



## Similar softening across different racial and ethnic groups of smokers in California as smoking prevalence declined



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### ABSTRACT

Smoking prevalence differs among different racial/ethnic groups. Previous research found that as smoking prevalence declined in the U.S., remaining smokers made more quit attempts and smoked fewer cigarettes per day (CPD), indicating so-called softening. We examined California, a state with a highly diverse population, to assess whether there is differential softening among remaining smokers in different racial/ethnic groups. We used the California Tobacco Survey (1990–2008, N: 145,128). We ran logistic and linear regressions for smoking prevalence, CPD, quit attempts and time to first cigarette (30 min) as a function of race/ethnicity (non-Hispanic White, Hispanic, African American, Japanese, Chinese, Filipino, Korean, other Asian/Pacific Islander, American Indian/Alaska Native) controlling for other demographics. Overall prevalence fell from 21.1% in 1990 to 12.3% in 2008 ( $p < 0.01$ ), showing similar declining trends across all racial/ethnic groups ( $p = 0.44$ ), albeit from different baseline prevalence levels. In terms of softening indicators the proportion with at least one quit attempt in the past 12 months increased from 46.2% to 59.3%, a factor of 1.25 per decade (95%CI = 1.17, 1.34) in the adjusted model. CPD declined from 16.9 to 10.9, by  $-2.95$  CPD per decade (95%CI =  $-3.24$ ,  $-2.67$ ) in the adjusted model. There were no significant changes in the time to first cigarette. Interactions of race/ethnicity and time show similar trends among all subgroups except Hispanics, whose CPD remained stable rather than declining. Although from different baseline levels, tobacco control policies have benefitted all subgroups of California smokers, exhibiting similar softening as prevalence fell. Interventions are still needed to reduce the baseline differences.

### 1. Introduction

The variability in smoking prevalence and intensity (cigarettes smoked per day, CPD) among different demographic subgroups of smokers is high (Centers for Disease Control and Prevention. CDC, 2016; Pierce et al., 2009; Gilpin et al., 2006; Fagan et al., 2007). In the US as a whole smoking prevalence is highest among American Indian/Alaska Natives followed by non-Hispanic multiple-race individuals, Whites and African Americans, Hispanics and Asians (Centers for Disease Control and Prevention. CDC, 2016). In California, the state with the second lowest smoking prevalence (behind Utah) in 2017, smoking prevalence was highest among Native American/Alaska Natives, followed by African Americans, Whites, Hispanics and Asians (California Department of Public Health, California Tobacco Control Program, 2018). Until 2017 California did not have high tobacco taxes.

It did, however, have the longest running major tobacco control program in the US which significantly contributed to reducing smoking and associated medical costs (Lightwood and Glantz, 2013) by denormalizing smoking and the tobacco industry, including through a media campaign and enactment of smokefree laws at the local and state levels through a high level of local and state tobacco control activity (Roessler and Burns, 2010).

While the levels of absolute prevalence vary, overall, absolute cigarette smoking prevalence among adults fell from 23.7% in 1988 to 10.5% in 2015 (California Department of Public Health, California Tobacco Control Program, 2018). Based on the California Health Interview Survey (CHIS), between 2001 and 2013/2014 prevalence for men in California dropped from 19.4% to 14.8% among Whites, from 20.8% to 15.0% among Hispanics, from 23.4% to 20.0% among African Americans, from 21.3% to 15.6% among Asians, and from 37.2% to

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36.2% among American Indian/Alaska Natives (California Department of Public Health, 2016). Prevalence for women dropped from 16.7% to 13.1% among Whites, from 9.0% to 5.6% among Hispanics, from 20.8% to 14.7% among African Americans, from 6.4% to 3.5% among Asians, and slightly increased from 28.3% to 28.4% for American Indian/Alaska Native women (California Department of Public Health, 2016). With overall declining prevalence it is important to understand the demographic characteristics of continuing smokers in order to reach them with interventions to help them quit in order to achieve health equity. Our previous research found that as smoking prevalence fell in the United States, the remaining smokers made more quit attempts and smoked fewer CPD, indicating so-called softening among the general population (Kulik and Glantz, 2016). The same softening pattern was observed among people with psychological distress, albeit from a higher baseline (Kulik and Glantz, 2017).

The demographic characteristics and potential differential softening of the remaining smokers in a low prevalence environment could require a different mix of state and local policies, interventions, and media messages than in the past. Using the California Tobacco Survey (CTS) this paper determined whether, over time as smoking prevalence declined, there were differential patterns of softening among the remaining California smokers by race/ethnicity, controlling for gender, age and educational level. The analyses also distinguished between different Asian subpopulations which are often analyzed as one group, but exhibit different smoking behaviors depending on specific countries of origin (Furuyama et al., 2012). The analyses cover the years between 1990 and 2008 when the California Tobacco Control Program (CTCP) was created and was particularly active, a time during which overall absolute smoking prevalence fell from 20.4% to 13.3% (California Department of Public Health, California Tobacco Control Program, 2018).

## 2. Data and methods

The California Tobacco Survey (CTS) is a representative statewide survey conducted by the University of California, San Diego for the California Department of Public Health between 1990 and 2008 that collected data on tobacco use and related attitudes and behaviors in California (Al-Delaimy, 2015). We used all eight waves (1990, 1992, 1993, 1996, 1999, 2002, 2005, 2008) of cross-sectional, individual level adult data (18 years and older), for a total of 145,128 respondents of whom 46,075 were current smokers, after removing 318 respondents from the analyses due to insufficient information on their race/ethnicity (0.21% of entire sample) (Table 1). For analyses including the number of cigarettes smoked per day (CDP) we had to exclude the 1993 wave because the needed data were not available that year, resulting in 40,489 smokers for the CPD analyses.

The analysis is based on current smokers who smoked at least 100 cigarettes in their lifetime. Current smokers were defined based on very similar, but slightly varying variables in the different survey waves. For

1990, 1992 and 1993 the analysis is based on those respondents who indicated that they were currently smoking (versus being a never or former smoker). Beginning in 1996 smoking status was assessed in more detail so analyses were based on those who indicated that they were smoking every day or some days. We excluded 80 non-daily smokers (0.17% of all current smokers) from the analyses who reported smoking > 20 CPD because we found this implausible for those who only smoke occasionally.

The race/ethnicity variable was created in two steps: (1) identify respondents who self-identified as Hispanic, non-Hispanic White, African American, Asian/Pacific Islander and Other; (2) those who self-identified as Asian/Pacific Islander or Other were further categorized as Japanese, Chinese, Filipino, Korean, “other Asian/Pacific Islander”, or American Indian/Alaska Native. The remaining Other ( $n = 318$ , 0.21% of the sample) were those who did not identify with any of the options given or whose answers were missing, and were excluded from the analyses due to the small size of the group.

Other demographic variables included age, gender and educational level. Age was coded as a continuous variable, gender as male/female. Education was categorized as 0–11 years of schooling, 12 years of schooling (high school graduate), post-secondary school or some college, Bachelor's degree or higher. Since marital status was only recorded in the surveys starting in 1996, we did not include the variable. We ran sensitivity analyses on the sample for the years 1996–2008 including marital status as a control variable and the results did not change.

We included time in ten year increments (centered on the mean (1998.125 for analyses including the year 1993, 1998.857 for analyses excluding it) in the analysis.

Quit attempt was coded 1 for those who reported at least one intentional quit attempt that lasted at least one day in the past 12 months; others were coded 0.

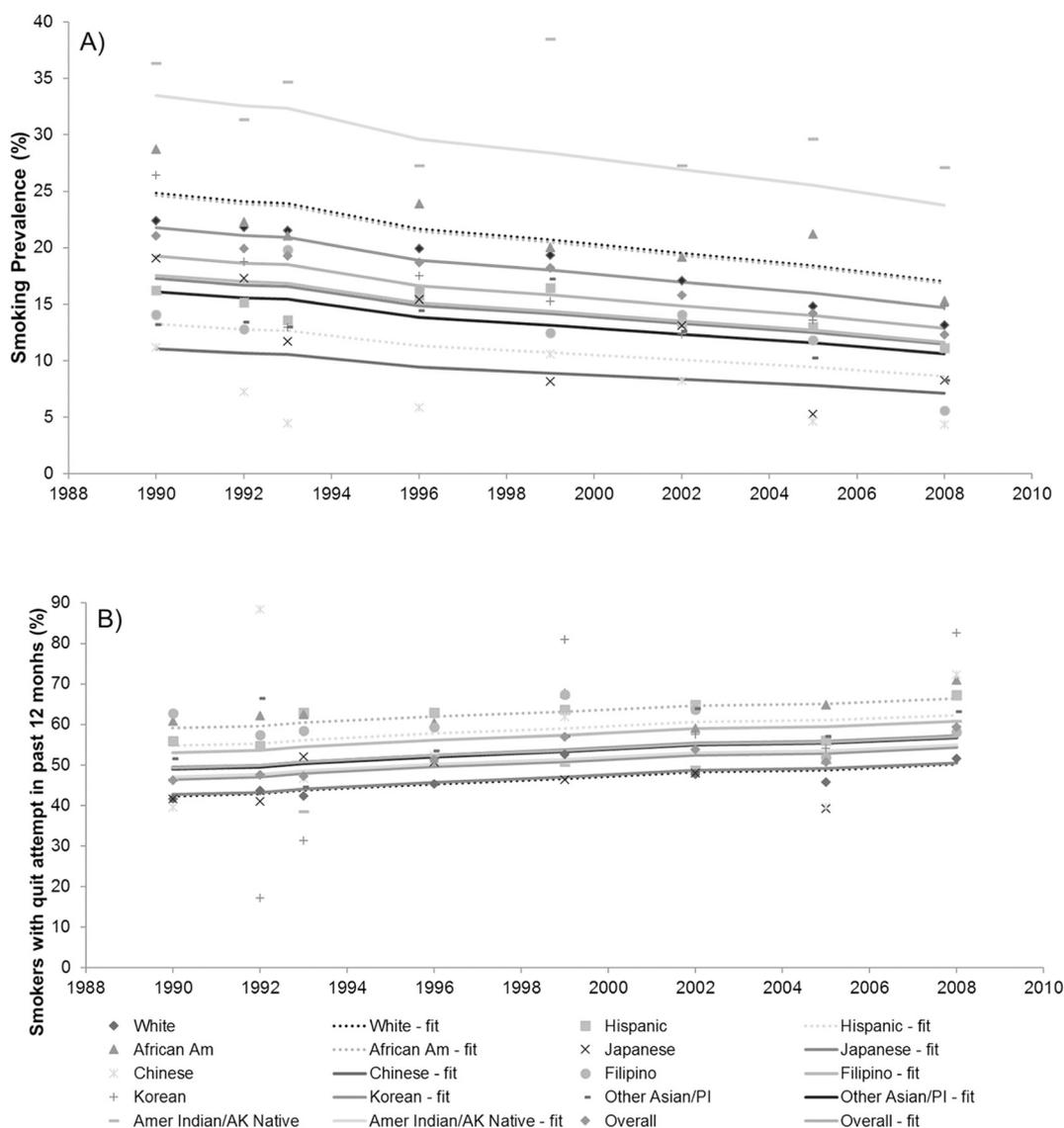
We used separate questions asking daily smokers and non-daily smokers about their CPD (on the days they smoked for non-daily smokers) except for 1993, which only included less specific questions and therefore had to be excluded for the analysis of CPD. Those who smoked some days were asked “On how many of the past 30 days did you smoke cigarettes?” and then “During the past 30 days, on the days that you did smoke, about how many cigarettes did you usually smoke per day?” We used this information to calculate average daily consumption of the non-daily smokers as (number of days smoked in last 30) × (non-daily CPD) / 30.

We coded smokers who smoked their first cigarette 30 min or less after waking (a measure of dependence) as 1 and the remaining smokers 0.

Data from all eight waves of the CTS (seven waves without 1993 for CPD) were pooled, accounting for the complex survey design of the CTS (described in the Online Appendix) which used jackknife replicate weights to compensate the variable probabilities of inclusion in the sample and produce unbiased estimates of the population parameters

**Table 1**  
Sample size characteristics, unweighted data, California Tobacco Survey, 1990–2008.

	Total sample	Current smokers		Total sample	Current smokers		Total sample	Current smokers
All years			Without 1993			Year		
White	94,134	32,710	White	72,485	28,450	1990	24,229	9343
Hispanic	26,789	6663	Hispanic	21,914	6010	1992	11,863	4620
African Am.	10,308	2945	African Am.	8622	2641	1993	30,673	5586
Japanese	1446	333	Japanese	1188	298	1996	18,561	8709
Chinese	2581	346	Chinese	2030	314	1999	14,717	5668
Filipino	2825	677	Filipino	2319	613	2002	20,478	5480
Korean	567	175	Korean	483	160	2005	14,232	3932
Other Asian/PI	3396	767	Other Asian/PI	2784	681	2008	10,375	2737
Am. Indian/AK Native	3082	1459	Am. Indian/AK Native	2630	1322			
Total	145,128	46,075	Total	114,455	40,489	Total	145,128	46,075



**Fig. 1.** A) Smoking prevalence declines by race/ethnicity and for the overall California population; B) Percentage with quit attempts within past 12 months increase by race/ethnicity and for the overall California population [CTS 1990–2008, unadjusted data points and fitted trend lines based on adjusted regressions].

(Al-Delaimy et al., 2009). There were 33 replicate weights for 1990 and 51 replicate weights for each of the other waves. We also used the full sample weight (person level weight) in each survey to adjust for region, gender, race, age, education and smoking status.

We computed smoking prevalence, the percentage of smokers with at least one quit attempt in the past 12 months, the number of cigarettes smoked, and the percentage of those smoking their first cigarette 30 min or less after waking, respectively.

We used logistic regression to assess changes over time in quit attempts and time to first cigarette, and linear regression for smoking prevalence and CPD, in unadjusted and adjusted models.

We coded race/ethnicity (including different subgroups of Asians) using effects coding (Glantz et al., 2016) (in which the regression coefficients quantify the difference of each group from the overall mean response rather than against a single reference group) and tested the null hypothesis that there were no differences in levels across ethnicities using Wald tests. We also tested for differences in time trends across groups using a Wald test for the interactions for time × race/ethnicity. The interaction between race/ethnicity and time showed no significant terms for prevalence ( $p = 0.44$ ), quit attempts ( $p = 0.71$ ), and time to first cigarette ( $p = 0.22$ ), meaning that the declining pattern was similar over time for all racial/ethnic groups, despite

beginning from different prevalence levels, so the interactions were dropped from further analysis for these variables.

There are differences in smoking prevalence between men and women, particularly in Asian populations (Furuyama et al., 2012). As additional sensitivity analyses, we also ran fully adjusted models testing for racial/ethnic differences by gender using a Wald test for the interaction between the two variables. While smoking prevalence and cigarettes smoked per day did differ by gender ( $p < 0.01$ ), the other two softening indicators did not, quit attempts ( $p = 0.33$ ), time to first cigarette ( $p = 0.89$ ). We include the results for smoking prevalence and CPD in Online Table A.5.

Analyses were done in Stata versions 14 and 15.

### 3. Results

#### 3.1. Smoking prevalence

In California overall smoking prevalence fell from 21.1% in 1990 to 12.3% in 2008, declining by a factor of 0.72 (95% CI = 0.70, 0.74) per decade in the unadjusted model and 0.84 (95% CI = 0.82, 0.87) per decade in the adjusted model (Fig. 1 and Table 2). Smoking prevalence varied significantly by race/ethnicity ( $p < 0.01$  for Wald test), with

**Table 2**  
Smoking prevalence and quit attempts within past 12 months (logistic regressions), California Tobacco Survey, 1990–2008.

Covariates and model fit	Smoking prevalence		Quit attempts within past 12 months	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Time, per decade, centered	0.72 (0.70, 0.74)	0.84 (0.82, 0.87)	1.28 (1.20, 1.36)	1.25 (1.17, 1.34)
Gender				
Male		1		1
Female		0.64 (0.62, 0.65)		0.97 (0.91, 1.04)
Age		0.98 (0.98, 0.99)		0.97 (0.97, 0.98)
Educational level				
0–11 years of schooling		1		1
12 years of schooling		0.83 (0.77, 0.88)		0.95 (0.86, 1.06)
Post-secondary school/some college		0.62 (0.58, 0.66)		1.16 (1.04, 1.28)
BA degree and higher		0.29 (0.27, 0.31)		1.19 (1.06, 1.35)
Race/ethnicity, dummy, difference from mean				
White		1.41 (1.34, 1.48)		0.74 (0.68, 0.81)
Hispanic		0.63 (0.59, 0.67)		1.26 (1.11, 1.42)
African American		1.39 (1.30, 1.49)		1.52 (1.33, 1.73)
Japanese		0.87 (0.72, 1.06)		0.76 (0.54, 1.07)
Chinese		0.51 (0.43, 0.60)		1.00 (0.70, 1.44)
Filipino		0.89 (0.77, 1.03)		1.17 (0.93, 1.48)
Korean		1.18 (0.92, 1.51)		0.89 (0.60, 1.31)
Other Asian/Pacific Islander		0.80 (0.70, 0.91)		0.99 (0.80, 1.22)
American Indian/Alaska Native		2.20 (1.90, 2.54)		0.91 (0.76, 1.08)
Constant	0.21 (0.21, 0.21)	0.71 (0.66, 0.77)	1.08 (1.04, 1.11)	3.36 (2.92, 3.88)
Model fit <i>p</i> -value	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.01	<i>p</i> < 0.01

prevalence highest among American Indians/Alaska Natives. (Online Table A.1 presents prevalence information on all races/ethnicities and all years.) It was followed by African Americans and Whites which all smoked above the overall average in the state. Hispanics remained below the average for the entire time, with the Chinese having the lowest smoking prevalence of all subgroups.

### 3.2. Quit attempts

In terms of softening indicators, the proportion of the entire smoking population with at least one quit attempt in the past 12 months increased from 46.2% in 1990 to 59.3% in 2008, by a factor (odds ratio) of 1.28 per decade (95%CI = 1.20, 1.36) in the unadjusted and by 1.25 per decade (95%CI = 1.17, 1.34) in the adjusted models. There was a significant variation across race/ethnicity (Wald test  $p < 0.01$ ), with the fraction with quit attempts consistently highest among African Americans and Hispanics (Fig. 1 and Tables 2 and A.2).

### 3.3. Cigarettes smoked per day

Cigarette consumption among continuing smokers declined from 16.9 to 10.9 CPD, a rate of  $-3.43$  CPD per decade (95%CI =  $-3.77$ ,  $-3.09$ ) in the unadjusted and  $-2.95$  (95%CI =  $-3.24$ ,  $-2.67$ ) in the adjusted model. As with the other outcomes, the main effects Wald test showed variation by race/ethnicity ( $p < 0.01$ ), but contrary to the other outcomes the interaction of time x ethnicity was significant ( $p < 0.01$ ), showing a significant difference in the rate of decline in CPD for Hispanics ( $p < 0.01$ ) (not shown). While all other racial/ethnic subgroups exhibited a decrease in CPD, Hispanics CDP remained stable at a low number of cigarettes (between 7.5 and 10.4 CPD) over time (Fig. 2 and Tables 3 and A.3).

### 3.4. Time to first cigarette

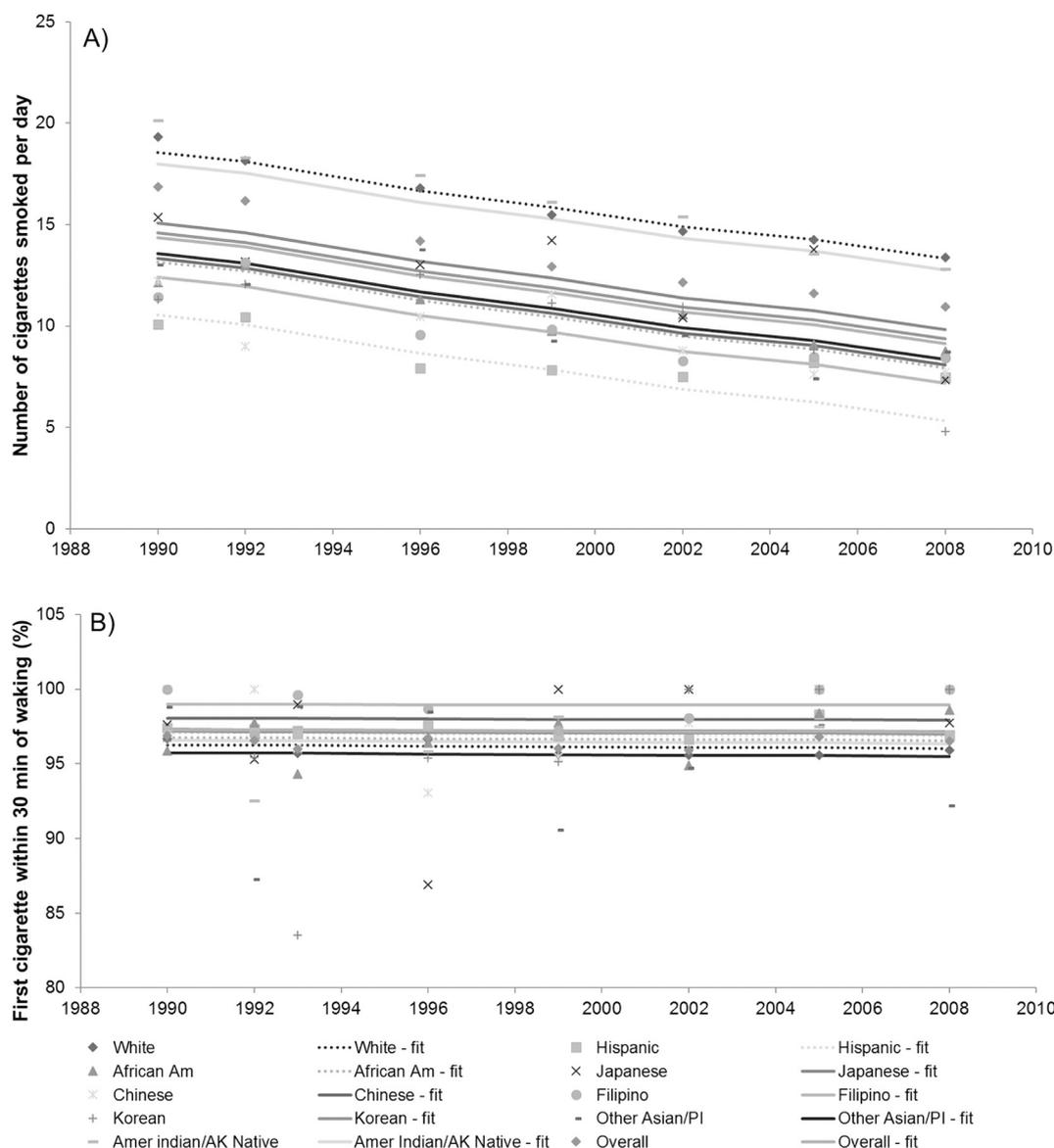
Time to first cigarette (30 min) was stable over the years ( $p = 0.82$ ) in the adjusted model, with marginally significant differences across different race/ethnicities ( $p = 0.053$  by Wald test) (Fig. 2 and Tables 3 and A.4).

## 4. Discussion

In California between 1990 and 2008 smoking prevalence declined markedly at similar absolute rates in all racial/ethnic subgroups. Quit attempts increased and CPD decreased. The fraction of smokers who smoked their first cigarette in 30 min or less after waking remained stable at about 96% of smokers as prevalence declined. There were similar trends across all race/ethnicity groups, except for CPD among Hispanics where CPD remained constant at a low level whereas it declined in the other groups. Thus, there was softening in smoking behavior across all groups, consistent with what was observed nationally in the US (and the European Union) among the general population (Kulik and Glantz, 2016) and among people with serious mental distress (Kulik and Glantz, 2017).

The time between 1990 and 2008 was characterized by an active tobacco control climate, including implementation of the aggressive California Tobacco Control Program (CTCP), funded by an earmarked tobacco tax, which included anti-tobacco advertising and state and local programs to involve communities in reducing the social acceptability of tobacco use, particularly through the accelerating enactment of smokefree laws at the local and, later, the state level. The CTCP consciously accounted for California's multicultural nature and worked to address health disparities (Roeseler and Burns, 2010; Glantz and Balbach, 2000). Examples of this were the operation of English and Spanish language smoking cessation telephone quitlines beginning in 1992, with four Asian language lines added in 1994, all being promoted by language-specific mass media. The first California anti-tobacco media campaign was launched in 1990 (California Department of Health Services, 2000). Simultaneously, four ethnic networks were established to exchange best practices and lessons learned from the large number of local projects (Tobacco Education and Research Oversight Committee, 2009). While increasing restrictions on opportunities to smoke during the day in workplaces and in public places are likely responsible for the decline in the number of cigarettes smoked, smokers continued to smoke their first cigarette of the day at home within 30 min of waking up.

In terms of differences in absolute prevalence among Asian subgroups, our analyses give similar results to those by the CDC based on the National Survey on Drug Use and Health, which found that in 2010–2013 among Asian subgroups in the US as a whole the Chinese



**Fig. 2.** A) Cigarettes smoked per day decline by race/ethnicity and for the overall California population; B) Time to first cigarette, percentage smoking within 30 min remains constant by race/ethnicity and for the overall California population [CTS 1990–2008, unadjusted data points and fitted trend lines based on adjusted regressions].

had a relatively low smoking prevalence (7.6%) compared to Koreans with about 20.0% (Centers for Disease Control and Prevention, 2016). Tong et al.'s (2009) analysis of California Health Interview Survey data collected in 2003 found that Asian American smokers in California are more likely to smoke fewer cigarettes than Whites, which is similar to what we found using the CTS data that were collected between 1990 and 2008.

The CTS is the only survey allowing an analysis of California smoking behaviors over a long period of time that permits analysis of racial-ethnic subgroups including Asian subpopulations and data were not available beyond 2008. Despite the efforts of the CTCF, funding for comprehensive, culturally tailored tobacco control programs for Asian Americans, Native Hawaiian and Pacific Islanders, and other priority populations declined after 2002 because of declining tax revenues available to support the CTCF (Roeseler and Burns, 2010), so we do not know if and how trends have continued to develop over time.

As with other cross-sectional time series analyses, a limitation of this study is that causation cannot be determined, including explicitly linking the California tobacco control program to changes in smoking

behavior. While the phrasing of the question assessing smoking status changed slightly as of 1996, we do not expect this to have influenced the numbers of those included in the sample of smokers in any significant way. All survey waves did include an initial question about whether someone had smoked at least 100 cigarettes in their lifetime. Further, the response rates in population surveys have been decreasing over time. However, given the similarity of results based on this data set and other nationally representative surveys the inclusion of survey weights accounting for under-coverage and nonresponse has largely alleviated this potential issue (Messer and Pierce, 2010).

### 5. Conclusion

Although from different baseline levels, all subgroups of California smokers were softening, reaping the associated health benefits. Despite the successes of the CTCF, there needs to be sustained funding to ensure that these achievements can be carried into the future, while being cognizant of the needs of California's culturally diverse communities. Interventions are still needed to reduce the baseline differences.

**Table 3**  
Cigarettes smoked per day (linear regression) and first cigarette within 30 min (logistic regression), California Tobacco Survey, 1990–2008.

Covariates and model fit	Cigarettes smoked per day		First cigarette within 30 min	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Time, per decade, centered	−3.43 (−3.77, −3.09)	−2.95 (−3.24, −2.67)	0.98 (0.85, 1.13)	0.98 (0.85, 1.14)
Gender				
Male		1		1
Female		−2.79 (−3.09, −2.49)		1.31 (1.11, 1.54)
Age		0.16 (0.15, 0.17)		1.00 (1.00, 1.01)
Educational level				
0–11 years of schooling		1		1
12 years of schooling		−0.62 (−1.11, −0.12)		0.70 (0.53, 0.92)
Post-secondary school/some college		−1.96 (−2.44, −1.48)		0.56 (0.42, 0.74)
BA degree and higher		−4.23 (−4.82, −3.65)		0.63 (0.47, 0.85)
Race/ethnicity, dummy, difference from mean				
White		4.20 (3.79, 4.62)		0.72 (0.56, 0.93)
Hispanic		−3.81 (−4.34, −3.29)		0.92 (0.67, 1.28)
African American		−1.20 (−1.79, −0.61)		0.83 (0.60, 1.15)
Japanese		0.70 (−1.05, 2.46)		1.01 (0.37, 2.77)
Chinese		−1.04 (−2.32, 0.25)		1.40 (0.67, 2.89)
Filipino		−1.95 (−2.87, −1.03)		2.73 (1.21, 6.18)
Korean		0.24 (−1.26, 1.74)		0.96 (0.36, 2.57)
Other Asian/Pacific Islander		−0.78 (−1.78, 0.22)		0.63 (0.31, 1.25)
American Indian/Alaska Native		3.63 (2.75, 4.52)		0.78 (0.49, 1.26)
Constant	13.53 (13.35, 13.72)	8.00 (7.32, 8.67)	26.90 (24.76, 29.21)	45.54 (27.93, 64.80)
Model fit R <sup>2</sup>	0.0353	0.1926		
Model fit p-value	p < 0.01	p < 0.01	p = 0.7595	p < 0.01

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**Contributions**

MCK collected the data, computed the statistics, and drafted the manuscript. SAG advised on data analysis and revised the manuscript.

**Conflicts of interest**

None.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ypmed.2019.01.020>.

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