the percentage declined steadily to 4.5% among adults aged ≥65 years. Adults aged 18–24 years (4.5%) and 25–44 years (4.2%) were more likely to be current e-cigarette users than adults aged 45–64 years (2.9%) and those aged ≥65 years (1.0%). Across all age groups, fewer than one fourth of adults who had ever used an e-cigarette reported being a current user.

Source: National Health Interview Survey, 2016 data. https://www.cdc.gov/nchs/nhis.htm.

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