

# Incidence and mortality rates of oral cancer in California from 1995-2004

## Abstract

**Background:** Oral cancer, or cancer of the oral cavity and pharynx (OCP), is an important global health concern accounting for 275,000 cases and 128,000 deaths annually. OCP cancer incidence and mortality varies markedly by sex, race/ethnicity, geographic location, and oral cancer subsite. The striking variations in the oral cancer rates underline the importance of studying the disease by these subpopulations. Epidemiological investigations describing the distribution and trends of disease between different subpopulations are crucial in developing theories to evaluate etiology, pathogenesis, and treatment so as to design possible preventative measures, screening, and early detection and implementation of relevant health policies.

**Objective:** To examine and analyze the age-adjusted incidence and mortality rates of OCP cancer in the state of California between the years of 1995-2004 for trends by year, gender, race, region of residence, and subsite of OCP cancer.

**Methods:** A total of 337,047,664 California residents between the years of 1995-2004 of ages 0 to 85+ were a part of this retrospective case series. The incidence and mortality rate data, age-adjusted per 100,000 persons, was obtained from the California Cancer Registry (CCR). Data was analyzed using SPSS.

**Result:** The incidence and mortality rates for both genders decreased over the ten year span of this study. Males had a 15.82 (95% CI 15.27, 16.37) incidence rate and females had a 6.57 (95% CI 6.22, 6.91) incidence rate. Males had a mortality rate of 4.21 (95% CI 3.93, 4.49) and females had a mortality rate of 1.85 (95% CI 1.70, 1.99). In terms of race, the highest incidence rate was seen in NH White males at 17.94 (95% CI 17.55, 18.34) and highest mortality rate was seen in NH Black males at 6.57 (95% CI 5.83, 7.31). For region of residence, the highest incidence rate of 12.59 (95% CI 12.10, 13.09) was seen in San Diego and the highest mortality rate of 3.21 (95% CI 2.87, 3.55) was seen in the Bay Area. In terms of oral cancer subsite, the highest incidence rate of 2.77 (95% CI 2.69, 2.86) and highest mortality rate of 0.74 (95% CI 0.71, 0.77) were both found in the tongue.

**Conclusion:** Males had a significantly higher incidence and mortality rate when compared to females. NH White males had the highest incidence and NH Black males had the highest mortality, whereas NH had the lowest incidence and mortality rates for each gender. San Diego had the highest age-adjusted incidence rate and Bay Area had the highest mortality. For oral cancer subsite, the tongue presented with the highest incidence and mortality rates.

The differences in incidence and mortality rates by year, gender, race, region of residence, and subsite illustrate the possible impact of varied cultural, behavioral, and biological factors in the development of disease in different ethnic subpopulations. The significant variation in subsite rates suggests the varied susceptibility to OCP cancer based on anatomical region. The difference seen in regions of residence may be attributable to demographic characteristics of the population residing within the region or environmental factors. The decreasing annual rates demonstrate the possible effect of education, prevention, and treatment on the disease. Further investigation is required to determine causality

**Keywords:** incidence, mortality, oral cancer, oropharynx, statistical program, hispanic

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**Abbreviations:** OCP, oral cavity and pharynx; CCR, California cancer registry; SPSS, statistical program for social studies; ANOVA, analysis of variance

## Introduction

Oral cancer, the clinical problem of interest, refers to the growth of cancerous tissue in the oral cavity, which includes the mouth, the oropharynx, and the exterior of lips. Primary lesions can arise in

any of the tissue types of the mouth. Most commonly oral cancer involves the tongue, but can involve the gingiva, lips, hard and soft palate, sinuses, cheek lining, salivary glands, tonsils, or oral mucosa. Although several types of oral cancer exist, squamous cell carcinomas of the mouth and lip account for approximately 95 percent of all cases of oral cancer.<sup>1</sup>

According to the Oral Cancer Foundation, in 2010, approximately 36,000 Americans will be diagnosed with oropharyngeal cancer of

which only about 50 percent will survive over 5 years. The high mortality rate of oral cancer is mainly due to the tendency to discover the cancer in the late stages of development as opposed to diagnosis or treatment being difficult. Survivability of oral cancer increases dramatically if discovered in the early stages.<sup>2</sup>

## Methods and materials

### Sampling

The sample size was 337,047,664 residents of California from 1995-2004. The sampling unit was residents of California of ages 0 to 85+ years. The sampling frame was residents of age 0 to 85+ who were residing in California from 1995-2004. The sampling elements have both inclusionary and exclusionary criteria.

The inclusionary criteria involved residents having the clinical features of oral cancer. The demographic features included people of all ages and gender. They must have been able to be categorized in the ethnic groups of Asian/Pacific Islander, Non-Hispanic Black, Hispanic, and Non-Hispanic White. The geographic features included residents of California.<sup>3</sup> The temporal features span from January 1, 1995 to December 31, 2004. In terms of exclusionary criteria, temporal features exclude all data prior to January 1, 1995 and after December 31, 2004. The geographic features excluded people who are not residents of California.

In terms of sampling design, 337,047,664 residents of California from 1995-2004 were a part of the cancer study. The incidence and mortality data used were age-adjusted per 100,000 people. The sample size was determined on the basis of power analysis of a statistical test at a 0.05 level of significance.

The data was made available through the doctors, hospitals, and facilities that diagnose and treat cancer patients. California law requires cancer case information to be reported to the California Cancer Registry.<sup>4</sup> The recruitment method was by regular oral cancer screening and by obtaining patient consent.

### Data collection

A comprehensive application was submitted to IRB, New York Campus of UMDNJ. The major source of data collection was the California Cancer Registry. The instrument used for data entry was a personal computer. The investigator reliability was criterion based (M.P.H. candidacy).

In this study, the variability of study variables was not addressed in terms of independent variables (i.e. tobacco use, alcohol consumption, genetics). The variability of dependent variables, incidence and mortality, was addressed.<sup>5</sup>

The validity of the study was assessed in terms of the statistical conclusion, internal validity, cause and effect, and external validity. There was a single group threat to the internal validity. History threat could be a major cause of internal validity threat because the oral cancer susceptibility of the patients could be attributed to their genetic characteristics. Co-variation of the cause and effect (i.e. if X then Y) was the criteria to meet cause and effect relationship. More than one causal factor exists for oral cancer, and therefore it posed a threat to the validity of the study. There did not exist a threat to the statistical conclusion validity because the sample size was large and homogenous. The external validity of the study was limited because the method for assigning subjects was non-random stratified sample selection.<sup>6</sup>

A pilot survey was conducted to train and calibrate the examiner. The intra-examiner and inter-examiner bias was eliminated by performing secondary data analysis and reaching an agreement between study examiners and experienced study epidemiologists.

Clinical examinations and screening for oral cancer was performed by doctors and hospitals; reports of oral cancer cases were entered into the California Cancer Registry for analysis. The age-adjusted rates per 100,000 persons for incidence and mortality of oral cancer were calculated by the California Cancer Registry. The age-adjusted rates incidence and mortality rates for year, gender, race, region, and oral cancer subsite were entered on an Excel software program and then transferred to Special Programs for Social Studies (SPSS) software, version 18. The clinical data was stored on a 640G hard drive and a 4G memory stick. The data was tested and edited for mistakes and omissions.<sup>7</sup>

Using SPSS Version 18 software packages, the significance levels between the means of assigned groups were determined and the linear models for dose-response were evaluated. Where appropriate, descriptive statistics, independent two-tailed t-tests, and analysis of variance (ANOVA) were used to determine difference among the groups.

### Statistical analysis

Statistical analysis was performed with Statistical Program for Social Studies (SPSS), version 18 (SPSS Inc., Chicago, IL.) The unit of analysis was the oral cavity. The univariate descriptive statistics (mean, central tendency, dispersion, and normality) and the bivariate analysis (independent t-test) determined equivalent groups.

A power analysis was utilized to determine the sample size with one degree of freedom and based on the following components: level of statistical significance (0.05), variance (2.0), and effect size (0.20). The demographic features included gender and race.<sup>8</sup> The geographic features included the region and state. The clinical features identified the presence of cancer and subsite. Descriptive statistics were univariate measures of mean, central tendency, dispersion and normality. Inferential statistics were derived by bivariate analysis using the independent t-test and multivariable analysis using ANOVA.

Association was the main statistical function of the statistical tests (two-tailed independent t-test and ANOVA).<sup>9</sup> The scale of measurement of the dependent study variables (incidence and mortality) was dichotomous (Table 1, 2.1&2.2).

In terms of race, Non-Hispanic Whites had the highest incidence of cancer and Hispanics had the lowest for both genders. Non-Hispanic White males had an average incidence of 17.9 and Hispanic males had an average incidence of 9.3. Non-Hispanic White males were 1.9 times more likely to develop OCP cancer as compared to Hispanic Males. Non-Hispanic White females had an average incidence of 7.4 and Hispanic females had an incidence of 3.8. Non-Hispanic White females were 1.9 times as likely to develop OCP cancer when compared with Hispanic females.

In terms of race, Non-Hispanic Blacks had the highest mortality of cancer and Hispanics had the lowest for both genders. Non-Hispanic Black males had an average mortality of 6.6 and Hispanic males had an average mortality of 2.9. Non-Hispanic Black males were 1.9 times more likely to die from OCP cancer as compared to Hispanic Males. Non-Hispanic Black females had an average mortality of 2.3 and Hispanic females had a mortality of 1.1. Non-Hispanic Black females were 2.1 times as likely to die from OCP cancer when compared with Hispanic females.

**Table 1** One-way ANOVA for Incidence Rate & Ethnicity-Sex (1995-2004)

Incidence Rate		95% C.I. for Mean						
Race & Sex	N	Lower Range	Upper Range	Mean	Std. Dev.	Lower Bound	Upper Bound	Sig.
Asian M	10	9.6	13.5	11.650	1.3159	10.709	12.591	.000
Asian F	10	5.0	6.7	5.730	0.5519	5.335	6.125	
Black M	10	15.1	20.6	17.380	1.5957	16.239	18.521	
Black F	10	4.7	7.0	6.100	0.8028	5.526	6.674	
Hispanic M	10	8.5	10.7	9.270	0.7875	8.707	9.833	
Hispanic F	10	3.1	4.2	3.770	0.3302	3.534	4.006	
White M	10	17.1	18.9	17.940	0.5522	17.545	18.335	
White F	10	6.8	8.1	7.350	0.4720	7.012	7.688	
Total	80	3.1	20.6	9.899	5.1039	8.763	11.035	

**Table 2.1** One-way ANOVA for Mortality Rate & Sex (1995-2004)

Mortality Rate		95% C.I. for Mean						
Race & Sex	N	Lower Range	Upper Range	Mean	Std. Dev.	Lower Bound	Upper Bound	Sig.
Asian	10	2.2	3.1	2.73	0.302	2.514	2.946	.000
NH Black	10	3.5	4.7	4.08	0.391	3.8	4.36	
Hispanic	10	1.7	2.1	1.9	0.1333	1.805	1.995	
NH White	10	2.7	3.7	3.07	0.2946	2.859	3.281	
Total	40	1.7	4.7	2.945	0.8406	2.676	3.214	

**Table 2.2** One-way ANOVA for Mortality Rate & Race-Sex (1995-2004)

Mortality Rate		95% C.I. for Mean						
Race & Sex	N	Lower Range	Upper Range	Mean	Std. Dev.	Lower Bound	Upper Bound	Sig.
Asian M	10	3.3	4.8	4.09	.5065	3.728	4.452	.000
Asian F	10	1.3	2.0	1.640	.2633	1.452	1.828	
Black M	10	5.1	8.5	6.570	1.0371	5.828	7.312	
Black F	10	1.8	2.9	2.260	.3307	2.023	2.497	
Hispanic M	10	2.5	3.3	2.930	.2751	2.733	3.127	
Hispanic F	10	0.7	1.4	1.090	.2470	0.913	1.267	
White M	10	3.8	5.4	4.420	.4826	4.075	4.765	
White F	10	1.5	2.4	2.010	.2424	1.837	2.183	
Total	80	0.7	8.5	3.126	1.7645	2.734	3.519	

## Results

Demographic Details included the gender and race of the individual. The clinical features included the cancer subsite if the disease was present. The geographic feature was the Californian region of residence. The temporal feature was a time frame of ten years, from January 1, 1995 to December 31, 2004.

Data about the independent variables, or the cancer-causing agents was not collected. The age-adjusted incidence and mortality rate per 100,000 residents of California was examined as the dependent

variable. Race, sex, region, and cancer sub site were also analyzed as modifying variables.

### By year

(Graph 1) The California state average age-adjusted incidence rate for 1995-2004 was 11.17.

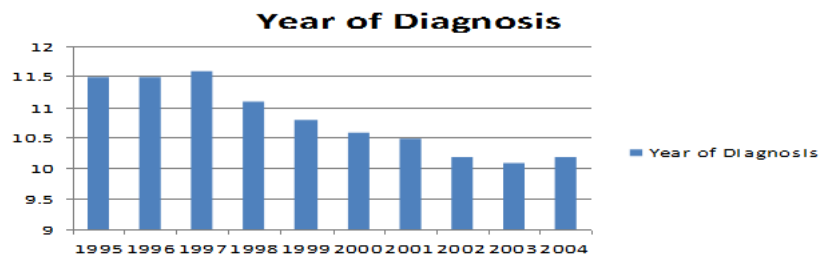
(Table 3) The percent rate of change of oral cavity and pharynx cancer incidence in California from 1995-2004 overall was -11.304 percent, with an average of -1.124 percent change per year.

(Table 4) Using the Linear Regression Model, there was a significant decrease of  $0.19 \pm 0.02$  in the incidence rate per year and  $0.07 \pm 0.02$  decreases in the mortality rate per year. The incidence or mortality rate (x) can be determined using the year of diagnosis or death (y) with the formulas listed below:

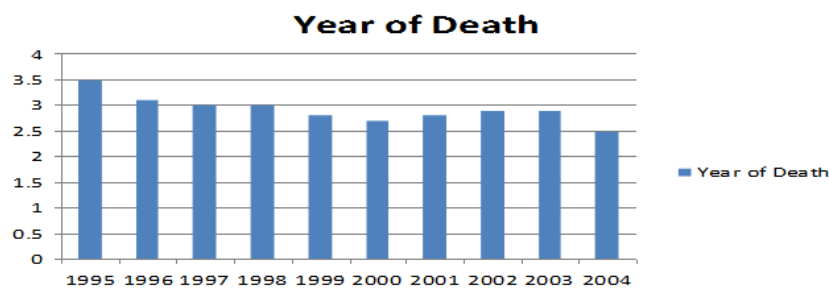
$$\text{Incidence: } y = -0.19x + 380.42$$

$$\text{Mortality: } y = -0.07x + 143.49$$

(See Appendix Graph 1.1&1.2 for significant change in incidence and mortality rates by year)



**Graph 1** Incidence rate of oral cancer by year (age-adjusted per 100,000 persons).



**Graph 2** Mortality rate of oral cancer by year (age-adjusted per 100,000 persons).

**Table 3** Incidence & Mortality of Oral Cancer, California-Percent Rate of Change 1995-2004

	Percent Rate of Change 1995-2004	Average Percent Rate of Change per Year
Total Population (Incidence)	-11.304%	-1.256%
Total Population (Mortality)	-28.571%	-3.175%

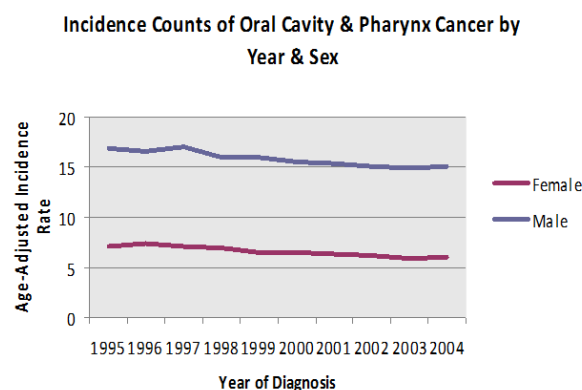
**Table 4** Incidence & Mortality Rate Change by Year (California, 1995-2004)

	m (slope)	Std. Error (m)	B (constant)	Std. Error (B)	P-value	Beta	R Square
Incidence	-0.19	0.02	380.42	37.33	0.00	-0.96	0.93
Mortality	-0.07	0.02	143.49	37.18	0.00	-0.80	0.64

## By Gender

(Graph 3, Table 5) The incidence rate for males was significantly higher in males than in females, as seen in Graph 3. Males were found

to have an average incidence rate of 15.82 (95% CI 15.27, 16.37). Females had an incidence rate of 6.57 (95% CI 6.22, 6.92). Comparing the means, males were 2.4 times more likely than females to develop oral cavity and pharynx cancer.



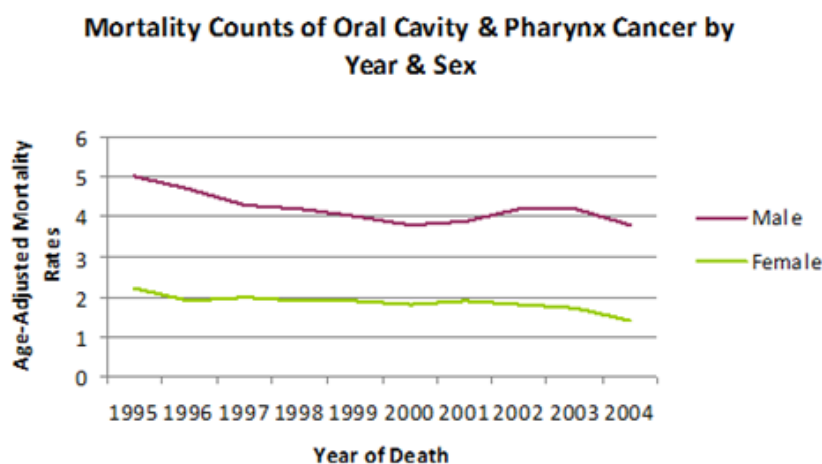
**Graph 3** Incidence counts of oral cavity & pharynx cancer by gender (age-adjusted rates per 100,000 persons).

**Table 5** Independent T-Test for Oral Cancer Incidence Rates in Males & Females (1995-2005)

Group Statistics						95% C.I	
Sex	N	Lower Range	Upper Range	Mean	Std. Dev	Lower	Upper
M	10	14.9	17	15.82	0.79	15.27	16.37
F	10	5.9	7.3	6.57	0.48	6.22	6.92

(Graph 4, Table 6) The mortality rate for males was significantly higher in males than in females, as seen in Graph 4. Males were found to have an average incidence rate of 4.21 (95% CI 3.93, 4.49). Females

had an incidence rate of 1.85 (95% CI 1.70, 1.99). Comparing the means, males were 2.2 times more likely than females to develop oral cavity and pharynx cancer.

**Graph 4** Mortality counts of oral cavity & pharynx cancer by gender (age-adjusted rates per 100,000 persons).**Table 6** Independent T-Test for Oral Cancer Mortality Rates in Males and Females (1995-2005)

Group Statistics						95% C.I	
Sex	N	Lower Range	Upper Range	Mean	Std. Dev	Lower	Upper
M	10	3.8	5	4.21	0.39	3.93	4.49
F	10	1.4	2.2	1.85	0.21	1.7	1.99

**Graph 4:** Mortality Counts of Oral Cavity & Pharynx Cancer by Gender (Age-Adjusted Rates per 100,000 Persons).

(Table 7) Using the Linear Regression Model, there was a significant decrease of  $0.24 \pm 0.03$  in the incidence rate for males and  $0.15 \pm 0.02$  decreases in the incidence rate for females. The incidence rate (x) can be determined using the year of diagnosis (y) with the formulas listed below:

$$\text{Male: } y = -0.24x + 490.85$$

$$\text{Female: } y = -0.15x + 310.74$$

(See Appendix Graph 2.1 and 2.2 for incidence rate change by gender graphs).

(Table 8) Using the Linear Regression Model, there was a significant decrease of  $0.10 \pm 0.03$  in the mortality rate for males and  $0.06 \pm 0.01$  decreases in the mortality rate for females. The mortality rate (x) can be determined using the year of death (y) with the formulas listed below:

$$\text{Male: } y = -0.10x + 196.89$$

$$\text{Female: } y = 0.06x + 119.40$$

(See Appendix Graphs 4.1 and 4.2 for mortality change by gender graphs)

### By Region

A. Oral Cancer Incidence Rates by Region (Age-Adjusted Rates per 100,000 Persons- California, 1995-2004): (Figure 1, Graph 5,6 & Table 9)

California region incidence was found to be lowest in Los Angeles at 10.3 and highest at San Diego at 12.6. San Diego had a 1.2 times higher incidence rate when compared to San Diego.

B. Oral Cancer Mortality Rates by Region (Age-Adjusted Rates per 100,000 Persons- California, 1995-2004): (Figure 2, Graph 7,8 & Table 10)

The lowest mortality rate by California region was seen in Tri-County at 2.3. The highest was seen in the Bay Area at 3.2. The Bay Area had a 1.4 times higher incidence rate when compared with the Tri-County.

**Table 7** Incidence Rate Change by Gender (1995-2004)

	<b>M (slope)</b>	<b>Std. Error (m)</b>	<b>B (constant)</b>	<b>Std. Error (B)</b>	<b>P-value</b>	<b>Beta</b>	<b>R Square</b>
Male	-0.24	0.03	490.85	63.21	0	-0.94	0.88
Female	-0.15	0.02	310.74	34.09	0	-0.95	0.91

**Table 8** Mortality Rate Change by Gender (1995-2004)

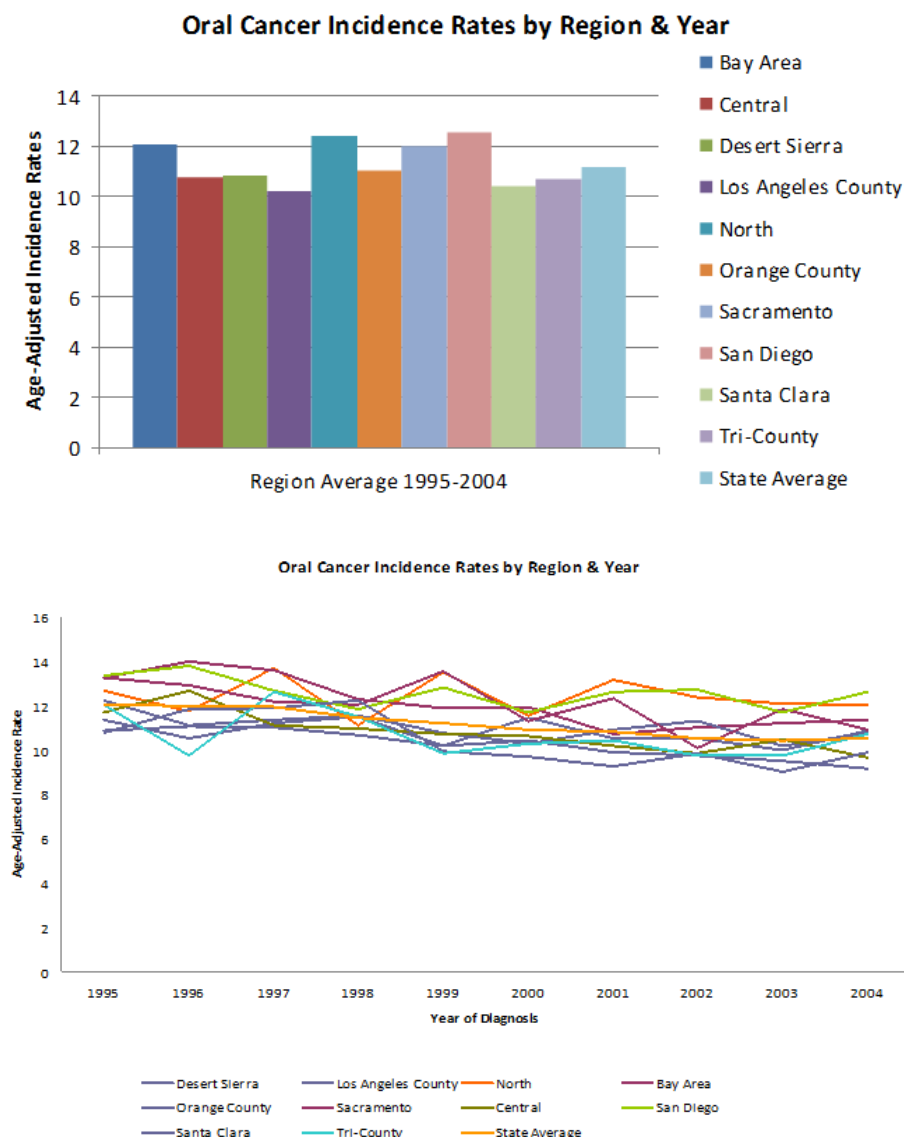
	<b>M (slope)</b>	<b>Std. Error (m)</b>	<b>B (constant)</b>	<b>Std. Error (B)</b>	<b>P-value</b>	<b>Beta</b>	<b>R Square</b>
Male	-0.1	0.03	196.89	59.42	0.01	-0.75	0.57
Female	-0.06	0.01	119.40	24.6	0.00	-0.86	0.74

**Table 9** One-way ANOVA for Incidence Rate & Region (1995-2004)

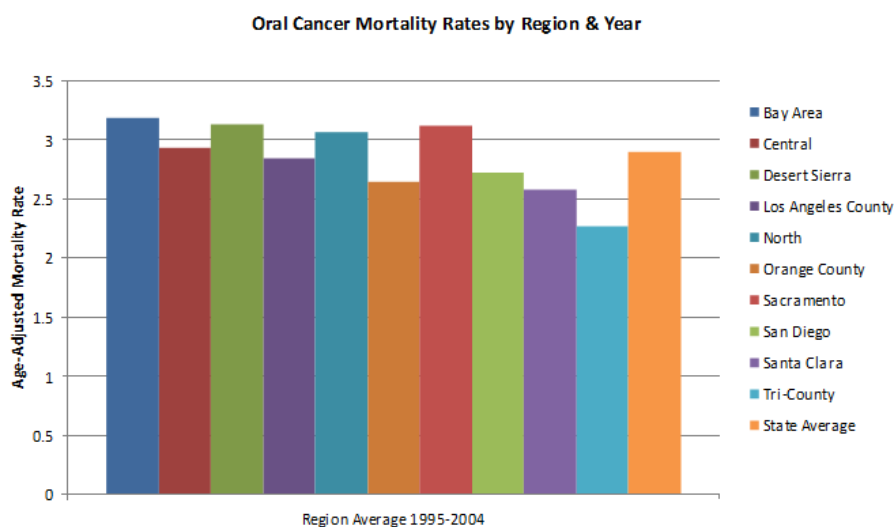
<b>Incidence Rate</b>						<b>95% C.I. for Mean</b>		<b>Sig.</b>
<b>Region</b>	<b>N</b>	<b>Lower Range</b>	<b>Upper Range</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Lower Bound</b>	<b>Upper Bound</b>	
Bay Area	10	10.75	14.02	12.1420	1.14172	11.3253	12.9587	.000
Central	10	9.66	12.68	10.8090	.89035	10.1721	11.4459	
Desert Sierra	10	10.02	11.52	10.8310	.53590	10.4476	11.2144	
Los Angeles	10	9.18	11.08	10.2570	.66790	9.7792	10.7348	
North	10	11.10	13.69	12.3960	.85570	11.7839	13.0081	
Orange County	10	10.21	12.26	11.0620	.61142	10.6246	11.4994	
Sacramento	10	10.09	13.55	12.0590	1.06892	11.2943	12.8237	
San Diego	10	11.69	13.79	12.5920	.68621	12.1011	13.0829	
Santa Clara	10	9.01	12.22	10.4500	1.16075	9.6197	11.2803	
Tri-County	10	9.75	12.61	10.6700	1.04390	9.9232	11.4168	
Total	100	9.01	14.02	11.3268	1.19176	11.0903	11.5633	

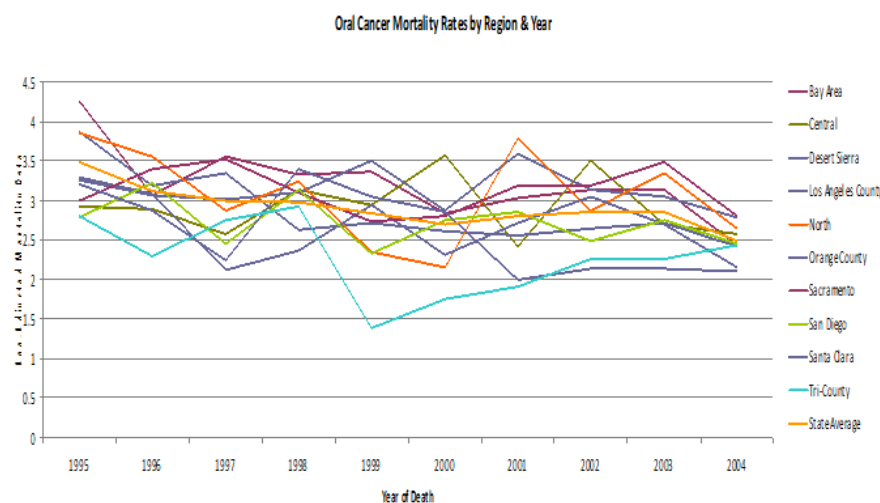
**Table 10** One-way ANOVA for Mortality Rate & Region (1995-2004)

<b>Mortality Rate</b>						<b>95% C.I. for Mean</b>		<b>Sig.</b>
<b>Region</b>	<b>N</b>	<b>Lower Range</b>	<b>Upper Range</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Lower Bound</b>	<b>Upper Bound</b>	
Bay Area	10	2.43	4.25	3.2120	.47614	2.8714	3.5526	.000
Central	10	2.42	3.58	2.9260	.38956	2.6473	3.2047	
Desert Sierra	10	2.78	3.59	3.1400	.25386	2.9584	3.3216	
Los Angeles	10	2.42	3.87	2.8690	.45337	2.5447	3.1933	
North	10	2.15	3.86	3.0650	.58694	2.6451	3.4849	
Orange County	10	2.11	3.29	2.6740	.41690	2.3758	2.9722	
Sacramento	10	2.74	3.52	3.1220	.28561	2.9177	3.3263	
San Diego	10	2.33	3.22	2.7220	.29713	2.5094	2.9346	
Santa Clara	10	2.00	3.40	2.6000	.52921	2.2214	2.9786	
Tri-County	10	1.38	2.93	2.2780	.49288	1.9254	2.6306	
Total	100	1.38	4.25	2.8608	.49757	2.7621	2.9595	

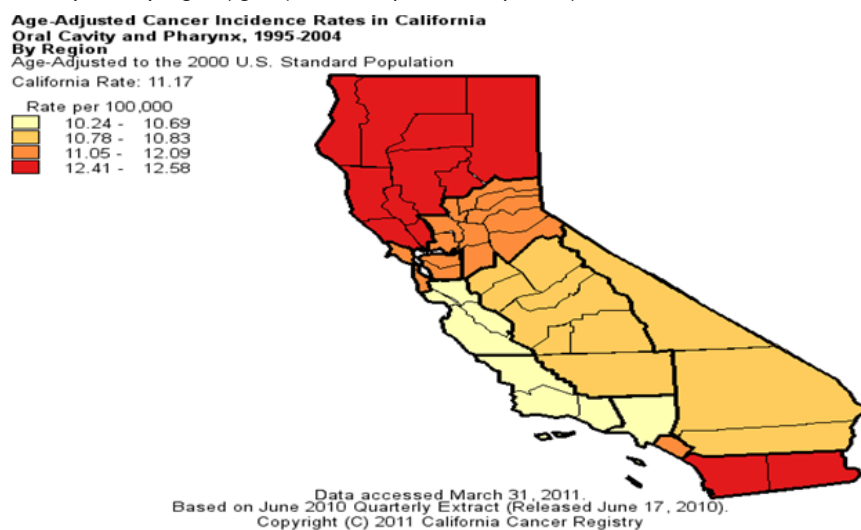


**Graph 5 & 6** Oral cancer incidence rates by region (age-adjusted rates per 100,000 persons).

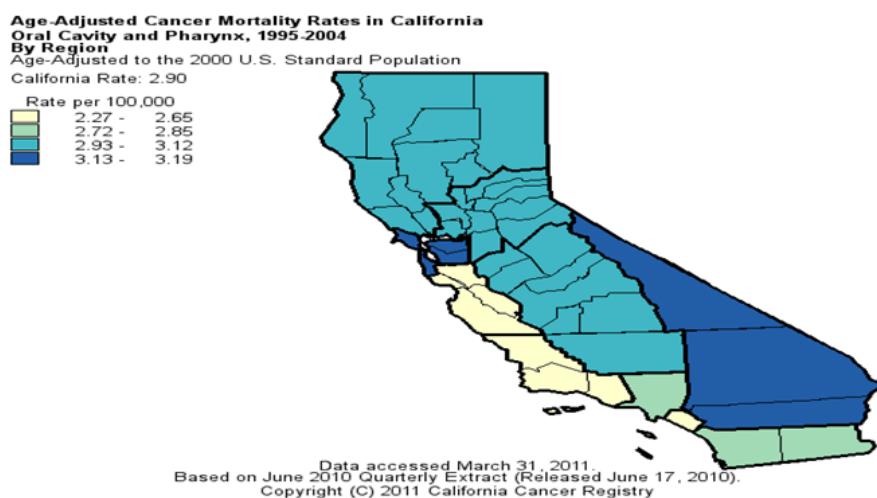




**Graph 7 & 8** Oral cancer mortality rates by region (age-adjusted rates per 100,000 persons).



**Figure 1** Oral cancer incidence rates by region (age-adjusted rates per 100,000 persons).



**Figure 2** Oral cancer mortality rates by region (age-adjusted rates per 100,000 persons).

## Discussion

The age-adjusted California incidence and mortality rates from 1995-2004 were analyzed by year, sex, race, region of residence and cancer sub site.

The incidence and mortality rates for both genders decreased over the ten year span of this study. Males had a 15.82 (95% CI 15.27, 16.37) incidence rate and females had a 6.57 (95% CI 6.22, 6.91) incidence rate. Males had a mortality rate of 4.21 (95% CI 3.93, 4.49) and females had a mortality rate of 1.85 (95% CI 1.70, 1.99). In terms of race, the highest incidence rate was seen in NH White males at 17.94 (95% CI 17.55, 18.34) and highest mortality rate was seen in NH Black males at 6.57 (95% CI 5.83, 7.31). For region of residence, the highest incidence rate of 12.59 (95% CI 12.10, 13.09) was seen in San Diego and the highest mortality rate of 3.21 (95% CI 2.87, 3.55) was seen in the Bay Area. In terms of oral cancer subsite, the highest incidence rate of 2.77 (95% CI 2.69, 2.86) and highest mortality rate of 0.74 (95% CI 0.71, 0.77) were both found in the tongue.

## Strengths and weaknesses

The objective for the study, to examine and analyze the incidence and mortality rates of oral cancer in the state of California between the years of 1995-2004, was met. The strengths and weaknesses of the study were determined in terms of study design, sampling plan, data collection, and statistical analysis. A weakness of the study design was in its sample groups. Given individuals of multiple ethnic backgrounds, it is an oversimplification to assign them to one of the four ethnic groups: Asian/Pacific Islander, Non-Hispanic Black, Hispanic, and Non-Hispanic White.<sup>10</sup> Sampling was strength of the study because the California population provided for large sample size. Data collection was a weakness of the study; the nature of cancer is that as it progresses it metastasizes, and thereby making note of the primary incidence site to be difficult. Another data collection weakness was due to attrition.<sup>11</sup> Not all residents remained in California for the entire period of the ten year study. In terms of statistical analysis, the limitations of the univariate analysis does not allow for a regression analysis; the impact of smoking, drinking, and other carcinogens and their impact on the development of oral cancer cannot be determined.<sup>12</sup>

## Limitations

A limitation of this study was that the validity and reliability of the diagnosis of oral cancer is questionable because it was not based on surgical biopsies. Another limitation was that this study did not include the most recent data available on the California Cancer Registry. The Veterans Health Administration hospitals did not report cancer cases to the California Cancer Registry in 2005-2008. Case counts and incidence and mortality rates for adult males in 2005-2008 as found on the California Cancer Registry were underestimated. Therefore, the data from 2005-2008 was not included in this ten year study. Additionally, there was great variability in the incidence and mortality rates among Asians that may be attributable to their sub-ethnic group culture and behavior; the data available on the California Cancer Registry did not provide information about these subcategories [13-15]. The California Cancer Registry also did not provide information on SES, education levels, annual income, and other potential confounding variables, and so a direct relationship between these factors and incidence and mortality of OCP cancer could not be determined. Furthermore, the data available on the

California Cancer Registry was aggregate data, which is susceptible to ecological fallacy.

**Future research** can be aimed at:

- Analyzing further trends of how California compares to other states and to the United States as a whole in terms of gender, race, regions, and oral cancer subsite affected.
- Determining if the incidence and mortality trends of California are skewed compared to all the other states because of the significantly larger Asian/Pacific Islander and Hispanic subpopulation groups.
- Comparing the results of the California oral cavity and pharynx cancer trends of 1995-2004 to the trends of 2005-2008 and determine if the rates and ratios are consistent?
- Making all diagnosis based on surgical biopsies.
- Determining the differences in susceptibility to carcinogens and molecular changes at each of the OCP cancer subsites.
- Analyze the incidence and mortality differences in the individual Asian sub-ethnic populations (i.e. Chinese, Japanese, Phillipino, Koreans, South Asian, Vietnamese).

## Conclusion

The incidence and mortality trends for oral cancer in the state of California for the years 1995-2004 were observed and analyzed. The incidence and mortality rates for both genders decreased over the ten year time span of this study in California; California followed a trend similar to the United States as a whole, which showed decreasing male and female incidence and mortality rates since the 1980s.<sup>1</sup> Males were more likely to develop and die from oral cancer than females. The differences in race showed that Non-Hispanic Whites had the highest incidence of oral cancer. This was inconsistent with the findings of Liu et al. who found that in California, Non-Hispanic Blacks had the highest incidence rate; this may be explained by different trends found in the time period of Liu et al.'s study, which took place from 1988-2001. Non-Hispanic Blacks had the highest mortality from cancer. A higher mortality rate among Non-Hispanic Black males may be associated with SES differences or a higher tobacco and alcohol consumption rate, as seen in the study by Zygianni et al.<sup>16</sup> Hispanics had the lowest incidence of oral cancer. This disparity may be explained by the diversity of the Hispanic population, which arises from more than 20 different countries with various cultural, SES, and religious backgrounds.<sup>1</sup> Region differences showed that San Diego had the highest age-adjusted incidence rate and the Bay Area had the highest mortality. These rates may be attributable to demographic characteristics or environmental factors of the given regions. For oral cancer subsite, highest incidence and mortality was found in the tongue, which was consistent with the study by Canto and Devesa.<sup>17</sup>

The differences in incidence and mortality rates by year, gender, race, region of residence, and subsite illustrate the possible impact of varied cultural, behavioral, and biological factors in the development of disease in different ethnic subpopulations. The significant variation in subsite rates suggests the varied susceptibility to OCP cancer based on anatomical region. The difference seen in regions of residence may be attributable to demographic characteristics of the population residing within the region or environmental factors.<sup>18</sup> The decreasing

annual rates of incidence and mortality of OCP cancer demonstrate the possible effect of education, prevention, and treatment on the disease. Further investigation is required to determine causality.

This study demonstrated the value of using population-based cancer registry data to study cancers with relatively low incidence and mortality to characterize rates based on sex, race, region, and subsite.<sup>19</sup> The trends observed can be used to generate a hypothesis to determine associations and causality and to identify high-risk populations. Furthermore, it can be used to target education and early detection and prevention programs to influence lifestyle choices and reduce morbidity/mortality associated with OCP cancer.

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## Conflicts of interest

Author declares that there is no conflict of interest.

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