



California Adults Increase Fruit and Vegetable Consumption from 1997-2007

Sharon Sugerman, MS, RD, FADA¹; Susan B. Foerster, MPH, RD²; Jennifer Gregson, MPH, PhD²; Amanda Linares, MS¹; Mark Hudes, PhD³

ABSTRACT

Objective: To determine whether fruit and vegetable consumption among California adults significantly increased from 1997-2007.

Design: Biennial telephone surveillance surveys of California adults' dietary practices.

Participants: California adults (n = 9,105 total all 6 surveys).

Intervention: Surveillance data reporting.

Main Outcome Measures: Changes in fruit and vegetable consumption over time between 1997-2007, measured by mean servings and percentage of adults eating ≥ 5 servings on any given day.

Analysis: Comparisons of subsets both within the same year and across years were made using *t* tests, chi-square, and Tukey Studentized Range tests at 5% procedure-wise error rate.

Results: California adults significantly increased mean daily servings of fruits and vegetables from 3.8 servings in 1997 to 5.2 servings in 2007.

Conclusions and Implications: Since 1998, notable improvements in fruit and vegetable consumption have occurred to California populations, including the target audience groups of the *Network for a Healthy California*.

Key Words: fruit, vegetables, socioeconomic factors (*J Nutr Educ Behav.* 2011;43:S96-S103.)

INTRODUCTION

Increasing fruit and vegetable (FV) consumption has been a primary goal of the *Network for a Healthy California (Network)* since its inception in 1998, operated at that time as the *California Nutrition Network* with the *California 5-A-Day Campaign*. The *Network* is a large-scale social marketing program funded in part by the United States Department of Agriculture (USDA) Supplemental Nutrition Assistance Program (SNAP) to provide nutrition education. Before 2008, the Supplemental Nutrition Assistance Program Education (SNAP-Ed) was called Food Stamp Nutrition Education; audiences included Food Stamp

participants and households and other low-income Californians. The primary target audiences of the *Network* are Latino parents and African American and white low-income mothers and their families, including Spanish-speaking-only households.

The purpose of this article is to report results of statewide surveillance from the *California Dietary Practices Survey of Adults (CDPS)* for FV consumption, a survey administered by the *Network*. Survey results are presented within and across survey years starting in 1997, before the *Network's* launch in spring 1998, and continuing biennially until the most current data from the 2007 survey.

Adequate FV consumption is a national public health priority for disease prevention and maintenance of good health.^{1,2} Not only do FV contribute valuable nutrients to the diet, they are vital elements of chronic disease prevention for heart disease, hypertension, certain cancers, vision problems of aging, and possibly type 2 diabetes.³⁻⁵ The Report of the Dietary Guidelines Advisory Committee (DGAC) of the Dietary Guidelines for Americans 2010 acknowledges that the 2005 DGAC report concluded that there was insufficient evidence to come to a firm conclusion on the impact of dietary energy density on body weight at the time of their deliberations.⁶ Subsequent "clear and consistent evidence led the 2010 Committee to conclude that dietary energy density does affect both weight loss and weight maintenance."⁷ Fruits and vegetables are major sources of the low energy-dense food that can contribute to weight control. Americans may also be getting inadequate amounts of the nutrients contained in FV. Fruits and vegetables supply many of the dietary constituents identified by the 2010 DGAC as of concern for potential

¹*Network for a Healthy California*, California Department of Public Health and Public Health Institute, Sacramento, CA

²*Network for a Healthy California*, California Department of Public Health, Policy, Planning and Evaluation Section, Research and Evaluation Unit, Sacramento, CA

³Center for Weight and Health, University of California, Berkeley, CA

STATEMENT OF POTENTIAL CONFLICT OF INTEREST AND FUNDING/SUPPORT: See page S102.

Address for correspondence: Sharon Sugerman, MS, RD, FADA, PO Box 997377, MS 7204, Sacramento, CA 95899-7377; Phone: (916) 449-5406; Fax: (916) 449-5415; E-mail: Sharon.Sugerman@cdph.ca.gov

©2011 SOCIETY FOR NUTRITION EDUCATION

doi:10.1016/j.jneb.2011.02.002

“shortfalls” in the American diet among some populations. National Health and Nutrition Examination Survey (NHANES) data classified vitamins A, C, D, E, and K, as well as choline, calcium, magnesium, potassium, and dietary fiber, as nutrient contributors of concern.^{6,7}

National data indicate that most Americans do not eat sufficient FV.⁸ Guenther and colleagues used the single 24-hour dietary recalls from over 8,000 respondents to the 1999-2000 NHANES, applying variances based on 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII 94-96), to estimate usual intake distribution for total FV. For both sexes, the youngest age group (19-30 years old) reported the lowest consumption, and the 31-50 age group reported greatest consumption. Men consistently reported eating more servings than did women. Usual intake of ≥ 5 servings/d was reported by $44.7\% \pm 4.7\%$ to $59.9\% \pm 4.1\%$ of men and $29.7\% \pm 4.1\%$ to $48.8\% \pm 4.0\%$ of women. Directly comparative later NHANES data were not available for combined FV consumption, but separate NHANES 2001-2004 data for FV indicated that for fruit, the youngest age group remained the lowest consuming, but the oldest age group (71+) was highest consuming, with little difference between the sexes. Men reported 1.1 ± 0.05 and women reported 1.0 ± 0.4 mean cup-equivalents of daily fruit. For vegetables including potatoes but excluding legumes, there was less difference between age groups for both sexes, but more difference between sexes, with men reporting 1.8 ± 0.04 and women reporting 1.5 ± 0.02 cup-equivalents.⁹

The Cancer Prevention and Nutrition Section of the California Department of Health Services developed the CDPS as a surveillance instrument for tracking key dietary behaviors among adult Californians in 1989. It is the most detailed dietary assessment of adults 18 years old and older in the state of California, particularly for FV consumption. It was initially developed in 1989 to collect biennial dietary and physical activity trends to track progress in increasing FV intake and physical activity behavior toward meeting recommendations from the National Cancer Institute, the USDA *Dietary Guidelines for Ameri-*

cans,¹⁰ the *California Daily Food Guide*,¹¹ and the *California 5-A-Day for Better Health!* campaign.^{12,13} The CDPS methodology is a simplified 24-hour recall focusing heavily on FV consumption and including other sentinel food items. The dietary recall emphasizes FV eaten at meals and snacks on the previous day.¹⁴ A detailed 24-hour dietary recall for the total diet is cost prohibitive.

This research paper describes 10-year trends for FV consumption using surveillance data that are unique to California and that highlight population changes.

METHODS

Data Collection

This project was approved by the California Department of Health Care Services Committee for the Protection of Human Subjects. Verbal consent was obtained from participants at the beginning of the telephone interview. Interviewers read approved scripts to elicit consent from potential participants.

The CDPS is administered biennially in odd-numbered years by using a random-digit-dial (RDD) procedure, which provides a representative sample of the adult population with land-line telephones. Computer-assisted telephone interviews are conducted in English and Spanish with adults throughout the state of California from July through October. To ensure a representative sample, standardized procedures developed by the Centers for Disease Control and Prevention for the Behavioral Risk Factor Surveillance System (BRFSS) are followed for calling back numbers that ring with no answer or give a busy signal, and for encouraging selected respondents who are reluctant to participate.¹⁴ An oversample of low-income Latino adults, low-income African American adults, and other low-income adults is collected to allow analysis of trends among these typically underrepresented population segments. The sample size is 1,400-1,700 respondents per survey year.

For the general population, respondents were randomly drawn from all possible telephone exchanges within the state. These exchanges included both listed and unlisted telephone numbers. All persons living in the

household, age 18 years or older, were eligible to participate in the survey. When more than 1 member of the household was eligible, 1 person was selected at random using a computer-generated random selection algorithm.

From 1997-2005, a low-income oversample was conducted using RDD supplemented with a sample selected from geographic areas in which a high proportion of the desired groups reside (low-income African American, low-income Latino, and low-income people in general). Starting in 2007, the low-income oversample was obtained from the Medi-Cal Eligibility Data System Central Data Base—Food Stamps Central Data Base, which provides the *Network* with a de-identified listing of the Food Stamp participants. For every survey year, approximately 500 respondents come from the general population and 900 from the oversample. In 2007, the cooperation rate was 54.1% for the general population and 51.5% for the low-income oversample.¹⁵ Across all survey years, the cooperation rate ranged between a low of 44.5% (2001) and a high of 66.0% (in 1997). This rate is calculated based on the equation $(I + P)/(I + P) + R$, with I as complete interviews, P as partial interviews, and R as refusals.

The weighting procedures included standard RDD and population adjustments. For the general population, the probability of selection for a household was a base weight. This result was combined with a cluster size adjustment and adults per telephone adjustment into a raw weight for the sample. After adjusting for probability of selection, the data were post-stratified to adjust for variability in sex, age, and race/ethnicity between the sample and the population. The California population data were from the 1990 (for 1997 and 1999) and 2000 (for the 2001-2007) United States Census.

In the oversample portion of the survey (1997-2005), weights were applied to compensate for differential probability of selection of household in the geographic region (defined by Federal Information Processing Standard and tract codes);¹⁶ the differential probability of selection of the household based on income, adjusting for multiple telephone lines in

the household; and the probability of selection of persons within the selected households. The cluster size adjustment varied because of selection based on household income and differing sample intensity (sampling rate).

For the 2007 Medi-Cal oversample, the raw weight was composed of only the cluster size adjustment and the adults per telephone adjustment. There was no information on the number of potential telephone banks that include current Medi-Cal populations, so the data were adjusted for probability of selection within the household only. After this adjustment, the Medi-Cal sample was post-stratified to adjust for variability in sex, age, and race/ethnicity between the sample and the Medi-Cal population. For all survey years, the oversample and the general population were combined into a final, combined weight. These adjustments provide a dataset that was representative of a statewide sample, comparable from year to year and suitable for long-term trend analysis.

Measures

FV consumption. Fruit and vegetable consumption data were collected using a modified 24-hour recall. Respondents were asked if they ate breakfast, lunch, and dinner or any snacks and whether any FV were consumed at each eating occasion, including in mixed dishes. If so, the respondent was asked to name the item, including major FV ingredients, and to identify how many servings of it were eaten. A serving was defined to the respondent as "whatever you think of as a normal portion for yourself." Respondents were asked to omit all fried potatoes, including French fries, from their listing. Only 100% juices were counted, and legumes were excluded from tabulation of FV totals. All forms of FV—fresh, frozen, canned, dried, and 100% juice—were included. The FV data for the population were displayed as a mean of servings, and as the percentage of the population eating 5 servings or more on the day prior to the interview. The 5-servings-or-more criterion was used since that was the national message for FV consumption from 1997-2005, most of the time covered by this article.

A calibration study conducted by Harrison et al compared the modified FV dietary recall used by the CDPS to an in-person 24-hour recall collected later the same day.¹⁷ The 24-hour recall used the multiple-pass method of the surveys being conducted in the early 2000s by the National Nutrition Monitoring System.¹⁸ The 24-hour recall FV data were entered into Food Intake Analysis System (version 3.99, University of Texas and USDA, 2000). Mean standard serving sizes were calculated based on the CSFII 94-96 database.¹⁹ Compared to the recall, investigators found that CDPS methodology significantly underestimated FV intake by almost 1 serving of fruit and more than 2 servings of vegetables, resulting in an overall underestimation for the population of about 3 servings per day. There was no significant variation in the amount of fruit and more than 2 servings of vegetables, resulting in an overall underestimation for the population of about 3 servings per day. There was no significant variation in the amount of underestimation by age, ethnicity, sex, education, or household income. All of the difference in consumption was explained by the data collection method. The CDPS method of recall has been used since the survey's inception, and there is no evidence that underestimation of FV has happened in an inconsistent manner in each survey year. Consequently, the calibration study report concluded that the CDPS remains a useful instrument for evaluating whether there is change in consumption over time, and *Network* investigators chose to retain the methodology that had been used by the CDPS since its inception.

The CDPS methodology was also studied by DiSogra and Hudes to determine if seasonal variation in FV consumption exists during the months of the year.²⁰ The overall conclusion of the study was that there are no major month-to-month seasonality effects during the usual period of data collection for the CDPS (July-October) for California adults, or specifically for whites, African Americans, Latinos, and the low-income segments of these 3 racial/ethnic groups. This was the finding for the total number of servings of FV consumed, as well as separately for servings of fruit or servings of vegetables.

Poverty. In 2003 a poverty index was added to the CDPS as a standard demographic measure. In part, this measure was added to better assess 2 of the 3 population segments targeted by the *Network*. Poverty status was determined by combining the income questions, household size, and the response to a question asking people whether they or anyone in their household had used food stamps within the past 12 months. All survey respondents were categorized as: food stamp program (FSP) participant, other respondent with household income \leq 130% Federal Poverty Level (FPL), or respondent with reported household income exceeding 130% FPL.

Statistical Analysis

Trends in means and distributions of FV consumption from baseline over the 10-year time period 1997-2007 were evaluated. Although the primary analysis was the comparison between the 2 time points 1997 and 2007, a further look at data between 2003, 2005, and 2007 was made to examine time trend patterns that appeared to vary by income group. Fruit and vegetable consumption was transformed into 2 variables: mean servings or the percentage of adults eating 0, 1-2, 3-4, or 5 or more servings. Mean servings were analyzed for differences between demographic subgroups using either 2-sample *t* tests or 1-way analysis of variance. The 2-sample *t* test was employed to compare differences by sex and poverty index. The 1-way analysis of variance was employed to compare differences in mean servings by ethnicity, education, income, and age-within-sex. If statistically significant, these tests were followed up with the Tukey Studentized Range Test at 5% procedurewise error rate. Analyses were bivariate. For distributional information, servings reported were classified into \geq 5 and $<$ 5. Because intake assessed on any 1 day has a wider distribution than usual intake,²¹ these data do not represent usual intake of the sample, but instead, intake on any given day. Differences in absolute percentage points for eating \geq 5 on a given day between 1997 and 2007 were tested. The proportions were examined for differences over time across demographic subgroups using

chi-square tests of independence. Differences for all tests were defined as statistically significant when present at the $P < .05$ level.

RESULTS

Ate ≥ 5 Servings of FV

The number of California adults who reported eating ≥ 5 servings of FV on the previous day had significantly increased over the past decade. From 1997-2007, a 17 percentage point increase in adults consuming ≥ 5 servings of FV on the previous day was found ($P < .001$), and half the respondents reported achieving that goal. Of the 28 demographic segments examined, only 2 groups did not demonstrate statistically significant improvement (Table 1).

Population segments of particular interest to the *Network* were target audience subgroups: women aged 18-50 years, low-income adults, Latinos, African Americans, those with household incomes $< \$25,000$, and those eligible for food stamps. For both sexes, the percentage reporting achieving intake toward the 5-or-more recommendation escalated significantly and nearly equally during the time period. The lowest and highest income groups, $\leq \$15,000$ and $> \$50,000$, reported the greatest absolute improvement in FV consumption. The proportion of adults consuming ≥ 5 FV on the previous day increased by 22% and 25%, respectively ($P < .001$). The midpoint income group, \$25,000-\$34,999, made the least progress, only an insignificant increase of 2%. Both Latino and African American adults reported significant and substantial gains. Although data were not collected on the Asian/Pacific Islander subgroup until 1999, this group showed a significant 34% gain from 1999-2007 ($P < .001$). Persons who were not white, African American, Latino, or Asian were dropped from the analysis because of the insufficient sample size. Even respondents with the least education showed significant improvement during the 10-year period ($P < .01$ or stronger).

From 2003-2007, 2 of the *Network's* primary target audiences, adults with incomes $\leq 130\%$ FPL with and without food stamps, showed 14% and

18% increases, respectively, in those reporting ≥ 5 servings of FV on the previous day ($P < .001$). The increase occurred between 2003-2005 for FSP users, and between 2005-2007 for their income-eligible counterparts who were not FSP users. In contrast, the similar increase shown by respondents with income above the food stamp threshold was more evenly distributed across the 5-year period (Table 1).

Mean Servings of FV

In 2007, California adults reported eating an average of 5.2 servings of FV on the previous day, an increase of 1.4 servings from the 1997 average. Both men and women displayed significant improvements ($P < .001$; Table 2). From 1997-2007, Latinos, whites, and African Americans all significantly improved their consumption, with Latinos showing a particularly strong 1.8-serving improvement ($P < .001$). From 1999-2007, Asians improved their FV consumption by just over 2 servings ($P < .01$). The 10-year trends by income showed similar results for both the lowest income group and the highest income group. Both demonstrated a 1.9-serving increase from 1997-2007 ($P < .001$). The middle income group, \$25,000-\$34,999, saw a nonsignificant 0.4-serving increase during this time period.

Among the *Network's* target audiences, adults using food stamps reported an increase in FV consumption of 1.3 servings, the same as respondents from households with incomes $> 130\%$ FPL ($P < .001$; Table 2). Respondents whose incomes were as low as those of food stamp users increased even more, but they did so almost completely between 2005-2007. In absolute terms, there were no significant differences among the 3 groups in 2003, but in both 2005 and 2007, the higher-income respondents reported greater consumption than 1 or the other very low-income groups ($P < .05$).

DISCUSSION

Although the federal and state recommendation of 5 FV servings per day has been increased in more recent

health policy guidance,^{7,22,23} 5-A-Day is the standard against which FV consumption has been measured since the late 1980s. The CDPS used a single 24-hour dietary recall to assess intake. This measure is useful for characterizing mean intakes. However, because of high day-to-day variability in dietary intakes, a single day of dietary information does not describe the population's distribution of usual intake, but rather its distribution of intake on any given day. Although CDPS cannot directly estimate meeting the recommendation for usual FV consumption, it can compare mean intakes and 1-day distributions for meeting recommendations at different time periods. Results from 6 biennial CDPS surveys show that over the course of 10 years, mean daily FV consumption rose from 3.8 servings to 5.2 servings. Similarly, proportions of California adults attaining at least 5 servings of FV on the day prior to the survey increased over the 10 years from one-third to one-half of the adult population in California.

In 2005, additional estimates of FV consumption for the state of California were available from BRFSS and California Health Interview Survey (CHIS). The CDPS found that 42% of California adults reported eating 5 servings of FV on a given day. The CHIS, which used a food frequency approach, found that 39% of Californian adults reported eating 5 servings of FV daily (University of California Los Angeles, Center for Health Policy Research, unpublished data, 2007). The congruence between CHIS usual FV intake estimates and CDPS estimates for a given day suggests that both constructs are measuring the same phenomenon. In contrast, the BRFSS, which also uses a food frequency approach, estimated that 29.1% of California adults reported eating 5 or more servings of FV daily.²⁴ (Note that all estimates excluded fried potatoes and legumes). Although the CHIS and BRFSS assessment methods are similar, an important difference is that the CHIS method employs an adjustment to its individual respondents' answers. The adjustment is based on each participant's sex and age group using median Food Guide Pyramid serving sizes as reported in USDA's CSFII 94-96 prior to calculating daily FV

Table 1. Percentage of Adults Consuming ≥ 5 Servings of Fruits and Vegetables per Day, 1997-2007

	1997	1999	2001	2003	2005	2007	1997-2007	1997-2007
n	1,703	1,492	1,561	1,472	1,409	1,468	9,105	4,340
Total (%)	33	32	34	38	42	50	17***	51.5%
Sex								
Male	30*	30*	33*	35***	38***	47**	17***	56.7%
Female	35*	35*	34*	41***	46***	53**	18***	51.4%
Age group, males (y)								
18-24	25**	26**	36	35*	24**	44**	19**	76.0%
25-34	28**	18**	34	32*	42**	46**	18**	64.3%
35-50	30**	37**	30	35*	42**	52**	22***	73.3%
51-64	34**	34**	31	31*	28**	34**	0	0.0%
≥ 65	35**	34**	39	44*	45**	59**	24**	68.6%
Age group, females (y)								
18-24	29*	27	27**	34	36*	51	22**	75.9%
25-34	32*	32	29**	38	52*	53	21***	65.6%
35-50	34*	37	39**	41	48*	51	17***	50.0%
51-64	37*	43	35**	46	43*	51	14**	37.8%
≥ 65	44*	36	39**	44	43*	62	18***	40.9%
Ethnicity								
White	33***	34*	36	39***	42	51	18***	54.5%
Latino	35***	31*	33	38***	38	50	15***	42.9%
African American	22***	26*	24	26***	31	39	17**	77.3%
Asian/Pacific Islander ^a		25*	33	44***	60	59	34***	136.0%
Education								
Less than high school	32***	21***	28***	31***	40***	45***	13**	40.6%
High school graduate	24***	26***	31***	32***	33***	43***	19***	79.2%
Some college	31***	34***	32***	36***	39***	48***	17***	54.8%
College graduate	42***	40***	40***	46***	50***	62***	20***	47.6%
Annual household income								
< \$15,000	24***	27***	28	32***	34***	46***	22***	91.7%
\$15,000-24,999	34***	30***	37	40***	36***	50***	16***	47.1%
\$25,000-34,999	37***	29***	36	34***	42***	39***	2	5.4%
\$35,000-49,999	33***	32***	34	31***	42***	50***	17**	51.5%
\geq \$50,000	33***	41***	36	42***	51***	58***	25***	75.8%
Poverty Index							2003-2007	2003-2007
Food Stamp participant	NA	NA	NA	30	44***	44**	14***	46.7%
All other/ \leq 130% FPL	NA	NA	NA	35	31***	53**	18***	51.4%
All other/ > 130% FPL	NA	NA	NA	39	47***	55**	16***	41.0%

NA indicates not available.

* $P < .05$; ** $P < .01$; *** $P < .001$.

^aAsian/Pacific Islander data were not collected until 1999, thus the change observed in the 1997-2007 column represents 1999-2007.

consumption.²⁵ The BRFSS does not make adjustments, and the BRFSS method has been shown to underestimate intake in several studies.^{26,27}

Unlike the trend displayed by the CDPS, the California BRFSS does not demonstrate an upward trend. In 1998, the percentage achieving 5 servings per day was estimated at 27.5%, and in 2007 it was estimated at 28.9%.²⁴ National trend data analyzed by Casagrande and colleagues comparing NHANES III 1988-2004

with NHANES 1999-2002 showed little change,²⁸ as did a more recent marketing study conducted for the Produce for Better Health Foundation and national BRFSS data.²⁹ Food disappearance data through 2008 also suggest there is no nationwide increase in fruit and vegetable consumption.³⁰

The trends in CDPS indicate that population groups at most income levels have increased their FV consumption on any given day. Sustained

social marketing campaigns have been shown to be associated with improvements in targeted health behaviors.^{12,31-34} Interventions like those of the *Network* that aim to both change fruit and vegetable consumption behavior, as well as add to public recognition of the benefits of eating FV, have been recommended as a means to reach national FV objectives.¹²

It is worth noting that to some extent, differences between FSP and

Table 2. Average Number of Servings^a of Fruits and Vegetables Eaten by Adults, 1997-2007

	1997	1999	2001	2003	2005	2007	1997-2007	1997-2007
n	1,703	1,492	1,561	1,472	1,409	1,468	9,105	4,340
Total	3.8	3.8	3.9	4.1	4.4	5.2	1.4***	36.8%
Sex								
Male	3.7	3.7	3.8	3.9**	4.0***	5.0	1.3***	35.1%
Female	3.9	4.0	4.0	4.4**	4.8***	5.4	1.5***	38.5%
Age group, males (y)								
18-24	3.5	3.4 ^{a,b,*}	3.9	3.8	3.3	4.6 ^{a,b,**}	1.1*	31.4%
25-34	3.5	3.1 ^{a,*}	3.9	3.6	4.1	4.9 ^{a,b,**}	1.4***	40.0%
35-50	3.6	4.0 ^{b,*}	3.8	4.0	4.1	5.7 ^{b,**}	2.1***	58.3%
51-64	4.0	4.0 ^{a,b,*}	3.4	3.7	3.8	4.0 ^{a,**}	0.0	0.0%
65+	4.1	4.0 ^{a,b,*}	3.9	4.4	4.6	5.6 ^{a,b,**}	1.5***	36.6%
Age group, females (y)								
18-24	3.4	3.4	3.3*	4.2	4.7	5.3	1.9***	55.9%
25-34	3.7	4.0	3.6*	4.4	5.0	5.6	1.9***	51.4%
35-50	3.9	4.1	4.2*	4.3	4.9	5.1	1.2***	30.8%
51-64	4.2	4.2	4.1*	4.5	4.6	5.4	1.2**	28.6%
65+	4.2	4.3	4.4*	4.6	4.7	6.3	2.1***	50.0%
Ethnicity								
White	3.9 ^{b,**}	3.9	4.0	4.2 ^{b,***}	4.5 ^{a,b,**}	5.2 ^{a,b,*}	1.3***	33.3%
Latino	3.9 ^{b,**}	3.7	3.9	4.1 ^{b,***}	4.3 ^{a,b,**}	5.7 ^{b,*}	1.8***	46.2%
African American	3.1 ^{a,**}	3.2	3.2	3.0 ^{a,***}	3.6 ^{a,**}	4.3 ^{a,*}	1.2**	38.7%
Asian/Pacific Islander ^b		3.7	3.6	5.0 ^{b,***}	5.2 ^{b,**}	5.8 ^{b,*}	2.1**	56.8%
Education								
Less than high school	3.4 ^{a,***}	3.1 ^{a,***}	3.4 ^{a,***}	3.6 ^{a,***}	4.2 ^{a,**}	5.1 ^{a,***}	1.7***	50.0%
High school graduate	3.2 ^{a,***}	3.3 ^{a,b,***}	3.8 ^{a,b,***}	3.8 ^{a,***}	4.1 ^{a,**}	4.7 ^{a,***}	1.5***	46.9%
Some college	3.7 ^{a,***}	3.8 ^{b,***}	3.6 ^{a,***}	4.2 ^{a,b,***}	4.3 ^{a,b,**}	5.0 ^{a,***}	1.3***	35.1%
College graduate	4.4 ^{b,***}	4.5 ^{c,***}	4.3 ^{b,***}	4.5 ^{b,***}	4.9 ^{b,**}	6.1 ^{a,***}	1.7***	38.6%
Annual household income								
< \$15,000	3.1 ^{a,***}	3.4 ^{a,***}	3.5	3.8	3.9 ^{a,***}	5.0 ^{a,**}	1.9***	61.3%
\$15,000-24,999	3.8 ^{b,***}	3.6 ^{a,***}	4.0	4.2	4.4 ^{a,b,***}	5.1 ^{a,b,**}	1.3***	34.2%
\$25,000-34,999	4.3 ^{b,***}	3.7 ^{a,b,***}	3.9	3.9	4.4 ^{a,b,***}	4.7 ^{a,**}	0.4	9.3%
\$35,000-49,999	3.8 ^{b,***}	3.8 ^{a,b,***}	3.8	3.9	4.1 ^{a,b,***}	4.8 ^{a,b,**}	1.0**	26.3%
≥ \$50,000	3.9 ^{b,***}	4.5 ^{b,***}	4.1	4.4	4.9 ^{b,***}	5.8 ^{b,**}	1.9***	48.7%
Poverty index				2003	2005	2007	2003-2007	2003-2007
Food Stamp participant	NA	NA	NA	3.6	4.6 ^{a,b,*}	4.9 ^{a,*}	1.3***	36.1%
All other/ ≤ 130% federal poverty level	NA	NA	NA	3.9	4.0 ^{a,*}	5.5 ^{a,b,*}	1.6***	41.0%
All other/ > 130% federal poverty level	NA	NA	NA	4.2	4.7 ^{b,*}	5.5 ^{b,*}	1.3***	31.0%

NA indicates not available.

* $P < .05$; ** $P < .01$; *** $P < .001$. Differences observed within these groups are statistically significant (analysis of variance).

^aA serving refers to what a participant considered "a normal portion for himself/herself"; ^bAsian/Pacific Islander data were not collected until 1999, thus the change observed in the 1997-2007 column represents 1999-2007.

Note: Categories sharing a common superscript (1, 2) are not statistically different from each other (Tukey test at a procedure-wise error rate = .05).

other low-income non-participants may have been somewhat age related. There were very few respondents over the age of 51 in the Food Stamp sample, particularly in 2003 and 2005, 8.0% and 11.3%, respectively, although it did reach 20.0% in 2007. However, in the same time period—2003, 2005, 2007—older respondents in the other low-income group made up 24.0%, 28.3%, and 33.8% of the population, respectively. The

over-130% FPL group contained the most respondents over the age of 50—33.6% in 2003 and 35.5% in 2005 (data not shown).

Limitations

A major limitation of the CDPS is the inability of a single 24-hour recall to directly estimate the distribution of usual intakes in a population because

of an excessive degree of within-person variance.²¹ However, the recall is useful for estimating a population's mean usual daily intake as a marker of progress toward meeting recommendations,³⁵ and the CDPS has shown steady progress in terms of increased mean FV consumption between 1997 and 2007.

Another limitation is its definition of portion size as "whatever you think of as a normal portion for

yourself” based on a 1-point-in-time calibration and applied to the 5 subsequent surveys. If, over the 10-year period examined, a given subgroup’s perception of “a normal portion” changed, findings could be affected. However, data suggest that portion sizes in prepared food, restaurants, and even home recipes have been steadily increasing over time, whereas available food supply data indicate that the supply has remained steady.^{30,36} Consequently, all indications are that if any change occurred during this time period, it would have been in the direction of the “normal portion” being larger over the course of time, with 1 serving in 2007 actually representing more than 1 serving in 1997.

Another limitation is that Asian/Pacific Islander Californians were not surveyed until 1999, and thus there was an inability to differentiate between diverse ethnic groups among non-English-speaking Asian/Pacific Islander respondents. When CDPS was established in 1989, BRFSS, the other major survey gathering state and national data, defined only 4 race/ethnicity groups: white, African American, Hispanic or Latino, and Asian/Other. The CDPS treated its data accordingly. At the time, this was standard practice for surveillance surveys. With the exception of CHIS, few surveillance surveys collect data in languages other than English and Spanish.

In addition, as a statewide survey, CDPS has a limited ability to generalize. The sample is selected to be representative of the California adult population. It can be generalized to the state’s diverse population, but not to that of the nation as a whole.

Another limitation is the change in phone use over the 10 years to cell phones, which may affect the representativeness of the sample drawn only from land lines.

CONCLUSIONS AND IMPLICATIONS

Findings suggest that a real increase in FV consumption has occurred in California since 1997. Examining FV trends by income demonstrates the importance of being able to survey all population groups, specifically the

low-income population, but also the higher-income groups. Such data document the overall population-wide trends and allow comparisons between more- and less-advantaged groups.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

This research project is funded in part by the USDA SNAP-Ed, the California Endowment, and the California Department of Public Health through a contract with the California Department of Public Health’s *Network for a Healthy California* (authors SBF and MH) administered by the Public Health Institute (authors SS, JG, and AL) for the data collection, analysis, interpretation of results, and manuscript preparation. The opinions expressed are those of the authors and do not necessarily represent the views or recommendations of their respective affiliations.

FUNDING/SUPPORT

This study was funded by the USDA SNAP-Ed the California Endowment, and the California Department of Public Health through a contract with the California Department of Public Health’s *Network for a Healthy California* administered by the Public Health Institute.

ACKNOWLEDGMENTS

The authors would like to thank the many *Network* staff who contributed to the CDPS: Akpene Ama Atiedu, MS; Sara Cook, MPH, RD; Michael Fierro, MPH; Michelle Oppen, MPH; and Shirley Wu, MPH, RD. We would also like to acknowledge the effort of Freeman, Sullivan, and Co. and Charles DiSogra, DrPh, as well as the Survey Research Group: Bonnie Davis, PhD; Marta Induni, PhD; and Fran Thompson, MPH, PhD, for advice on dietary methodology.

REFERENCES

1. United States Department of Health and Human Services. *Healthy People 2010. With Understanding and Improving Health and Objectives for Improving Health*. 2nd ed. Washington, DC: US Government Printing Office; 2000.
2. United States Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health*. Washington, DC: US Department of Health and Human Services; 2000.
3. Joint World Health Organization and Food and Agriculture Organization Expert Consultation. *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*. Geneva, Switzerland: World Health Organization; 2003. WHO Technical Report Series 916.
4. Cho E, Seddon JM, Rosner B, Willett WC, Hankinson SE. Prospective study of intake of fruits, vegetables, vitamins, and carotenoids and risk of age-related maculopathy. *Arch Ophthalmol*. 2004;122:883-892.
5. World Cancer Research Fund/American Institute for Cancer Research. *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective*. Washington DC: AICR; 2007.
6. United States Department of Health and Human Services. *The Report of the Dietary Guidelines Advisory Committee on Dietary Guidelines for Americans, 2005*. <http://www.health.gov/dietaryguidelines/dga2005/report/default.htm>. Published August 19, 2004. Accessed March 29, 2011.
7. United States Department of Agriculture, United States Department of Health and Human Services. *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans (Advisory Report), 2010*. <http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm>. Published June 14, 2010. Accessed March 29, 2011.
8. Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM. Most Americans eat much less than recommended amounts of fruits and vegetables. *J Am Diet Assoc*. 2006;106:1371-1379.
9. National Cancer Institute, Applied Research Program. Usual Dietary Intakes: Food Intakes, US Population, 2001-04. Risk Factor Monitoring and Methods Branch Web site. <http://riskfactor.cancer.gov/diet/usualintakes/pop/>. Updated December 21, 2010. Accessed March 29, 2011.
10. United States Department of Agriculture, United States Department of Health and Human Services. *Dietary*

- Guidelines for Americans, 1985.* Home and Garden Bulletin; 1985. No. 232.
11. *The California Daily Food Guide: Guidelines for Californians.* Sacramento, CA: California Department of Health Services; 1990.
 12. National Cancer Institute, 5-A-Day Program Evaluation Group. *5-A-Day for Better Health Program Evaluation Report.* Bethesda, MD: National Cancer Institute; 2000.
 13. Foerster SB, Kizer KW, Disogra LK, Bal DG, Krieg BF, Bunch KL. California's "5-A-Day—for better health!" campaign: an innovative population-based effort to effect large-scale dietary change. *Am J Prev Med.* 1995;11:124-131.
 14. Survey Research Group. *California Dietary Practices Survey Technical Documentation.* Sacramento, CA: California Department of Public Health and Public Health Institute; 2007.
 15. American Association for Public Opinion Research. AAPOR Outcome Rate Calculator. <http://www.aapor.org/Content/aapor/Resources/ForResearchers/default.htm>. Accessed April 12, 2011.
 16. United States Census Bureau. US Census 2000 data for the State of California. <http://www.census.gov/census2000/states/ca.html>. Accessed May 10, 2011.
 17. Harrison GG, Cumberland WG, Stormer A. *A Final Project Report, Cancer Research Award #99-86872, Calibrating California Dietary Instruments.* Sacramento, CA: California Cancer Research Program, California Department of Health Services; 2002.
 18. Conway J, Ingwersen L, Vinyard B, Moshfegh A. Effectiveness of the US Department of Agriculture 5-step multiple-pass method in assessing food intake in obese and nonobese women. *Am J Clin Nutr.* 2003;77:1171-1178.
 19. United States Department of Agriculture, Agricultural Research Service. *Results from USDA 1994-96 Continuing Survey of Food Intakes by Individuals and 1994-96 Diet and Health Knowledge Survey.* Beltsville, MD: Food Surveys Research Group, Beltsville Human Nutrition Research Center, Agricultural Research Service, US Department of Agriculture; 2000.
 20. DiSogra C, Hudes M. *Final Project Report, Cancer Research Award No. 99-86877, California Fruit & Vegetable Intake Calibration Study.* Sacramento, CA: California Cancer Research Program, California Department of Health Services; 2004. Revised August 9, 2005.
 21. National Cancer Institute Applied Research Program. Usual Dietary Intakes: Background. <http://riskfactor.cancer.gov/diet/usualintakes>. Updated September 28, 2010. Accessed April 12, 2011.
 22. United States Department of Health and Human Services, US Department of Agriculture. *Dietary Guidelines for Americans, 2005.* 6th ed. Washington, DC: US Government Printing Office; 2005.
 23. California Department of Health Care Services, California Department of Public Health. California Food Guide. <http://www.cafoodguide.ca.gov>. Accessed March 29, 2011.
 24. Centers for Disease Control and Prevention. Prevalence and Trends Data. Behavior Risk Factor Surveillance System Web site. <http://apps.nccd.cdc.gov/brfss>. Accessed May 5, 2011.
 25. National Cancer Institute Applied Research Program. Fruit & Vegetable Screener in the 2000 CHIS. Fruit and Vegetable Screener: Scoring Procedures. Applied Research Web site. <http://appliedresearch.cancer.gov/surveys/chis/fvscreener/scoring.html>. Updated October 13, 2010. Accessed March 29, 2011.
 26. Thompson FE, Kipnis V, Subar AF, et al. Evaluation of 2 brief instruments and a food-frequency questionnaire to estimate daily number of servings of fruit and vegetables. *Am J Clin Nutr.* 2000;71:1503-1510.
 27. Smith-Warner SAEP, Fosdick L, Tharp TM, Randall B. Reliability and comparability of three dietary assessment methods for estimating fruit and vegetable intakes. *Epidemiology.* 1997;8:196-201.
 28. Casagrande SS, Wang Y, Anderson C, Gary TL. Have Americans increased their fruit and vegetable intake? The trends between 1988 and 2002. *Am J Prev Med.* 2007;32:257-263.
 29. NPD Group. *State of the Plate 2010: America's Consumption of Fruit and Vegetables.* Port Washington, NY: Produce for Better Health Foundation; 2010.
 30. United States Department of Agriculture. *Food Availability (per capita loss adjusted) Data System US per capita loss-adjusted food availability: All Fruits and All Vegetables.* Washington, DC: United States Department of Agriculture, Economic Research Service; 2010.
 31. Economos C, Hyatt R, Goldberg J, et al. A community intervention reduces BMI z-score in children: Shape Up Somerville first year results. *Obesity.* 2007;15:1325-1336.
 32. Economos C, Brownson R, DeAngelis M, et al. What lessons have been learned from other attempts to guide social change? *Nutr Rev.* 2001;59(3 suppl):S40-S56.
 33. Berkowitz J, Huhman M, Nolin M. Did augmenting the VERB campaign advertising in select communities have an effect on awareness, attitudes, and physical activity? *Am J Prev Med.* 2008;34(6 suppl):S257-S266.
 34. McAlister A, Morrison T, Hu S, et al. Media and community campaign effects on adult tobacco use in Texas. *J Health Commun.* 2004;9:95-109.
 35. Thompson FE, Midthune D, Subar AF, McNeel T, Berrigan D, Kipnis V. Dietary intake estimates in the National Health Interview Survey, 2000: methodology, results, and interpretation. *J Am Diet Assoc.* 2005;105:352-363.
 36. Young LR, Nestle M. The contribution of expanding portion sizes to the US obesity epidemic. *Am J Public Health.* 2002;92:246-249.