



# Human Papillomavirus (HPV)-Associated Cancers and HPV Vaccination Coverage in California



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## Content

What is HPV .....	1
What is the HPV Vaccine .....	1
HPV Vaccination Coverage in CA for Male and Female Adolescents .....	2
HPV-Associated Cancers in CA .....	4
Total Number of HPV-Associated Cancers in 2010 .....	4
Average Incidence Rates for 2006-2010 by Gender and Race/Ethnicity .....	6
Short-term Trends in Annual Incidence Rates for HPV-Associated Cancers from 2000-2009 by Gender and Race/Ethnicity .....	10
Technical Notes .....	14

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## HUMAN PAPILLOMAVIRUS (HPV) AND HPV VACCINATION COVERAGE IN CALIFORNIA

***HPV is the most common sexually transmitted infection.***

### What is HPV<sup>1</sup>

The human papillomavirus (HPV) is the most common sexually transmitted infection. Nearly all sexually active men and women will get HPV infection at some point during their lives. More than 40 types of HPV can infect the genitals, mouth and throat. HPV infection is transmitted most often through vaginal and anal sexual contact, but also may be transmitted during oral sex.

Most people infected with HPV do not know they have been infected because the virus does not cause any obvious symptoms, or signs of illness. Approximately 90 percent of HPV infections resolve on their own within two years; however, some HPV infections do not go away and can cause serious health problems, including genital warts, nearly all cases of cervical cancer, and some types of cancer of the vagina, vulva, anus, penis and oropharynx (base of the tongue, tonsils and back of throat).

***Two HPV vaccines are currently available to protect both males and females against infection.***

### What is the HPV Vaccine?<sup>2</sup>

Two HPV vaccines are currently available to protect both males and females against infection with some of the most common HPV types and consequent long-term health problems.

Both vaccines (Cervarix, made by GlaxoSmithKline; Gardasil, made by Merck) protect against HPV types 16 and 18. These types of HPV are most commonly responsible for cervical cancer and cancers of the vulva, vagina, penis, anus, and oropharynx. While nearly all cervical cancers are caused by HPV viruses, HPV 16 and 18 account for approximately 70 percent of cervical cancer cases. An estimated 85 percent of anal cancers are caused by HPV 16, nearly half of vaginal, vulvar and penile cancers are caused by HPV types 16 and 18, and more than 50 percent of oropharynx cancers are linked to HPV 16. Both vaccines have also been shown to prevent cervical pre-cancers in females.

1. Source: <http://www.cdc.gov/std/hpv/stdfact-hpv.htm>

2. Sources: <http://www.cdc.gov/std/hpv/stdfact-hpv.htm>, <http://www.cdc.gov/vaccines/vpd-vac/hpv/vac-faqs.htm>, and <http://www.cancer.gov/cancertopics/factsheet/Risk/HPV>

Of the two HPV vaccines, Gardasil is the only one approved for use in males. In addition to protecting against HPV types 16 and 18, Gardasil protects against HPV types 6 and 11, which cause most genital warts in both males and females. Gardasil is also the only vaccine that has been shown to protect against pre-cancers of the vulva, vagina and anus.

Both HPV vaccines are given as a series of three shots over six months. It is necessary to receive all three doses for optimal protection. It is recommended that females receive all three doses of either vaccine between age 11 and 12 years, or between ages 13 and 26 years if all doses were not received when younger. It is recommended that males receive the Gardasil vaccine between age 11 and 12 years or between 13 and 21 years if all doses were not received when younger.

### **HPV Vaccination Coverage in California for Male and Female Adolescents<sup>3</sup>**

The Centers for Disease Control and Prevention (CDC) conducts the National Immunization Survey-Teen (NIS-Teen) to measure progress towards increasing immunization rates among adolescents. This study collects data through telephone interviews of random households in all 50 states and the District of Columbia. Selected areas of the country are oversampled to increase the reliability of the data. Vaccination data are also collected through a mail survey of each adolescent respondent's pediatrician, family physician, or other primary health care provider. The NIS-Teen's estimates of adolescent vaccination coverage reflect information provided by both surveyed households and immunization providers.

The 2012 NIS-Teen survey found that HPV vaccination coverage among adolescent girls failed to increase from 2011 to 2012, both nationally and in California.<sup>4</sup> In California, 65.0 percent of girls aged 13-17 years received at least one dose of the HPV vaccine, the same as in 2011.<sup>5</sup> 35.8 percent of adolescent girls in California received three doses of the vaccine in 2012, compared to 42.9 percent in 2011.

Both nationally and in California, HPV vaccine coverage among boys increased from 2011 to 2012, the first year after the HPV vaccine was routinely recommended for males. Among California boys aged 13-17 years, 29.4 percent received at least one dose of the HPV vaccine in 2012, an increase from 8.3 percent in 2011. In 2012, 11.7 percent

**2012 NIS-Teen survey found that HPV vaccination coverage among adolescent girls failed to increase from 2011 to 2012, both nationally and in California.<sup>4</sup>**



3. Sources: [http://www.cdc.gov/nchs/nis/about\\_nis.htm#nis\\_teen](http://www.cdc.gov/nchs/nis/about_nis.htm#nis_teen); [http://www.cdc.gov/vaccines/stats-surv/nisteent/data/tables\\_2011.htm](http://www.cdc.gov/vaccines/stats-surv/nisteent/data/tables_2011.htm); <http://www.cdc.gov/vaccines/who/teens/vaccination-coverage.html>; <http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicid=23>  
4. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6229a4.htm>  
5. <http://www.cdc.gov/vaccines/who/teens/vaccination-coverage.html>

## Human Papillomavirus (HPV)-Associated Cancers and HPV Vaccination Coverage in California

of adolescent boys received three doses of the vaccine. Comparison data from 2011 are not available.

California's adolescent HPV vaccination rates are higher than national rates (see Table 1 below), but still well below the Healthy People 2020 goal. The HPV vaccination coverage goal for Healthy People 2020 is to have 80 percent of 13 to 15 year old females complete the three dose vaccine series.

Importantly, even the lower than desired HPV vaccination rate has been found to provide significant protection. A recent study of the National Health and Nutrition Examination Survey data found that the vaccine-type HPV prevalence (HPV-6, -11, -16, or -18) among females aged 14-19 years decreased from 11.5 percent in 2003-2006 (representing the pre-vaccine era) to 5.1 percent in 2007-2010 (the period when the vaccine was introduced). The effectiveness of at least one dose of the vaccine was found to be 82 percent.<sup>6</sup>

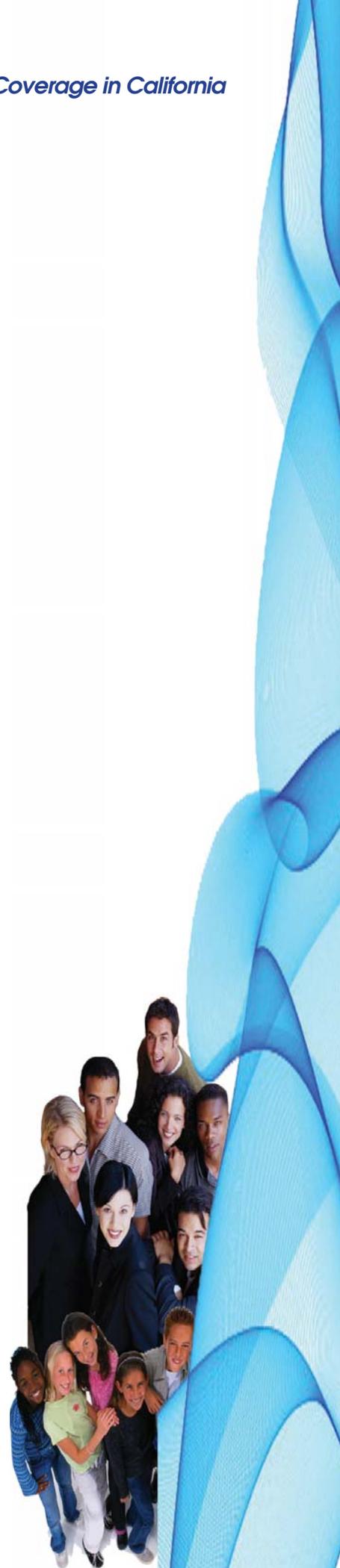
**TABLE: 1**

### Adolescent HPV Vaccination Rates in California, 2011-2012

	Year	Females		Males	
		≥1 dose of HPV	≥3 doses of HPV	≥1 dose of HPV	≥3 doses of HPV
U.S. National	2012	53.8%	33.4%	20.8%	6.8%
	2011	53.0%	34.8%	8.3%	1.3%
California	2012	65.0%	35.8%	29.4%	11.7%
	2011	65.0%	42.9%	13.0%	NA

≥ 1 HPV refers to 1 or more doses of the quadrivalent or bivalent human papillomavirus vaccine.  
 ≥ 3 HPV refers to 3 or more doses of the quadrivalent or bivalent human papillomavirus vaccine.

6. "Reduction in Human Papillomavirus (HPV) Prevalence Among Young Women Following HPV Vaccine Introduction in the United States, National Health and Nutrition Examination Surveys, 2003–2010."



## HPV-ASSOCIATED CANCERS IN CALIFORNIA

**HPV-Associated cancers<sup>7</sup> accounted for 3.2 percent of all cancers diagnosed in females and 1.9 percent of all new cancers diagnosed in males California in 2010.**

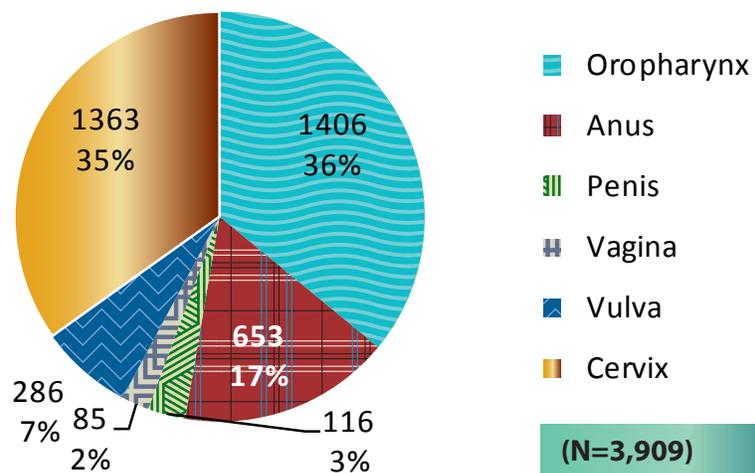
### Total Number of HPV-Associated Cancers in 2010

HPV infection was associated with 2.5 percent of all cancers diagnosed in California in 2010. HPV-associated cancers<sup>7</sup> accounted for 3.2 percent of all cancers diagnosed in females in 2010 (2,417 of 75,895 total cases) and 1.9 percent of all new cancers diagnosed in males (1,492 of 79,038). Among males, HPV infection was most often associated with oropharyngeal cancer (representing 76 percent of HPV-associated cancers), followed by anal cancer (16 percent of HPV-associated cancers).

Cervical cancer was the most common type of HPV-associated cancer diagnosed among females in 2010 (56 percent of new HPV-associated cancers); anal cancer was the second most common (17 percent of HPV-associated cancers). Among both men and women, 36 percent of HPV-associated cancers in California in 2010 were of the cervix and 35 percent were of the oropharynx. See Figures 1-3.

**Figure 1:**

### Number of New HPV-Associated Cancer in California, 2010

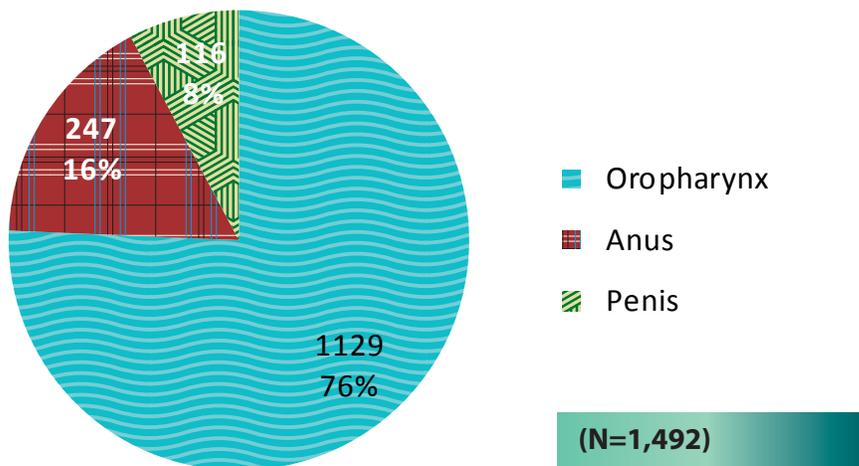


Source: California Cancer Registry, California Department of Public Health  
Released by the California Department of Public Health, California Cancer Registry

7. HPV-associated cancers in this report were identified using the case selection criteria outlined in the following studies: Watson, M., Saraiya, M., Ahmed, F., Cardinez, C. J., Reichman, M. E., Weir, H. K. and Richards, T. B. (2008), Using population-based cancer registry data to assess the burden of human papillomavirus-associated cancers in the United States: Overview of methods. *Cancer*, 113: 2841–2854. (<http://onlinelibrary.wiley.com/doi/10.1002/cncr.23758/full>) Annual Report to the Nation on the Status of Cancer, 1975–2009 Featuring the Burden and Trends in Human Papillomavirus (HPV)-Associated Cancers and HPV Vaccination Coverage Levels - <http://jnci.oxfordjournals.org/content/105/3/175>

Figure 2:

Number of New HPV-Associated Cancer in Males in California, 2010

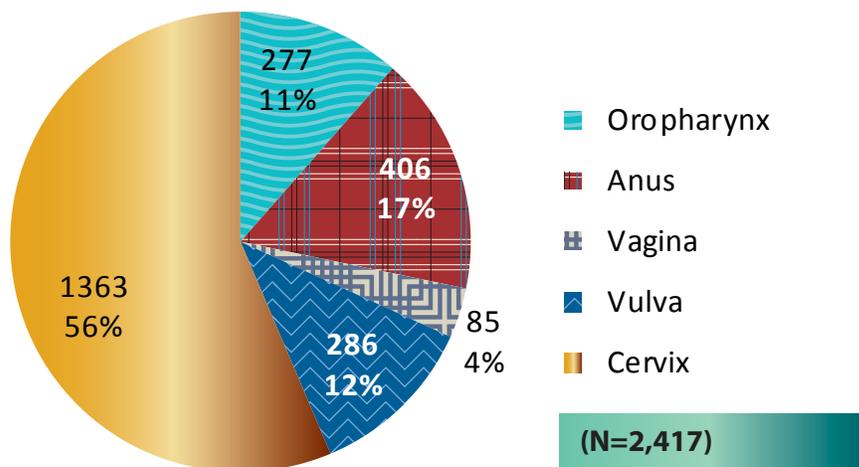


*In males, HPV infection was most often associated with oropharyngeal cancer in California in 2010.*

Source: California Cancer Registry, California Department of Public Health  
Released by the California Department of Public Health, California Cancer Registry

Figure 3:

Number of New HPV-Associated Cancer in Females in California, 2010



*In females, HPV infection was most often associated with cervical cancer in California in 2010.*

Source: California Cancer Registry, California Department of Public Health  
Released by the California Department of Public Health, California Cancer Registry



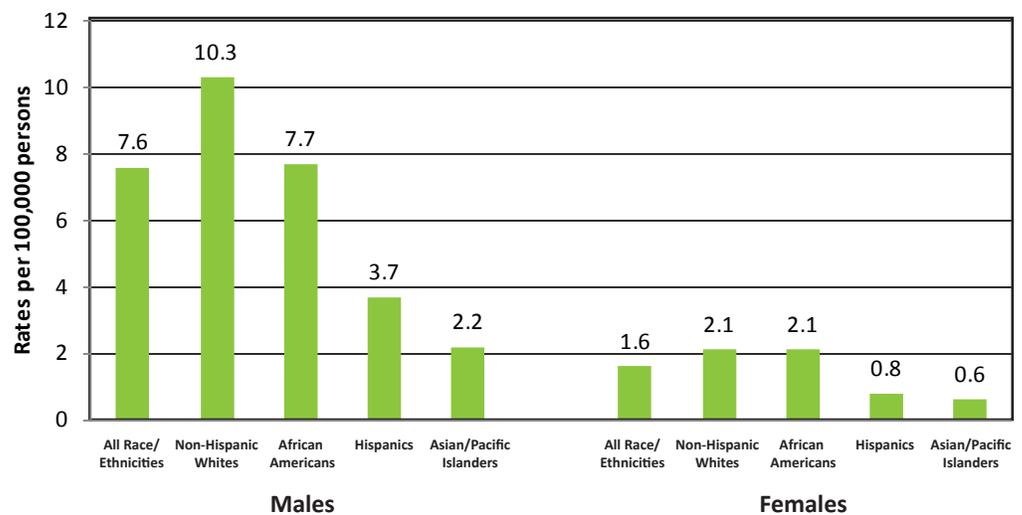
### Average Incidence Rates for 2006-2010 by Gender and Race/Ethnicity

Incidence rates for each of the HPV-associated cancers vary by gender and race/ethnicity. Between 2006 and 2010, the average incidence rates of HPV-associated cancer of the oropharynx were highest among males compared to females. Among males, non-Hispanic whites followed by African Americans had the highest rates (10.3 and 7.7 cases per 100,000 males, respectively). Among women, both non-Hispanic white and African-American females had the highest incidence rates (2.1 cases per 100,000 females). See Figure 4.

**Non-Hispanic white males had the highest incidence rates of HPV-associated cancer of the oropharynx.**

Figure 4:

**Subsites of Oropharynx Cancer Incidence Rates in California by Race/Ethnicity, 2006-2010**

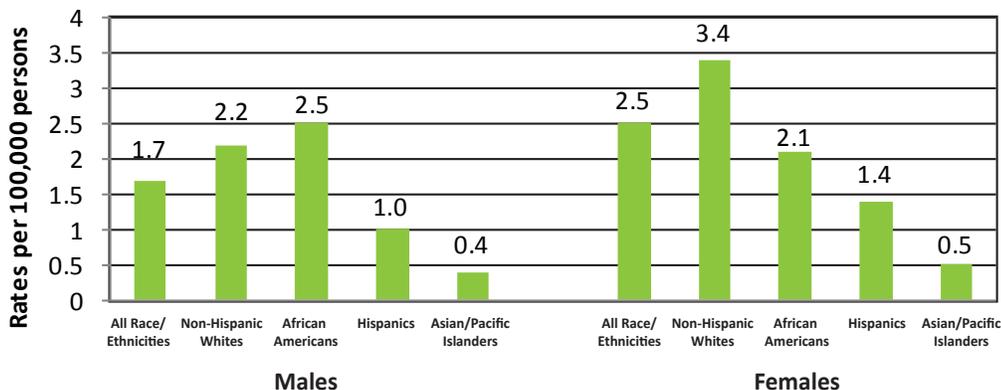


Rates are age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry

Overall, between 2006 and 2010, females had slightly higher average incidence rates of cancer of the anus compared to males. Among females, non-Hispanic whites had the highest incidence rate of cancer of the anus (3.4 cases per 100,000 females); among males, African Americans had the highest incidence rate (2.5 cases per 100,000 males). See Figure 5.

Figure 5:

Cancer of the Anus Incidence Rates in California by Race/Ethnicity, 2006-2010



**African-American males had the highest incidence rate of cancer of the anus in California from 2006-2010.**

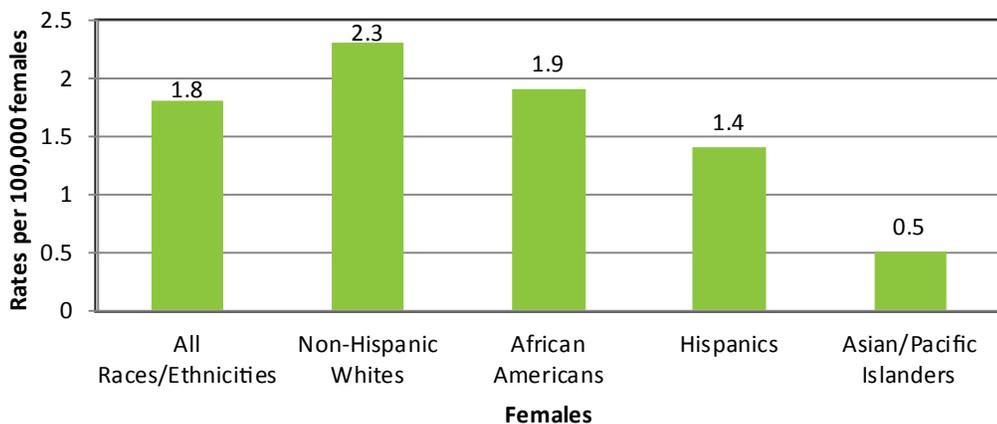
Rates are age-adjusted to the 2000 U.S. Standard Population.

Source: California Cancer Registry, California Department of Public Health  
Released by the California Department of Public Health, California Cancer Registry

Between 2006 through 2010, non-Hispanic white females had the highest incidence rate of cancer of the vulva (2.3 cases per 100,000 females); African Americans had the highest incidence rate of cancer of the vagina (0.8 cases per 100,000 females); and Hispanic females had the highest incidence rate of cervical cancer (13.4 cases per 100,000 females). See Figures 6-8.

Figure 6:

Cancer of the Vulva Incidence Rates in California by Race/Ethnicity, 2006-2010



**Non-Hispanic white females had the highest incidence rate of cancer of the vulva in California from 2006-2010.**

Rates are age-adjusted to the 2000 U.S. Standard Population.

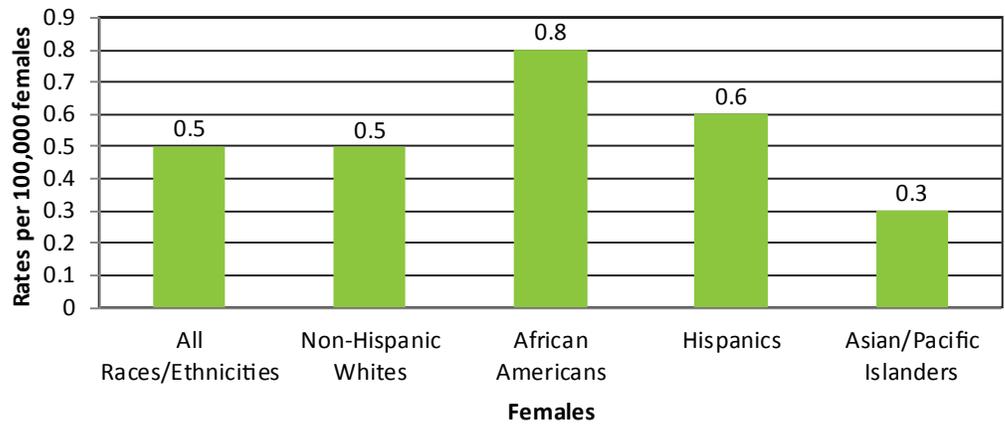
Source: California Cancer Registry, California Department of Public Health  
Released by the California Department of Public Health, California Cancer Registry



**African-American females had the highest incidence rate of cancer of the vagina cancer in California from 2006-2010.**

**Figure 7:**

**Cancer of the Vagina Incidence Rates in California by Race/Ethnicity, 2006-2010**



Rates are age-adjusted to the 2000 U.S. Standard Population.

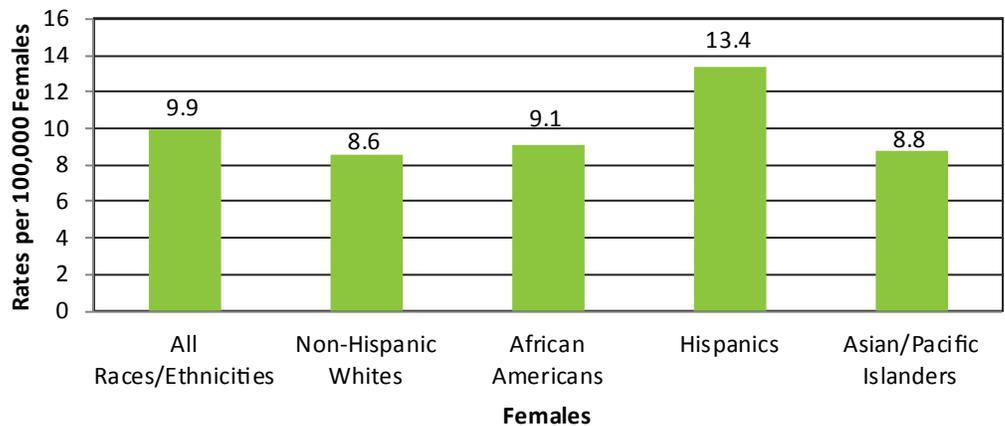
Source: California Cancer Registry, California Department of Public Health

Released by the California Department of Public Health, California Cancer Registry

**Hispanic females had the highest incidence rate of cervical cancer in California from 2006-2010.**

**Figure 8:**

**Cancer of the Cervix Incidence Rates in California by Race/Ethnicity, 2006-2010**



Rates are age-adjusted to the 2000 U.S. Standard Population.

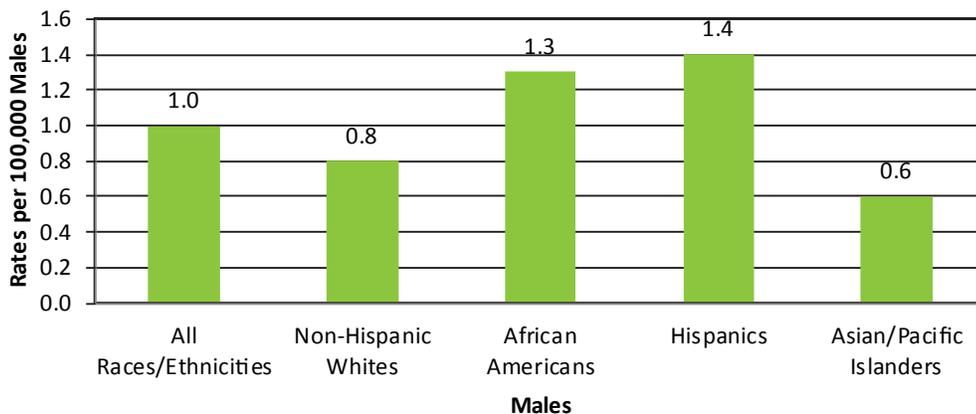
Source: California Cancer Registry, California Department of Public Health

Released by the California Department of Public Health, California Cancer Registry

During 2006 through 2010, Hispanic males, followed by African-American males, had the highest incidence rates of cancer of the penis (1.4 and 1.3 cases per 100,000 males, respectively).

Figure 9:

Cancer of the Penis Incidence Rates in California by Race/Ethnicity, 2006-2010



*Hispanic males had the highest incidence rate of cancer of the penis in California from 2006-2010.*

Rates are age-adjusted to the 2000 U.S. Standard Population.

Source: California Cancer Registry, California Department of Public Health

Released by the California Department of Public Health, California Cancer Registry



### Short-Term Trends in Annual Incidence Rates for HPV-Associated Cancers from 2000-2009 by Gender and Race/Ethnicity

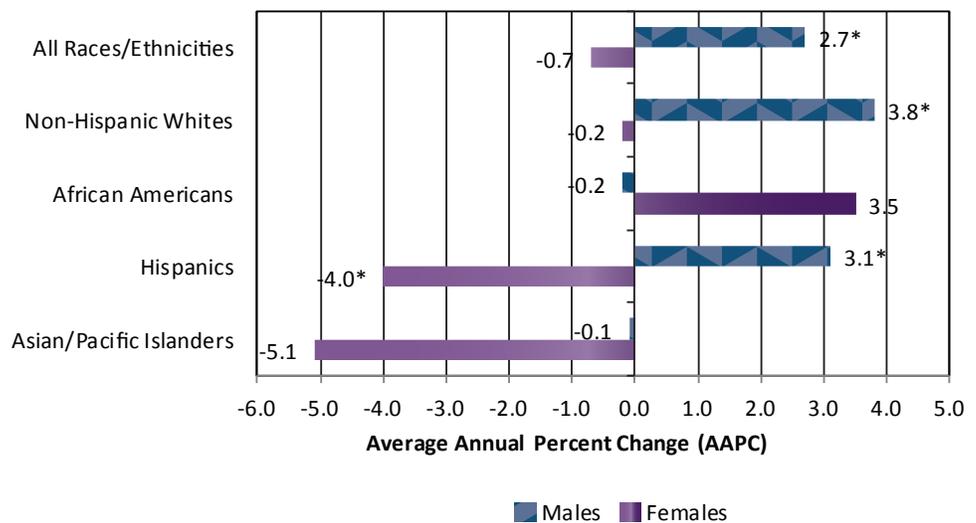
California trends in age-adjusted HPV-associated cancer incidence rates are similar to the trends seen nationally. Both the United States as a whole and California experienced statistically significant increases in incidence rates for HPV-associated cancers of the oropharynx, anus and vulva between 2000 and 2009.<sup>8</sup>

From 2000 to 2009, all California males combined, non-Hispanic white males and Hispanic males experienced statistically significant increases in incidence rates for HPV-associated cancer of the oropharynx. During this same time, all females combined and non-Hispanic white females had statistically significant increases in incidence rates of cancer of the anus. Between 2000 and 2009, incidence rates for cancer of the vulva increased significantly for all California females combined and for non-Hispanic white females. Incidence trends for cancer of the penis were not statistically significant among the four major racial/ethnic groups in California. See Figures 10-15.

California experienced increases in incidence trends for HPV-associated cancers of the oropharynx, between 2000 and 2009.

Figure 10:

Subsites of Oropharynx Cancer Incidence Trends by Race/Ethnicity and Gender, in California, 2000-2009

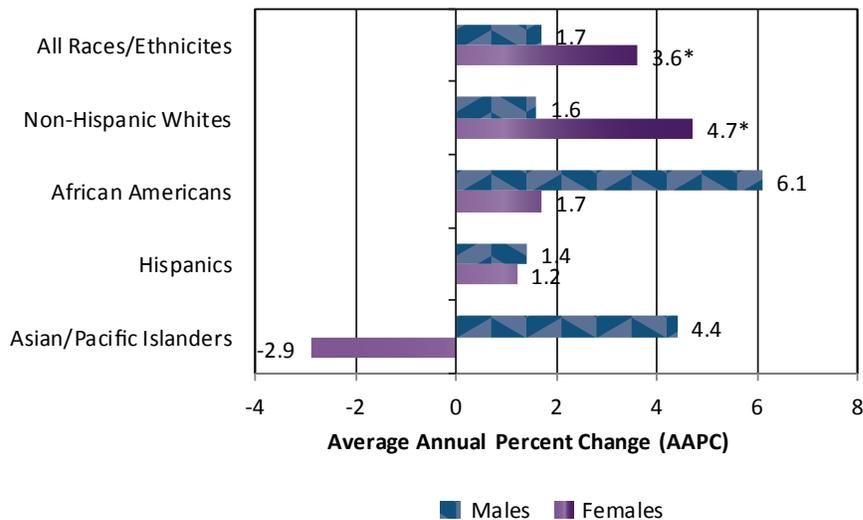


\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry

8. Annual Report to the Nation on the Status of Cancer, 1975-2009, Featuring the Burden and Trends in Human Papillomavirus (HPV)-Associated Cancers and HPV Vaccination Coverage Levels.

Figure 11:

Cancer of the Anus Incidence Trends by Race/Ethnicity and Gender, in California 2000-2009

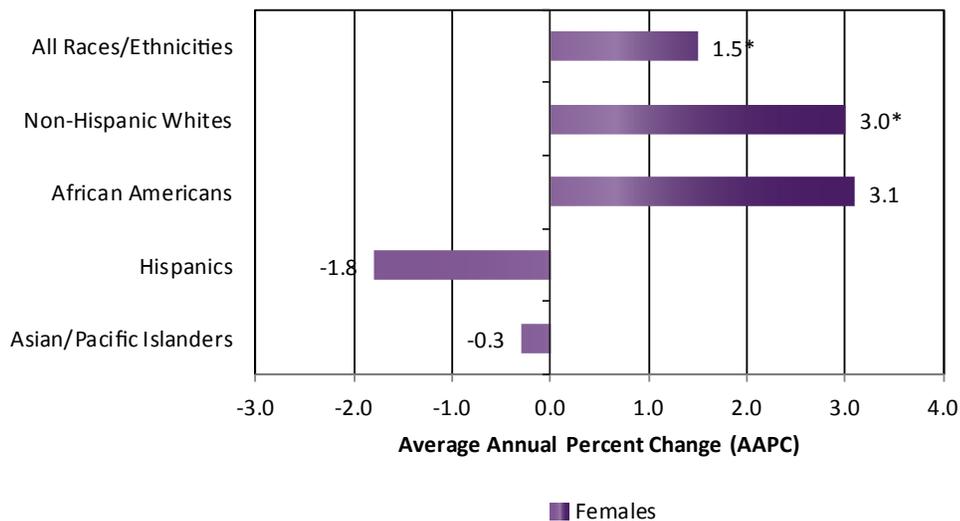


Non-Hispanic white females & African American males had increasing incidence trends of cancer of the anus in California from 2000-2009.

\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry

Figure 12:

Cancer of the Vulva Incidence Trends by Race/Ethnicity, in California Females, 2000-2009



Between 2000 and 2009, incidence rates for cancer of the vulva increased for all California females.

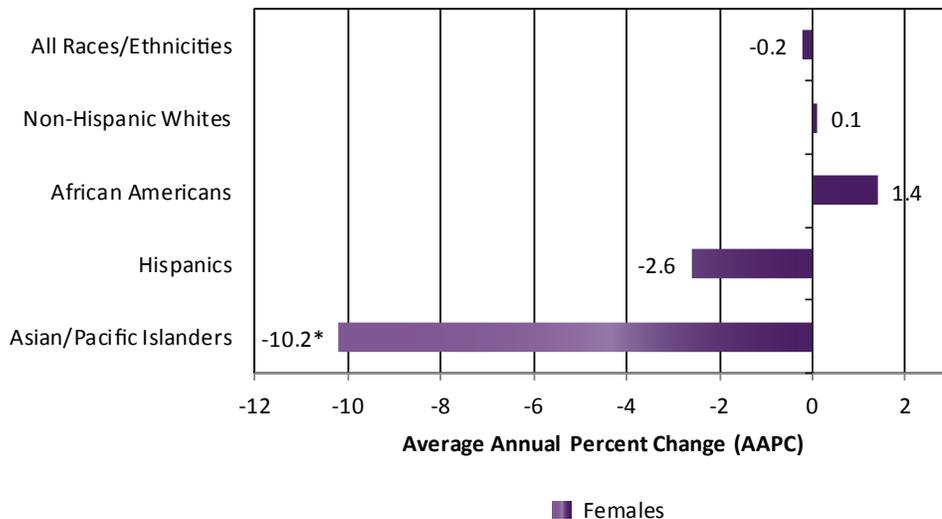
\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry



**African-American females had a increase in incidence rates of cancer of the vagina in California from 2000-2009.**

**Figure 13:**

**Cancer of the Vagina Incidence Trends by Race/Ethnicity, in California Females, 2000-2009**

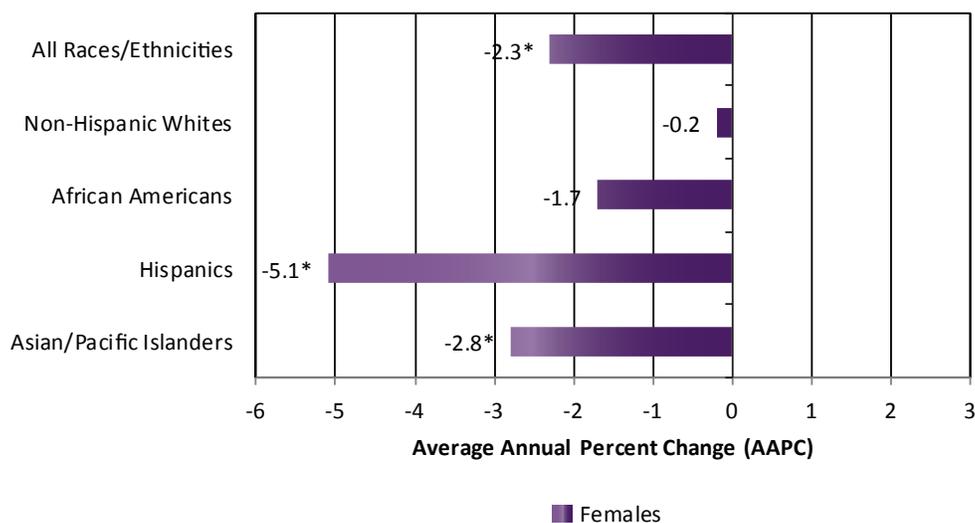


\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry

**Incidence rates of cancer of the cervix decreased in all race/ethnicity groups in California from 2000-2009.**

**Figure 14:**

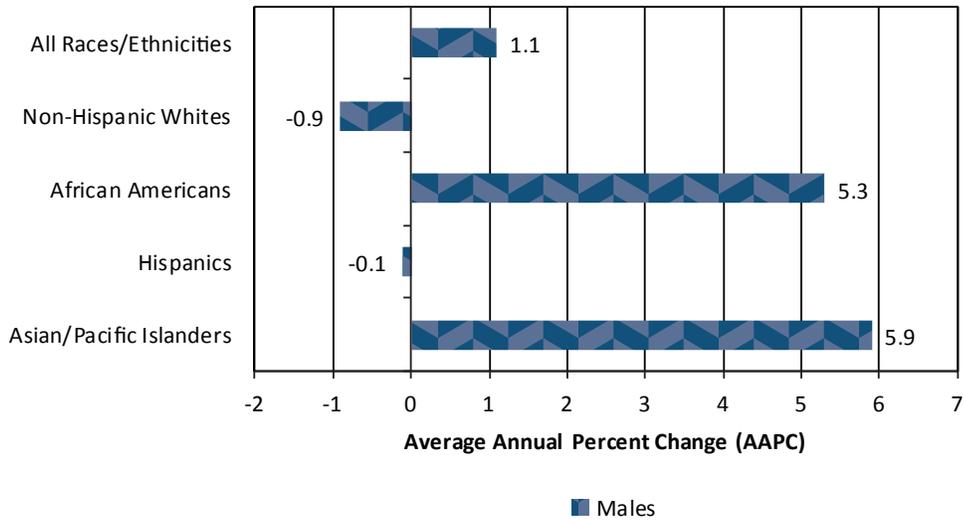
**Cancer of the Cervix Incidence Trends by Race/Ethnicity, in California Females, 2000-2009**



\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry

**Figure 15:**

**Cancer of the Penis Incidence Trends by Race/Ethnicity, in California Males, 2000-2009**



*Incidence trends for cancer of the penis were not statistically significant among the four major racial/ethnic groups in California, between 2000 and 2009.*

\*- AAPC is significantly different from zero at  $p < 0.05$   
 Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population.  
 Source: California Cancer Registry, California Department of Public Health  
 Released by the California Department of Public Health, California Cancer Registry



## TECHNICAL NOTES

### 1. Incidence (New Cases)

This report includes cases of cancer diagnosed between January 1, 1988 and December 31, 2010, and reported to California Cancer Registry (CCR) as of February 2013. A “case” is defined as a primary cancer; tumors that result from the spread, or metastasis, of cancer to another organ from a primary cancer are not counted as new cases. Only invasive cancers (those that have infiltrated the tissue of the organ of origin) are included in this report. Regional registries covering the entire state report cancer incidence data to the CCR, Chronic Disease Surveillance and Research Branch of the California Department of Public Health (CDPH). Standards for data abstracting, collection, and reporting are specified by the CCR. Only cases diagnosed in California residents are included in this report: persons who were treated for cancer in California but who were residents of another state or country are not included.

### 2. Statistical Methods

**Calculation of Age-Adjusted Rates:** Rates for adults were calculated as the number of new cases (incidence) or deaths (mortality) in specific age groups per 100,000 persons each year and were age-adjusted to the 2000 United States standard population. Age-adjusted rates are weighted averages of age-specific rates, where the weights represent the age distribution of a standard population. Such adjustment eliminates differences in rates due to changes in the age of a population over time or differences in age distribution between population groups. Rates in this report were calculated using the Surveillance Research Program, National Cancer Institute SEER\*Stat software version 6.2.3 (<http://srab.cancer.gov/seerstat>).

**Annual Percent Change (APC):** The estimated annual percent change (APC) represents the average percent increase or decrease in cancer rates per year over a specified period of time. It is calculated by first fitting a linear regression to the natural logarithm of the annual age-adjusted rates ( $r$ ), using calendar year as the predictor variable:

$$\ln(r) = m(\text{year}) + b.$$

From the slope of the regression line, the APC is calculated as

$$APC = 100*(e^m - 1).$$

Testing the hypothesis that the APC is equal to zero is equivalent to testing the hypothesis that the slope of the line in the regression is equal to zero. Statistical significance was set at alpha = 0.05. This means that the trend in cancer rates was considered significantly different if there was less than a five percent chance that the difference was the result of random variation.

**Joinpoint Analysis of Trends:** Joinpoint linear regression was used to determine trends in cancer incidence and mortality. In this analysis, a statistical algorithm detects joinpoints, or points in time where the slope of the regression line significantly changes. Thus, the model describes trends during different time segments. At each segment, trends in rates are measured using the estimated APC, which assumes that rates change by a constant percentage each year. The SEER JoinPoint regression software version 3.0 (<http://srab.cancer.gov/joinpoint>) was used for all trend analyses in this report.

**Average Annual Percent Change (AAPC):** Average Annual Percent Change (AAPC) is a summary measure of a trend over a pre-specified fixed interval. It allows us to use a single number to describe the average APCs (Annual Percent Changes) over a period of multiple years. It is valid even if the joinpoint model indicates that there were changes in trends during those years. It is computed as a weighted average of the APC's from the joinpoint model, with the weights equal to the length of the APC interval.

## TECHNICAL NOTES