

## Human Papillomavirus–Associated Cancers — United States, 2008–2012

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Human papillomavirus (HPV) is a known cause of cervical cancers, as well as some vulvar, vaginal, penile, oropharyngeal, anal, and rectal cancers (1,2). Although most HPV infections are asymptomatic and clear spontaneously, persistent infections with one of 13 oncogenic HPV types can progress to precancer or cancer. To assess the incidence of HPV-associated cancers, CDC analyzed 2008–2012 high-quality data from the CDC's National Program of Cancer Registries and the National Cancer Institute's Surveillance, Epidemiology, and End Results program. During 2008–2012, an average of 38,793 HPV-associated cancers were diagnosed annually, including 23,000 (59%) among females and 15,793 (41%) among males. By multiplying these counts by the percentages attributable to HPV (3), CDC estimated that approximately 30,700 new cancers were attributable to HPV, including 19,200 among females and 11,600 among males. Cervical precancers can be detected through screening, and treatment can prevent progression to cancer; HPV vaccination can prevent infection with HPV types that cause cancer at cervical and other sites (3). Vaccines are available for HPV types 16 and 18, which cause 63% of all HPV-associated cancers in the United States, and for HPV types 31, 33, 45, 52, and 58, which cause an additional 10% (3). Among the oncogenic HPV types, HPV 16 is the most likely to both persist and to progress to cancer (3). The impact of these primary and secondary prevention interventions can be monitored using surveillance data from population-based cancer registries.

CDC analyzed data from population-based cancer registries that participate in the CDC's National Program of Cancer Registries and the National Cancer Institute's Surveillance, Epidemiology, and End Results program and met the criteria for high data quality for all years 2008–2012, covering approximately 99% of the U.S. population.\* Cases were classified by anatomic site using the

*International Classification of Diseases for Oncology, 3rd Edition*<sup>†</sup> and were confirmed histologically. HPV-associated cancers were defined as invasive cancers at anatomic sites (i.e., cervix, vulva, vagina, penis, oropharynx, anus, and rectum) with cell types in which HPV DNA frequently is found (all carcinomas of the cervix, including adenocarcinomas and squamous cell cancers [SCC]; SCCs only for the other anatomic sites). Oropharyngeal cancers included cancers of the base of tongue; pharyngeal tonsils, anterior and posterior tonsillar pillars, and glosso tonsillar sulci; anterior surface of soft palate and uvula; and lateral and posterior pharyngeal walls.<sup>§</sup> Age-adjusted incidence rates were calculated per 100,000 persons and standardized to the 2000 U.S. standard population. Rates were considered significantly different from the referent category at a p-value of <0.05.

<sup>†</sup> <http://codes.iarc.fr/>.

<sup>§</sup> American Joint Committee on Cancer (AJCC). AJCC Cancer Staging Manual. 7th ed. Chicago, IL: Springer; 2010.

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\* <http://www.cdc.gov/uscs>.



Cancer registries do not routinely collect information on HPV DNA presence in cancer tissues, and HPV-associated cancers defined by anatomic site and cell type include cancers not caused by HPV. Therefore, to calculate HPV-attributable cases, the number of HPV-associated cancers was multiplied by the percentage of each cancer type attributable to HPV based on polymerase chain reaction genotyping studies (3). Because rectal squamous cell carcinoma was not included in the genotyping study, the HPV-attributable percentage for anal squamous cell carcinoma, a biologically similar tumor, was used (2).

Overall, an average of 38,793 HPV-associated cancers (11.7 per 100,000 persons) were diagnosed annually, including 23,000 (13.5) among females and 15,793 (9.7) among males. The most common of these cancers were 11,771 (7.4 per 100,000 females) cervical carcinomas, and 15,738 (4.5 per 100,000 persons) oropharyngeal SCCs (12,638 among males and 3,100 among females) (Table 1). Rates of oropharyngeal SCC were higher among males (7.6) than females (1.7), whereas rates of anal and rectal SCC were higher among females (1.8 and 0.3) than males (1.1 and 0.2).

Rates of cervical carcinoma were higher among blacks (9.2) than among whites (7.1), and among Hispanics (9.7) than non-Hispanics (7.1); a similar pattern was observed for penile SCCs (Table 1). Rates of vulvar SCC were lower among blacks (1.5) compared with whites (2.1) and among Hispanics (1.3) compared with non-Hispanics (2.1). Among females, rates of anal SCC were lower among blacks (1.4) than whites (1.9),

but among males, were higher among blacks (1.5) compared with whites (1.1). The rate of anal SCC among Hispanic males and females (1.1) was lower than among non-Hispanics (1.5). Rates of oropharyngeal SCC in both males and females were higher among whites (8.0 and 1.8) compared with blacks (6.9 and 1.5), and among non-Hispanics (8.0 and 1.8) compared with Hispanics (4.2 and 0.9).

By state, overall rates of all HPV-associated cancers combined ranged from 7.5 per 100,000 persons (Utah) to 14.7 (Kentucky); among females, rates ranged from 9.1 (Utah) to 17.0 (Kentucky and West Virginia), and among males, rates ranged from 6.0 (Utah) to 12.8 (District of Columbia) (Table 2). Most states with overall HPV-associated cancer rates that exceeded the U.S. rate (11.7 per 100,000) were located in the U.S. Census Southern region,<sup>‡</sup> driven by a similar pattern in the distribution of the rates of cervical, anal, and oropharyngeal cancers. The highest rate of cervical cancer was found in Puerto Rico (11.7 per 100,000 females); among the states, the lowest was found in Vermont (4.1) and the highest in West Virginia (9.9).

By multiplying HPV-associated cancer counts by the percent attributable to HPV, 30,700 HPV-associated cancers (79%) were estimated to be attributable to HPV (Table 3). Among these, 24,600 (80%) were attributable to HPV types 16 and 18, which can be prevented by the bivalent, quadrivalent and 9-valent HPV vaccines, and 3,800 (12%) were attributable to

<sup>‡</sup> [https://www.census.gov/geo/reference/gtc/gtc\\_census\\_divreg.html](https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html).

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**TABLE 1. Rate\* and average annual number of human papillomavirus (HPV)-associated cancers,<sup>†</sup> by anatomic site, sex, age, race, and ethnicity<sup>§</sup> — United States, 2008–2012<sup>¶</sup>**

Characteristic	Cervical carcinoma		Vaginal SCC		Vulvar SCC		Penile SCC		Rectal SCC					
	Female		Female		Female		Male		Female		Male			
	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.		
<b>Total</b>	<b>7.4</b>	<b>11,771</b>	<b>0.4</b>	<b>802</b>	<b>2.0</b>	<b>3,554</b>	<b>0.8</b>	<b>1,168</b>	<b>0.3</b>	<b>513</b>	<b>0.2</b>	<b>237</b>		
<b>Age group (yrs)</b>														
<20	0	12	0	0	—**	—	—**	—	0	0	—	—		
20–29	3.0	636	—	—	0.1	23	0	4	—	—	—	—		
30–39	11.9	2,350	0.1	19	0.7	134	0.2	30	0	8	0	5		
40–49	14.0	3,028	0.4	81	2.0	455	0.5	108	0.3	61	0.2	35		
50–59	11.9	2,542	0.7	156	3.3	704	0.9	192	0.7	156	0.3	62		
60–69	11.4	1,740	1.2	178	4.6	701	2.1	292	0.9	137	0.4	58		
70–79	10.0	919	1.9	178	7.6	694	4.1	306	0.9	82	0.6	42		
≥80	7.7	545	2.6	188	11.7	843	5.8	235	1.0	69	0.8	33		
<b>Race</b>														
White <sup>††</sup>	7.1	9,034	0.4	650	2.1	3,170	0.8	989	0.3	455	0.2	196		
Black	9.2 <sup>§§</sup>	1,891	0.6 <sup>§§</sup>	117	1.5 <sup>§§</sup>	301	0.9 <sup>§§</sup>	129	0.2 <sup>§§</sup>	43	0.2 <sup>§§</sup>	32		
American Indians/Alaska Natives	6.3 <sup>§§</sup>	113	0.3	5	1.1 <sup>§§</sup>	16	0.7	8	—	—	—	—		
Asian/Pacific Islander	6.1 <sup>§§</sup>	530	0.2 <sup>§§</sup>	19	0.4 <sup>§§</sup>	31	0.4 <sup>§§</sup>	25	0 <sup>§§</sup>	3	—	—		
<b>Ethnicity</b>														
Non-Hispanic <sup>††</sup>	7.1	9,855	0.4	733	2.1	3,363	0.7	991	0.3	468	0.2	220		
Hispanic	9.7 <sup>§§</sup>	1,916	0.5	69	1.3 <sup>§§</sup>	191	1.3 <sup>§§</sup>	177	0.3	44	0.1	17		
			<b>Oropharyngeal SCC</b>				<b>Anal SCC</b>							
			Female		Male		Female and male		Female		Male		Female and male	
			Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.
<b>Total</b>	<b>1.7</b>	<b>3,100</b>	<b>7.6</b>	<b>12,638</b>	<b>4.5</b>	<b>15,738</b>	<b>1.8</b>	<b>3,260</b>	<b>1.1</b>	<b>1,750</b>	<b>1.5</b>	<b>5,010</b>		
<b>Age group (yrs)</b>														
<20	—	—	—	—	—**	—	—	—	—	—	—**	—		
20–29	0	8	0.1	16	0.1	25	0	4	0.1	11	0	15		
30–39	0.3	62	0.8	150	0.6	211	0.3	66	0.4	74	0.4	141		
40–49	1.5	338	7.1	1,568	4.2	1,906	2.0	443	1.8	386	1.9	829		
50–59	4.2	905	22.5	4,627	13.1	5,532	4.8	1,035	2.6	534	3.8	1,569		
60–69	6.0	908	29.1	4,047	17.0	4,955	5.5	843	3.0	413	4.3	1,256		
70–79	6.2	570	22.4	1,680	13.5	2,250	5.6	513	2.8	211	4.4	723		
≥80	4.4	308	13.3	549	7.7	856	5.0	355	2.9	121	4.3	476		
<b>Race</b>														
White <sup>††</sup>	1.8	2,692	8.0	11,180	4.7	13,871	1.9	2,905	1.1	1,448	1.5	4,353		
Black	1.5 <sup>§§</sup>	327	6.9 <sup>§§</sup>	1,152	3.9 <sup>§§</sup>	1,479	1.4 <sup>§§</sup>	279	1.5 <sup>§§</sup>	260	1.4 <sup>§§</sup>	539		
American Indians/Alaska Natives	0.9 <sup>§§</sup>	16	4.4 <sup>§§</sup>	66	2.6 <sup>§§</sup>	81	0.9 <sup>§§</sup>	15	0.5 <sup>§§</sup>	7	0.7 <sup>§§</sup>	22		
Asian/Pacific Islander	0.6 <sup>§§</sup>	46	2.0 <sup>§§</sup>	136	1.2 <sup>§§</sup>	182	0.4 <sup>§§</sup>	30	0.2 <sup>§§</sup>	15	0.3 <sup>§§</sup>	45		
<b>Ethnicity</b>														
Non-Hispanic <sup>††</sup>	1.8	2,959	8.0	12,025	4.7	14,984	1.9	3,039	1.2	1,634	1.5	4,673		
Hispanic	0.9 <sup>§§</sup>	141	4.2 <sup>§§</sup>	612	2.4 <sup>§§</sup>	754	1.4 <sup>§§</sup>	221	0.7 <sup>§§</sup>	116	1.1 <sup>§§</sup>	337		

**Abbreviation:** SCC = squamous cell cancer.

\* Per 100,000 persons; age-adjusted to the 2000 U.S. standard population.

<sup>†</sup> HPV-associated cancers were defined as cancers at specific anatomic sites with specific cell types in which HPV DNA frequently is found. All cancers were confirmed histologically. Cervical cancers (*International Classification of Diseases for Oncology, 3rd Edition* [ICD-O-3] site codes C53.0–C53.9) are limited to carcinomas (ICD-O-3 histology codes 8010–8671, 8940–8941). Vaginal (ICD-O-3 site code C52.9), vulvar (ICD-O-3 site codes C51.0–C51.9), penile (ICD-O-3 site codes C60.0–60.9), anal (ICD-O-3 site code C21.0–C21.9), rectal (ICD-O-3 site code C20.9), and oropharyngeal (ICD-O-3 site codes C01.9, C02.4, C02.8, C05.1, C05.2, C09.0, C09.1, C09.8, C09.9, C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9, C14.0, C14.2 and C14.8) cancer sites are limited to squamous cell carcinomas (ICD-O-3 histology codes 8050–8084, 8120–8131).

<sup>§</sup> Rates are not presented separately for persons with unknown or other race or unknown ethnicity.

<sup>¶</sup> Compiled from population-based cancer registries in 49 states and the District of Columbia that participate in the National Program of Cancer Registries, and/or the Surveillance, Epidemiology, and End Results Program and meet criteria for high-quality data for all five years (2008–2012), covering approximately 99% of the U.S. population.

\*\* Data suppressed because the total number of cancers for 2008–2012 was <16.

<sup>††</sup> Referent group.

<sup>§§</sup> Rate differed significantly from the rate in the referent group ( $p < 0.05$ ).

TABLE 2. State incidence\* of human papillomavirus (HPV)-associated cancers,† by cancer site and sex — National Program of Cancer Registries and Surveillance, Epidemiology, and End Results program, United States, 2008–2012<sup>‡</sup>

State/Territory	Cervical	Vaginal	Vulvar	Penile	Anal		Rectal		Oropharyngeal			HPV-associated cancers combined				
	Female	Female	Female	Male	Male and female	Male	Female	Male and female	Male	Female	Male and female	Male	Female			
Alabama	8.1	0.6	2.1	0.8	1.4	1.0	1.7	0.4	0.2	0.5	4.9	8.3	2.0	12.7	10.4	15.0
Alaska	6.7	—¶	2.0	—¶	1.1	—¶	1.6	—¶	—¶	—¶	4.1	6.4	1.7	10.6	8.1	13.1
Arizona	6.2	0.3	1.2	0.6	1.1	0.7	1.4	0.2	0.2	0.3	3.5	6.0	1.3	9.1	7.5	10.6
Arkansas	9.6	0.4	2.2	0.8	1.3	0.9	1.7	0.2	—¶	0.3	5.2	8.9	1.8	13.5	10.9	16.0
California	7.4	0.4	1.4	0.8	1.5	1.2	1.7	0.2	0.2	0.3	3.9	6.7	1.3	10.8	8.9	12.6
Colorado	5.6	0.3	1.6	0.6	1.4	1.0	1.8	0.1	—¶	0.2	4.1	6.9	1.5	9.8	8.6	11.1
Connecticut	6.1	0.5	2.1	0.9	1.3	1.0	1.5	0.2	—¶	0.2	4.4	7.6	1.6	10.9	9.7	12.0
Delaware	8.3	—¶	2.5	—¶	1.6	1.4	1.9	—¶	—¶	—¶	4.7	7.8	2.0	12.8	10.1	15.3
District of Columbia	9.2	—¶	1.7	—¶	2.4	2.7	2.0	—¶	—¶	—¶	5.2	8.9	2.2	14.3	12.8	15.9
Florida	8.5	0.4	1.7	0.8	1.9	1.4	2.3	0.3	0.2	0.4	5.7	9.7	2.2	13.7	12.1	15.4
Georgia	7.7	0.5	2.1	0.9	1.6	1.3	1.8	0.3	0.2	0.4	4.8	8.3	1.8	12.6	10.7	14.3
Hawaii	7.5	0.4	1.0	0.5	0.9	0.7	1.1	—¶	—¶	—¶	3.5	6.2	1.0	9.4	7.6	11.2
Idaho	6.1	0.4	1.9	0.5	1.8	1.0	2.6	0.2	—¶	—¶	4.4	7.5	1.5	10.9	9.0	12.8
Illinois	7.9	0.5	2.1	0.8	1.4	1.1	1.6	0.2	0.1	0.2	4.6	7.9	1.8	12.1	9.9	14.1
Indiana	7.3	0.5	2.4	0.8	1.6	1.1	2.0	0.2	0.1	0.2	5.0	8.5	1.8	12.3	10.5	14.2
Iowa	6.8	0.4	2.8	1.0	1.5	0.9	2.0	0.2	—¶	0.2	4.3	7.2	1.5	11.5	9.2	13.7
Kansas	6.9	0.4	2.2	0.8	1.3	0.7	1.7	0.3	—¶	0.4	4.3	7.5	1.4	11.1	9.1	13.0
Kentucky	8.5	0.7	3.0	1.2	1.7	1.1	2.3	0.3	0.2	0.3	5.8	9.7	2.2	14.7	12.2	17.0
Louisiana	9.1	0.6	2.2	0.9	1.6	1.3	1.8	0.3	0.2	0.4	5.1	8.6	1.9	13.5	11.0	15.9
Maine	5.8	0.4	2.6	1.0	1.7	1.5	1.8	—¶	—¶	—¶	5.4	8.8	2.3	12.3	11.4	13.2
Maryland	6.3	0.4	1.9	0.6	1.4	1.2	1.6	0.2	—¶	0.2	4.1	7.3	1.4	10.5	9.1	11.8
Massachusetts	5.1	0.4	2.3	0.9	1.4	1.1	1.7	0.2	0.1	0.2	5.0	8.2	2.1	11.2	10.3	11.9
Michigan	6.6	0.5	2.4	0.8	1.4	1.0	1.7	0.2	0.2	0.3	4.5	7.5	1.8	11.5	9.5	13.4
Minnesota	5.8	0.4	2.0	1.0	1.2	0.9	1.6	0.1	—¶	0.2	4.2	6.9	1.6	10.2	8.8	11.6
Mississippi	9.3	0.7	2.4	1.2	1.7	1.3	2.0	0.2	—¶	0.3	5.3	9.0	2.0	14.3	11.5	16.7
Missouri	8.1	0.5	2.3	0.6	1.7	1.3	2.0	0.2	—¶	0.2	4.8	8.2	1.8	12.6	10.2	14.9
Montana	6.2	—¶	1.8	1.0	1.4	0.8	1.8	—¶	—¶	—¶	4.5	7.1	1.8	10.7	9.1	12.2
Nebraska	6.8	0.4	2.5	0.7	1.2	0.8	1.5	0.2	—¶	—¶	3.6	5.8	1.5	10.2	7.4	12.9
Nevada¶	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**	—**
New Hampshire	5.0	0.4	2.1	0.8	1.5	0.9	2.1	—¶	—¶	—¶	5.0	7.8	2.3	10.8	9.5	12.0
New Jersey	7.6	0.5	1.9	0.7	1.4	1.0	1.8	0.2	0.1	0.3	3.8	6.6	1.5	11.1	8.5	13.5
New Mexico	7.2	0.5	1.2	1.0	1.2	0.8	1.6	0.2	—¶	0.4	3.3	5.5	1.3	9.9	7.5	12.2
New York	7.7	0.4	1.8	0.9	1.6	1.4	1.8	0.3	0.2	0.3	3.9	6.6	1.6	11.4	9.1	13.6
North Carolina	6.8	0.6	2.3	0.8	1.5	1.2	1.9	0.2	0.1	0.2	5.4	9.3	2.0	12.6	11.3	13.8
North Dakota	6.5	—¶	2.3	—¶	0.6	—¶	0.9	—¶	0	—¶	4.0	6.7	1.3	9.5	7.8	11.3
Ohio	7.1	0.4	2.2	0.8	1.5	1.0	1.8	0.2	0.1	0.3	4.6	7.7	1.7	11.8	9.7	13.7
Oklahoma	8.9	0.4	2.2	0.7	1.6	1.2	2.1	0.3	0.2	0.4	4.8	8.1	1.8	13.0	10.2	15.8
Oregon	6.6	0.4	2.1	0.6	2.0	1.3	2.6	0.1	—¶	0.2	4.7	7.9	1.7	11.7	9.9	13.5
Pennsylvania	7.5	0.4	2.5	0.6	1.4	1.1	1.8	0.2	0.1	0.3	4.5	7.6	1.8	11.9	9.4	14.2
Rhode Island	6.1	0.4	3.4	0.7	1.5	1.0	1.9	—¶	—¶	—¶	4.2	7.3	1.4	11.3	9.1	13.3
South Carolina	7.4	0.4	2.4	0.7	1.5	1.1	1.7	0.2	0.1	0.3	5.3	9.0	2.0	12.7	10.9	14.3
South Dakota	6.6	—¶	2.2	—¶	1.4	0.9	1.9	—¶	—¶	—¶	3.9	6.3	1.6	10.4	8.1	12.8
Tennessee	8.4	0.6	2.5	0.9	1.8	1.3	2.2	0.3	0.2	0.3	4.9	8.3	1.9	13.4	10.6	15.9
Texas	8.4	0.4	1.5	1.0	1.2	0.9	1.4	0.2	0.2	0.3	4.1	6.9	1.5	11.2	9.0	13.5
Utah	5.1	0.3	1.3	0.7	1.0	0.7	1.3	—¶	—¶	—¶	2.7	4.5	0.9	7.5	6.0	9.1
Vermont	4.1	—¶	2.4	1.1	1.4	1.0	1.9	—¶	—¶	—¶	4.9	8.5	1.5	10.7	10.9	10.5
Virginia	6.0	0.4	1.9	0.7	1.4	1.0	1.8	0.2	0.1	0.3	4.3	7.5	1.5	10.6	9.4	11.8
Washington	6.6	0.4	1.8	0.7	1.7	1.1	2.1	0.2	0.2	0.3	4.5	7.5	1.7	11.2	9.5	12.9
West Virginia	9.9	0.5	2.5	1.1	1.5	0.8	2.1	0.2	—¶	—¶	5.1	8.6	1.7	13.9	10.7	17.0
Wisconsin	5.8	0.3	2.0	0.7	1.3	0.9	1.6	0.1	—¶	—¶	4.3	6.8	1.9	10.2	8.5	11.8
Wyoming	8.2	—¶	2.3	—¶	0.8	—¶	1.1	—¶	—¶	—¶	4.3	6.9	1.7	11.0	8.0	14.1
Puerto Rico	11.7	0.7	1.3	2.4	1.1	0.7	1.3	0.4	0.2	0.6	3.2	6.0	0.8	13.1	9.3	16.5

\* Rate per 100,000 persons; age-adjusted to the 2000 U.S. standard population.

† HPV-associated cancers were defined as cancers at specific anatomic sites with specific cell types in which HPV DNA frequently is found. All cancers were confirmed histologically. Cervical cancers (*International Classification of Diseases for Oncology, 3rd Edition* [ICD-O-3] site codes C53.0–C53.9) are limited to carcinomas (ICD-O-3 histology codes 8010–8671, 8940–8941). Vaginal (ICD-O-3 site code C52.9), vulvar (ICD-O-3 site codes C51.0–C51.9), penile (ICD-O-3 site codes C60.0–60.9), anal (ICD-O-3 site code C21.0–C21.9), rectal (ICD-O-3 site code C20.9), and oropharyngeal (ICD-O-3 site codes C01.9, C02.4, C02.8, C05.1, C05.2, C09.0, C09.1, C09.8, C09.9, C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9, C14.0, C14.2 and C14.8) cancer sites are limited to squamous cell carcinomas (ICD-O-3 histology codes 8050–8084, 8120–8131).

‡ Compiled from population-based cancer registries in 49 states and the District of Columbia that participate in the National Program of Cancer Registries, and/or the Surveillance, Epidemiology, and End Results Program and meet criteria for high-quality data for all five years (2008–2012), covering approximately 99% of the U.S. population.

¶ Rate suppressed because fewer than 16 cases were reported.

\*\* Data from Nevada did not meet United States Cancer Statistics publication criteria, which assess completeness and the quality of the source of the data. [http://www.cdc.gov/cancer/npcr/uscs/technical\\_notes/criteria.htm](http://www.cdc.gov/cancer/npcr/uscs/technical_notes/criteria.htm).

the five additional HPV types (31, 33, 45, 52, 58), which can be prevented by the 9-valent HPV vaccine. Among cervical carcinoma cases, 7,800 cases were attributable to HPV types 16 and 18 and 1,700 were attributable to the additional HPV types. Among oropharyngeal SCC cases, 9,500 cases were attributable to HPV types 16 and 18, and another 900 cases were attributable to the additional types.

### Discussion

Each year during 2008–2012, an average of 38,793 HPV-associated cancers were diagnosed, including 23,000 among females and 15,793 among males; 79% of these were attributable to HPV. Compared with a previous analysis, which reported 33,369 HPV-associated cancer cases diagnosed each year during 2004–2008, the results of this analysis demonstrate an overall increase in HPV-associated cancer incidence, from 10.8 per 100,000 persons during 2004–2008 to 11.7 per 100,000 persons during 2008–2012, despite a slight decrease in the rate of cervical carcinoma (4). Part of this increase is because of the inclusion of additional subsites for oropharyngeal cancer; however, the increase persisted when these subsites were excluded from analysis.

The Advisory Committee on Immunization Practices recommends routine vaccination with any of the available HPV vaccines (bivalent, quadrivalent, or 9-valent) for females and quadrivalent or 9-valent for males (5). Vaccination is recommended at ages 11–12 years and through age 26 years for females and age 21 years for males, if they were not previously vaccinated (5). High-income countries have observed a population-level impact of HPV vaccination programs, including reductions in vaccine type prevalence and rates of anogenital warts, most of which are caused by HPV types 6 and 11, two types targeted by the quadrivalent and 9-valent HPV vaccines (6). Among U.S. adolescent females aged 13–17 years in 2014, 60.0% received  $\geq 1$  dose, 50.3% received  $\geq 2$  doses, and 39.7% received  $\geq 3$  doses; male coverage with  $\geq 1$ ,  $\geq 2$ , and  $\geq 3$  doses was 41.7%, 31.4%, and 21.6%, respectively (7). Series initiation was higher among blacks and Hispanics compared with whites, and among persons below the poverty level, in both male and female U.S. populations. Increasing vaccination coverage could decrease the cancer incidence and disparities in the United States.

Most cervical cancers are preventable with regular screening for precancerous lesions among women aged 21–65 years linked with follow-up for abnormal test results (8); there are currently no effective population-based screening strategies for the other HPV-associated cancers. The *Healthy People 2020* target for cervical cancer screening is 93%\*\*; however

\*\* <http://www.healthypeople.gov/2020/topicsobjectives2020/default.aspx>.

### Summary

#### What is already known about this topic?

Persistent infections with human papillomavirus (HPV) can cause carcinomas of the cervix, and squamous cell cancers of the vulva, vagina, penis, anus, rectum, and oropharynx. Many of these cancers are preventable with currently available vaccines; effective screening programs can identify cervical precancers for treatment before they can progress to cancer.

#### What is added by this report?

An average of 38,793 HPV-associated cancers (11.7 per 100,000 persons) were diagnosed annually in the United States during 2008–2012, including 23,000 (13.5) among females and 15,793 (9.7) among males. Among these cancers, CDC estimates that 30,700 (79%) can be attributed to HPV, and 28,500 of these are attributable to HPV types that are preventable with the 9-valent HPV vaccine.

#### What are the implications for public health practice?

Full vaccination coverage of the U.S. population could prevent future HPV-attributable cancers and potentially reduce racial and ethnic disparities in HPV-associated cancer incidence. Ongoing surveillance for HPV-associated cancers using high-quality population-based registries is needed to monitor trends in cancer incidence that might result from increasing use of HPV vaccines and changes in cervical cancer screening practices.

in 2013, only 80.7% of women reported up-to-date cervical cancer screening, with even lower rates noted among Asians, Hispanics, women aged 51–65 years, foreign-born, uninsured, and publicly insured women (9).

The findings in this report are subject to at least two limitations. First, although population-based cancer registries provide a reliable system for counting invasive cancers, no registry routinely collects or reports information on HPV DNA status in cancer tissue, so the HPV-attributable cancers are only estimates. Second, reporting of race and ethnicity uses data from medical records, which might be inaccurate in a small proportion of cases.

Of the 38,793 cancers that occurred each year in the United States at anatomic sites associated with HPV, approximately 30,700 can be attributed to HPV. Of these, 24,600 cancers are attributable to HPV types 16 and 18, which are included in all current HPV vaccines, and 28,500 are attributable to high-risk HPV types included in the 9-valent HPV vaccine. Ongoing surveillance for HPV-associated cancers using high-quality population-based registries is needed to monitor trends in cancer incidence that might result from increasing use of HPV vaccines and changes in cervical cancer screening practices.

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**TABLE 3. Estimated average annual percentage and estimated number of cancers attributable to human papillomavirus (HPV),\* by anatomic site and sex — United States, 2008–2012†**

Cancer	Average annual no.	Attributable to any HPV type <sup>§</sup>	Attributable to HPV 16/18 <sup>§</sup>	Attributable to HPV 31/33/45/52/58 <sup>§</sup>	Attributable to HPV 16/18/31/33/45/52/58 <sup>§</sup>
		No. (%)	No. (%)	No. (%)	No. (%)
Cervical	11,771	10,700 (90.6)	7,800 (66.2)	1,700 (14.7)	9,500 (80.9)
Vaginal	802	600 (75.0)	400 (55.1)	100 (18.3)	600 (73.4)
Vulvar	3,554	2,400 (68.8)	1,700 (48.6)	500 (14.2)	2,200 (62.8)
Penile	1,168	700 (63.3)	600 (47.9)	100 (9.0)	700 (56.9)
All anal cancers	5,010	4,600 (91.1)	4,000 (79.4)	400 (8.2)	4,400 (87.6)
Female	3,260	3,000 (92.5)	2,600 (79.5)	400 (10.8)	2,900 (90.3)
Male	1,750	1,600 (88.7)	1,400 (79.1)	100 (3.8)	1,500 (82.9)
All rectal cancers	750	700 (91.1)	600 (79.4)	100 (8.2)	700 (87.6)
Female	513	500 (92.5)	400 (79.5)	100 (10.8)	500 (90.3)
Male	237	200 (88.7)	200 (79.1)	— (3.8)	200 (82.9)
All oropharyngeal cancers	15,738	11,000 (70.1)	9,500 (60.2)	900 (5.7)	10,400 (65.9)
Female	3,100	2,000 (63.3)	1,600 (50.8)	300 (9.5)	1,900 (60.3)
Male	12,638	9,100 (72.4)	8,000 (63.4)	600 (4.4)	8,600 (67.8)
<b>Total</b>	<b>38,793</b>	<b>30,700 (—)</b>	<b>24,600 (—)</b>	<b>3,800 (—)</b>	<b>28,500 (—)</b>

\* HPV-associated cancers were defined as cancers at specific anatomic sites with specific cell types in which HPV DNA frequently is found. All cancers were confirmed histologically. Cervical cancers (International Classification of Diseases for Oncology, 3rd Edition [ICD-O-3] site codes C53.0–C53.9) are limited to carcinomas (ICD-O-3 histology codes 8010–8671, 8940–8941). Vaginal (ICD-O-3 site code C52.9), vulvar (ICD-O-3 site codes C51.0–C51.9), penile (ICD-O-3 site codes C60.0–60.9), anal (ICD-O-3 site code C21.0–C21.9), rectal (ICD-O-3 site code C20.9), and oropharyngeal (ICD-O-3 site codes C01.9, C02.4, C02.8, C05.1, C05.2, C09.0, C09.1, C09.8, C09.9, C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9, C14.0, C14.2 and C14.8) cancer sites are limited to squamous cell carcinomas (ICD-O-3 histology codes 8050–8084, 8120–8131).

† Compiled from population-based cancer registries in 49 states and the District of Columbia that participate in the National Program of Cancer Registries, and/or the Surveillance, Epidemiology, and End Results Program and meet criteria for high-quality data for all five years (2008–2012), covering approximately 99% of the U.S. population.

§ Estimates for attributable fraction were based on studies that used population-based data from cancer tissue to estimate the percentage of those cancers probably caused by HPV. The attributable fraction for rectal squamous cell carcinoma was based on the attributable fraction for anal squamous cell carcinoma. The estimated number of HPV-attributable cancers was calculated by multiplying the HPV-associated cancer counts by the percentage of each cancer attributable to HPV. Estimates were rounded to the nearest 100. Estimates less than 100 are not presented. Individual counts may not sum to the total count because of rounding.

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