



The Oral Health Status of Adults 65 and Older in California: 1995-2006

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ABSTRACT There has been no overall change in the oral health of adults aged 65 years and older from 1995 to 2006. However, approximately 75 percent of the elderly in California were missing one or more teeth due to disease in 2006. Californians who are older, black, less educated, have low family income, and are current or former smokers are more likely to be missing teeth.

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Individuals aged 65 and older are particularly susceptible to oral health problems, which tend to increase with age. Oral health is particularly important for the elderly. Oral health problems that cause difficulty with chewing and eating can interfere with nutrition. Individuals who are missing teeth or who are edentulous may limit the types of food they eat to soft foods, potentially limiting the nutritional content of their food. This can contribute to both poor nutritional status and to unintended weight loss.^{1,2} In addition, diets with low intakes of vitamin D and calcium can contribute to further tooth loss.³

In addition, one's oral health status can affect and be affected by other health problems. An increasing area of research focuses on how periodontal diseases interact and are associated with other common conditions through various inflammatory processes. Periodontal disease has been shown to be associated with many diseases that affect the elderly

including heart disease, stroke, osteoporosis, pneumonia, and diabetes.⁴⁻¹⁴

Preventive dental care is as important, if not more so, for the elderly as it is for younger age groups. The long-term incidence of periodontal attachment loss has been found to be common among the elderly suggesting that periodontal treatment continues to be important.¹⁵ Even those who are edentulous benefit from preventive care. Approximately 30,000 new cases of oral cancer are reported annually, with 50 percent occurring in those aged 65 and older. The progression of bone resorption, poor nutrition, and oral health problems that affect social interactions can all be avoided through periodic assessments that allow needed interventions to be done in a timely manner.¹⁶

The population of those aged 65 years or older to which all of the above applies is growing in California. It is expected to increase by 112 percent from 1990 to 2020 according to the California Department of Aging.¹⁷ While there has been an improvement nationally in the number of teeth

maintained by adults as they age, not all elderly share in this improvement.^{18,19} A number of factors have been found to be associated with tooth loss. A more advanced age, lower levels of education, lower incomes, and being black have all been found to be associated with edentulism in research based on national survey data.²⁰

To date there has been no long-term analysis of the oral health of the elderly population in California. In order for private and public stakeholders to perform appropriate planning that ensures that sufficient resources are devoted to caring for the oral health of California's elderly population, it is critical to clearly measure both overall oral health among the elderly and the variation in oral health across subgroups.

While the most precise way to determine the oral health status of the elderly population is through clinical evaluation conducted by licensed dentists, this approach is prohibitively expensive when surveying large population groups.²¹ An alternative approach is to use a simple measure of oral health that can be accurately determined via telephone surveys and which provides a good approximate picture of the oral health of a population. This measure is the self-reported number of teeth that an adult is missing due to disease.

A study by Lang et al. compared the measure of teeth missing due to disease with the Oral Health Status Index, OHSI, an index that combines information from a clinical examination of the teeth and the periodontium into an overall score ranging from -54 to 100.⁶ The OHSI was developed by Marcus et al. and validated in both general and minority populations.^{22,23} Lang et al. found that the measure of missing teeth, a component of the OHSI, performed almost as well as the OHSI in a population aged 18 to 93.²⁴ Since the elderly are far more likely to be missing teeth due to poor oral health status than young-

er individuals, this is a good measure for our purposes. Self-reported information on missing teeth collected in telephone interviews has been validated in both middle-aged adults and the elderly.^{25,26}

In this paper, the authors use the measure of teeth missing due to disease to examine the oral health of the elderly population of California using data from 1995 to 2006. The authors explore the association between oral health and basic sociodemographic characteristics of elderly individuals.

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Methods

This analysis uses the 1995, 1997, 1999, 2000, 2002, 2004, and 2006 versions of the California Behavioral Risk Factor Survey, BRFS. (Although the BRFS is an annual survey, not all years of the BRFS contained questions on missing teeth. Approximately every other year contained information on missing teeth.) The Behavioral Risk Factor Survey is an ongoing collaborative effort of the California Department of Health Services, the Public Health Institute, and the Centers for Disease Control and Prevention. The survey is conducted by the Survey Research Group, SRG, of the California Department of Health Services, CDHS, Cancer Surveillance Section, CSS. It is supported in part by funds from Cooperative

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Data were collected from adults aged 18 and over through a random digit-dial telephone survey. The 2006 California BRFS sample size is 5,692 individuals. Earlier surveys contained approximately 4,000 to 4,500 observations per year. However, since the authors are only considering individuals aged 65 and older, the estimation sample across all years only contains 4,659 observations, in keeping with the fact that only approximately 11 percent of California's population is aged 65 or older.²⁷ The BRFS survey question asked "How many of your permanent teeth have been removed because of tooth decay or gum disease? Include teeth lost to infection, but do not include teeth lost for other reasons, such as injury or orthodontics," and added the following note, "If wisdom teeth are removed because of tooth decay or gum disease, they should be included in the count for lost teeth."

The data used allow for four levels of oral health with regard to missing teeth: (1) no missing teeth, (2) one to five missing teeth, (3) missing six teeth or more, but not all, and (4) all teeth missing (edentulism). In order to correctly assess long-term changes in oral health over the 1995-2006 period, it is essential to account for the changes that have occurred in the characteristics of the elderly population of California during this time. For example, the oral health of the elderly population may appear to be worsening over time if the elderly population as a whole is simply getting older on average as time passes. Conversely, the oral health of the elderly population may appear to be

improving over time when in fact the population as whole is simply becoming younger on average as time passes (e.g., the oldest elderly Californians move to other states and/or the younger elderly move to California from other states).

This can be accounted for by statistically removing the effects of the changing age composition of the elderly population. In order to accurately measure long-run trends, the authors not only removed the effects of changes in the age composition of the elderly population, but also account for other changes in the composition of the population that may change over time.

The authors thus accounted for the following sociodemographic factors: gender (male, female), age (65-69, 70-74, 75-79, 80-84, and 85 or greater), marital status (unmarried, married), education status (less than high school, high school graduate, some post-high school training, college graduate, post-college), and race/ethnicity (white, Asian/Pacific Islander, Hispanic, black, and other race), annual household income (less than \$10,000; \$10,000-\$14,999; \$15,000-\$19,999; \$20,000-\$24,999; \$25,000-\$34,999; \$35,000-\$49,999; \$50,000-\$74,999; \$75,000 or higher), household size (1, 2, 3, 4 or more), and smoking status (never smoked, former smoker, current smoker).

All regressions are estimated using ordered probit. Ordered probit is similar to ordinary probit but allows simultaneous estimation of outcomes that are categorically ordered. The statistical software used was Stata 9.2. The authors do not report the actual ordered probit coefficients or cut-points as they are not interpretable without transformation. The coefficients reported in each table are transformed and scaled so that they represent marginal probabilities, on a scale from 0 to 1 (so a coefficient of, for

TABLE 1

Weighted Sample Proportions, Adults Aged 65 and Older: 1995-2006		HOUSEHOLD SIZE	
Variables	Weighted Sample Proportions		
GENDER		1 person	31.2%
Male	44.3%	2 people	54.0%
Female	55.8%	3 people	8.0%
Age		4 or more people	6.8%
65-69	32.8%	FAMILY INCOME	
70-74	27.3%	Less than \$10,000	12.2%
75-79	22.2%	\$10,000-\$14,999	11.6%
80-84	12.1%	\$15,000-\$19,999	10.6%
85 and older	5.6%	\$20,000-\$24,999	10.8%
RACE/ETHNICITY		\$25,000-\$34,999	15.0%
White	70.6%	\$35,000-\$49,999	15.7%
Black	5.0%	\$50,000-\$74,999	12.4%
Asian/Pacific Islander	9.5%	\$75,000 or higher	11.7%
Hispanic	12.6%	MARITAL STATUS	
Other	2.3%	Married	54.9%
EDUCATION		Unmarried	45.1%
Less than high school	15.9%	Smoking	
High school	27.5%	Current	7.5%
Some post-high school	27.7%	Former	46.3%
College graduate	17.3%	TEETH MISSING	
Post college	11.6%	None	15.1%
		1 to 5	37.2%
		6 or more (but not all)	25.0%
		All	22.7%
		Observations	4,659

example, 0.05, implies a five percent probability that a person is included in the category of missing teeth being examined relative to the reference group).

Marginal probabilities are computed assuming that all other independent variables are equal to their means (the average person in the population). The statistical analysis accounts for the survey design of the BRFSS including probability weighting. Probability weights were standardized to the population of California according to the 2000 U.S. Census using weights supplied by the Survey Research Group.

Results

During 2006 in California, 74.6 percent of the elderly suffered from reduced oral health status, that is, they were missing one or more teeth due to disease. Among the elderly, 14.3 percent were edentulous, suffering the loss of all teeth. Another 26.9 percent suffered from the loss of six or more, but not all, teeth. Finally, 33.3 percent suffered from the loss of one to five teeth. (The sum of the three subsets does not exactly equal 74.6 due to rounding.) Descriptive statistics for all data from 1995 to 2006 are shown in TABLE 1.

TABLE 2

The Association of Individual Characteristics and Missing Teeth in California Adults Aged 65 and Older: 1995-2006

Variables	(1) No Teeth Missing	Std. Errors	(2) 1 to 5 Teeth Missing	Std. Errors	(3) 6 or More Teeth Missing (but not all)	Std. Errors	(4) All Teeth Missing	Std. Errors
GENDER								
Male	reference		reference		reference		reference	
Female	-0.012	0.014	-0.004	-0.004	0.007	0.009	0.009	0.010
Age								
65-70								
70-74	0.001	0.016	0.000	0.006	-0.001	0.010	-0.001	0.012
75-79	-0.013	0.017	-0.005	0.007	0.008	0.011	0.010	0.013
80-84	-0.044***	0.017	-0.020**	0.009	0.028***	0.010	0.037**	0.015
85 and older	-0.053**	0.022	-0.026*	0.014	0.033**	0.013	0.047**	0.022
RACE/ETHNICITY								
White								
Black	-0.082***	0.021	-0.048***	0.018	0.050***	0.012	0.080***	0.027
Asian/Pacific Islander	-0.041	0.028	-0.018	0.016	0.025	0.017	0.034	0.026
Hispanic	0.123***	0.030	0.019***	0.004	-0.074***	0.017	-0.068***	0.012
Other race	-0.081	0.052	-0.049	0.048	0.049	0.029	0.080	0.071
EDUCATION								
Less than high school								
High school	0.033	0.023	0.011	0.007	-0.020	0.014	-0.023	0.015
Some college	0.095***	0.024	0.024***	0.005	-0.058***	0.015	-0.061***	0.014
College graduate	0.110***	0.030	0.021***	0.004	-0.067***	0.018	-0.065***	0.014
Post-college	0.155***	0.035	0.017***	0.005	-0.092***	0.020	-0.080***	0.013
INCOME								
Less than \$10,000								
\$10,000-\$14,999	-0.036	0.026	-0.016	0.013	0.022	0.016	0.029	0.023
\$15,000-\$19,999	0.068**	0.030	0.016***	0.004	-0.042**	0.018	-0.042***	0.016
\$20,000-\$24,999	0.073**	0.031	0.016***	0.004	-0.045**	0.019	-0.045***	0.016
\$25,000-\$34,999	0.111***	0.032	0.020***	0.003	-0.067***	0.019	-0.064***	0.015
\$35,000-\$49,999	0.140***	0.033	0.021***	0.004	-0.084***	0.019	-0.077***	0.014
\$50,000-\$74,999	0.237***	0.037	0.004	0.010	-0.134***	0.019	-0.107***	0.011
\$75,000 or higher	0.250***	0.043	-0.001	0.013	-0.140***	0.021	-0.109***	0.012
HOUSEHOLD SIZE								
1 person								
2 people	-0.013	0.020	-0.005	0.007	0.008	0.012	0.009	0.015
3 people	-0.038	0.030	-0.017	0.016	0.024	0.018	0.031	0.028
4 or more people	-0.050	0.032	-0.024	0.020	0.031	0.019	0.043	0.033

TABLE 2 CONTINUES ON 575

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MARITAL STATUS								
Unmarried								
Married	-0.001	0.020	0.000	0.007	0.000	0.013	0.000	0.015
SMOKE								
Never smoked								
Current	-0.149***	0.012	-0.124***	0.019	0.079***	0.006	0.194***	0.027
Former	-0.101***	0.013	-0.038***	0.006	0.062***	0.008	0.076***	0.010
YEAR								
1995								
1997	0.017	0.020	0.006	0.006	-0.011	0.013	-0.012	0.014
1999	-0.028	0.020	-0.012	0.009	0.017	0.012	0.022	0.017
2000	-0.018	0.022	-0.007	0.010	0.011	0.014	0.014	0.018
2002	-0.011	0.020	-0.004	0.008	0.007	0.012	0.008	0.015
2004	0.010	0.021	0.003	0.007	-0.006	0.013	-0.007	0.014
2006	-0.011	0.027	-0.004	0.011	0.007	0.017	0.008	0.021
Observations: 4,659								
*p<0.05, **p<0.01, ***p<0.001								

Marginal effects from ordered probit model. Actual coefficients and cut-points not reported.

Over the 11-year period of 1995 to 2006, it was found that there has been no detectable change in the overall oral health status of the elderly population of California. **TABLE 2** shows that none of the year indicators are statistically different from zero, indicating there has been no change in the oral health status of the elderly population, as measured by missing teeth due to disease from 1995 to 2006.

TABLE 2 also presents the probabilities that elderly individuals in California with different characteristics will have differing numbers of teeth missing due to disease. Each entry in the table should be understood as the change in probability that a person with a given characteristic will have a given number of missing teeth relative to the reference group where all other variables in the sample are at their means. The reference group is listed for each group of variables.

In column 1 of **TABLE 2**, the numbers refer to the probability of a person having lost none of their teeth to disease. In column 2 of **TABLE 2**, the numbers refer to the probability of a person having lost one to five

teeth due to disease. In column 3 of **TABLE 2**, the numbers refer to the probability of a person having lost six or more teeth (but not all). Finally, the numbers in column 4 of **TABLE 2** refer to the probability of a person has lost all of their teeth to disease. The authors' focus on columns 2 and 3 since these columns represent the bulk of elderly Californians with poor oral health. These columns also represent elderly Californians who still have teeth that can be saved.

In column 2 of **TABLE 2**, it can be found that age is related to whether a person has lost one to five teeth due to disease. Those aged 70 to 79 are not more likely, those aged 80 to 84 are 2.0 percentage points less likely, and those aged 85 years and older are 2.6 percentage points less likely than those aged 64 to 69 to have lost one to five teeth due to disease.

In column 3 of **TABLE 2**, it also can be found that the older a person is, the more likely they are to have lost six or more teeth (but not all) due to disease. While those aged 70 to 79 are not more or less likely, those aged 80 to 84 are 2.8 percentage points more

likely, and those aged 85 and older are 3.3 percentage points more likely than those aged 64 to 69 to have lost six or more teeth (but not all) due to disease.

Also found were that some racial/ethnic groups differ a great deal from whites with regard to the likelihood that they are missing teeth. Column 2 of **TABLE 2** shows that blacks are 4.8 percentage points less likely, and that Hispanics are 1.9 percentage points more likely than whites to be missing one to five teeth. In column 3 of **TABLE 2** we see that blacks are 5.0 percentage points more likely, and that Hispanics are 7.4 percentage points less likely than whites to be missing six or more (but not all) teeth.

Education is also associated with tooth loss due to disease. In column 2 of **TABLE 2**, those who have attended some post-high school training are 2.4 percentage points more likely, those who have graduated from college are 2.1 percentage points more likely, and those who have post-college education are 1.7 percentage points more likely to have lost one to five teeth due to disease relative to those with

TABLE 3

The Overall Probability of Missing 1 to 5 Teeth Due to Disease in 2006

Select Subgroups		Probability	95% CI (lower)	95% CI (upper)
Subgroup (1):	Year 2006, male, aged 65-69, white, college graduate, never smoked, household income of \$75,000 or greater, married, household of four or more	0.391	0.375	0.408
Subgroup (2):	Year 2006, female, aged 65-69, black, high school education, current smoker, household income of \$35,000-\$49,999, unmarried, household of four or more	0.180	0.162	0.198
Subgroup (3):	Year 2006, male, aged 80-84, Hispanic, less than high school education, current smoker, household income of \$35,000-\$49,999, married, household of four or more	0.319	0.295	0.343
Subgroup (4):	Year 2006, female, aged 65-69, Asian/Pacific Islander, some college education, former smoker, household income of \$20,000-\$24,999, married, household of four or more	0.326	0.302	0.350

less than high school education. In column 3 of **TABLE 2**, those who attended some post-high school training are 5.8 percentage points less likely, those who have graduated from college are 6.7 percentage points less likely, and those who have post-college education are 9.2 percentage points less likely to have lost six or more (but not all) teeth due to disease relative to those with less than high school education.

Household income is also related to the loss of teeth due to disease (note that household income is adjusted for household size by the inclusion of household size in the model). In column 2 of **TABLE 2**, those individuals with a household income that is \$15,000-\$19,999 are 1.6 percentage points more likely, those with a household income that is \$20,000-\$24,999 are 1.6 percentage points more likely, those with a household income that is \$25,000-\$34,999 are 2.0 percentage points more likely, and those with a household income that is \$35,000-\$49,999 are 2.1 percentage points more likely than those with a household income that is less than \$10,000 to missing one to five teeth.

In column 3 of **TABLE 2**, it can be seen that those individuals with a household income that is \$15,000-\$19,999 are 4.2 percentage points less likely, those with a household income that is \$20,000-\$24,999

are 4.5 percentage points less likely, those with a household income that is \$25,000-\$34,999 are 6.7 percentage points less likely, those with a household income that is \$35,000-\$49,999 are 8.4 percentage points less likely, those with a household income that is \$50,000-\$74,999 are 13.4 percentage points less likely, and those with a household income that is \$75,000 or higher are 14.0 percentage points less likely than those with a household income that is less than \$10,000 to have lost six or more teeth (but not all).

Finally, smoking is associated with the loss of teeth due to disease. In column 2 of **TABLE 2**, current smokers are 12.4 percentage points less likely, while former smokers are 3.8 percentage points less likely than those who have never smoked to have lost one to five teeth. In column 3 of **TABLE 2**, current smokers are 7.9 percentage points more likely, while former smokers are also 6.2 percentage points more likely than those who have never smoked to have lost six or more teeth (but not all).

To get an understanding of how oral health status varies across different socioeconomic groups, four subgroups of individuals are examined. These subgroups are for purposes of illustration only and were chosen to show the diversity in the likelihood of missing teeth across different groups.

The first subgroup is made up of white males, aged 65-69, who are college graduates, have a household income equal to \$75,000 or more, have never smoked, are married, and have a household of four or more people. The second subgroup is made up of black females, aged 65-69, who have a high school education, have a household income that is \$35,000-\$49,999, are current smokers, are unmarried, and have a household of four or more people. The third subgroup is made up of Hispanic males, aged 80-84, who have less than a high school education, have a family income that is \$35,000-\$49,999, are current smokers, are married, and have a household of four or more people. The final subgroup is made up of Asian females, aged 65-69, who have some college education, have a household income that is \$20,000-\$24,999, are former smokers, are married, and have a household of four or more people.

As can be seen in **TABLES 3 AND 4**, these subgroups vary a great deal in the overall probability that they will fall into a given category with regard to missing teeth. The first subgroup has a 0.391 probability of missing one to five teeth and a 0.145 probability of missing six or more teeth (but not all). The second subgroup has an 0.180 probability of missing one to five teeth and a 0.316 probability of missing six or more teeth (but not all).

TABLE 4

The Overall Probability of Missing 6 or More Teeth (but Not All) Due to Disease In 2006

Select Subgroups		Probability	95% CI (lower)	95% CI (upper)
Subgroup (1):	Year 2006, male, aged 65-69, white, college graduate, never smoked household income of \$75,000 or greater, married, household of four or more	0.145	0.140	0.150
Subgroup (2):	Year 2006, female, aged 65-69, black, high school education, current smoker, household income of \$35,000-\$49,999, unmarried, household of four or more	0.316	0.291	0.341
Subgroup (3):	Year 2006, male, aged 80-84, Hispanic, less than high school education, current smoker, household income of \$35,000-\$49,999, married, household of four or more	0.331	0.310	0.351
Subgroup (4):	Year 2006, female, aged 65-69, Asian/Pacific Islander, some college education, former smoker, household income of \$20,000-\$24,999, married, household of four or more	0.328	0.308	0.348

The third subgroup has 0.319 probability of missing one to five teeth and a 0.331 probability of missing six or more teeth (but not all). The final subgroup also has a high probability of missing teeth due to disease, having a 0.326 probability of missing one to five teeth and a 0.328 probability of missing six or more teeth (but not all).

Discussion

The variation among subgroups of adults aged 65 and older suggest areas where significant progress is possible in terms of both prevention and restorative care. Targeted interventions may be able to effectively reduce the current disparities that exist between each group.

Interventions focused on smoking cessation may yield the largest gains. Interventions in the area of smoking cessation have been extensively studied and their effectiveness is well understood.^{28,29}

An additional potential area of intervention is dental insurance, particularly among the Medi-Cal population. Among men aged 65 and older, those who are enrolled in Medi-Cal and also know they are covered by Denti-Cal are just as likely to visit a dental provider as those with private dental insurance, while those with Medi-Cal who

don't know they are also covered by Denti-Cal are no more likely to visit a dental provider than the uninsured.³⁰ Education about Denti-Cal would likely resolve this problem. Although most Denti-Cal benefits will not be available to adults starting July 1, 2009, this does not mean that Denti-Cal benefits will never be restored. Policy opportunities vary over time depending on the political and economic environment and the above policy intervention may be viable over the long run.

Finally, improving access to care among those with functional limitations also has significant potential to improve the oral health of individuals who have mobility problems. This has been extensively discussed elsewhere in this issue.³⁰

This study is subject to a number of limitations. First, dental insurance is missing from the authors' model. Data on dental insurance was only available for the years 1995, 1997, and 2000 and therefore could not be included in the long-term analysis. In addition, the authors' data is made up of repeated cross-sections which did not allow for control for unmeasured individuals differences that do not change over time and the authors' results may therefore be subject to omitted variable bias.

Conclusion

Almost three-quarters of California adults aged 65 and older have diminished oral health. The 11-year (1995-2006) analysis showed that Californians who are older; black; less educated; have low household incomes, and are current or former smokers are more likely to be missing teeth. A focused approach on reducing the variation in oral health that exists in this population may yield large gains on the average level of oral health. ■■■■

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