Simulated Effect of Tobacco Tax Variation on Latino Health in California
Sherry Emery, PhD, Christopher F. Ake, PhD, Ana M. Navarro, PhD, Robert M. Kaplan, PhD

Background: Over one fourth of the California population was Latino in 1999, and by 2015 Latinos are expected to be the single largest ethnic group in California. Patterns of smoking and nicotine dependence among Latino smokers may be quite different from those of smokers in other ethnic groups. In addition, Latino smokers may be more sensitive to cigarette prices. Therefore, the effect of an increase in cigarette excise taxes on Latino smoking prevalence may be quite large, and consequently the impact on Latino health may be proportionately greater than on population health in general.

Methods: We simulated changes in Latino smoking, morbidity, mortality, and quality-adjusted life years (QALYs) that would result from a range of actual and proposed cigarette excise-tax increases using a range of cigarette price-elasticity estimates specific to Latino smokers. Monte Carlo simulation was used to generate confidence intervals.

Results: Assuming a Latino price elasticity of demand for cigarettes of \(-1.0\), reductions in Latino smoking resulting from an additional $0.50/pack tax would produce nearly 3000 Latino QALYs in California in 1999. Greater benefits would accrue each year, until a steady state relative to population size is reached 75 years after the program is initiated.

Conclusions: If Latino smokers are more responsive to changes in cigarette prices than other smokers, Latino smokers also stand to gain a disproportionate share of the health benefit from an excise tax increase.


Introduction

Cigarette excise taxes are an attractive public policy tool for two reasons. First, they generate substantial revenue for the government unit levying the tax. Second, there is considerable evidence that a cigarette excise tax increase will reduce cigarette consumption by discouraging youth from taking up smoking, stimulating adult smokers to quit, and motivating many other smokers to reduce their daily consumption.1–9

The beneficial features of an excise tax, however, are coupled with a tangible cost to smokers that should not be ignored. Cigarette taxes represent a transfer—or reallocation of income—from smokers to the general population.10,11 Whether such a transfer is appropriate depends in part on whether it compensates society for the excess costs imposed by smokers through smoking-related diseases and premature mortality. Economists refer to this criterion as economic efficiency. The efficiency of cigarette excise taxes and the social costs of smoking have been topics of considerable debate.10,12–15

It is also important to consider whether such a tax is equitable. A tax is considered inequitable if it disproportionately burdens low-income individuals, compared to those with higher incomes. It has been argued that cigarette excise taxes are regressive in two ways. First, low-income and minority smokers pay a larger portion of their income toward these taxes. Second, if low-income groups smoke more than others, in theory they would even more disproportionately finance the transfer of resources. However, research in several countries has shown that low-income smokers may be more likely than other smokers to quit smoking or to cut down in response to cigarette price increases.6,16,17 If this hypothesis is correct, cigarette excise taxes could be considered progressive at the population level for lower-income smokers because they would receive a
larger share of the health benefits of reduced smoking. \(^{18}\)

In this paper, we explore the possibility that cigarette excise taxes are not regressive, and expand upon this premise to estimate effects of increases of $0.50/pack and $1.00/pack on the health status (rather than the economic status) of Latino smokers in California. We concentrate on the Latino population because it comprises one fourth of California citizens. By 2015, Latinos are expected to be the single largest ethnic group in California. Further, although the reasons are not clear, previous studies have shown that patterns of smoking and nicotine dependence among Latino smokers may be quite different from those of smokers in other ethnic groups\(^{19–23}\) and that Latino smokers may be more sensitive to cigarette prices compared to other smokers.\(^6\) Thus, Latino smokers may be more likely (and more able) to quit smoking in response to cigarette price increases. We use this information to modify previous estimates of the health effects of increases in cigarette excise taxes on overall population health in California.

**Methods**

We closely followed previously used methodology to estimate the effect of increased cigarette excise taxes on population health in California; the details of our approach are reported elsewhere.\(^{24}\) Briefly, we used estimates from the literature of smokers’ sensitivity to cigarette price changes (price elasticity) to project the expected changes in Latino smoking prevalence that would result from a range of cigarette tax increases in California. We then translated these changes in prevalence to changes in population mortality, using the Smoking-Attributable Morbidity, Mortality and Economic Costs (SAMMEC) program.\(^{25}\) Using quality-of-life estimates from the National Health Interview Survey (NHIS), we also translated prevalence changes into changes in population morbidity, and combined these mortality and morbidity changes into changes in quality-adjusted life years (QALYs) for the California Latino population.

There were three important differences between the approach used for the current analyses and that used previously. First, because the literature provides strong evidence that Latino smokers may respond differently from the overall population to changes in cigarette prices, we used Latino-specific elasticity estimates in our models. Second, we used Latino-specific data as input for SAMMEC. Finally, we used Latino-specific data from the National Health Interview Surveys (NHIS) to calculate QALYs. The details of these modifications are provided in the next section.

**Elasticity Estimates**

Price elasticity of demand is a measure of consumers’ responsiveness to changes in price, that is, the extent to which demand for a product is affected by price. An expert panel convened by the National Cancer Institute arrived at a consensus estimate of the adult overall price elasticity of demand for cigarettes of −0.4,\(^4\) meaning that for every 10% increase in the real price of cigarettes, demand is expected to drop by 4%. Overall price elasticity of demand for cigarettes consists of two components: (1) participation elasticity, the extent to which price influences whether or not people smoke; and (2) conditional demand elasticity, the amount of cigarettes consumed by those who smoke. Most studies attribute approximately half of the change in overall demand to changes in smoking participation (increased quitting and reduced initiation) and half to reduced consumption among the remaining smokers.\(^2\),\(^26\)

Although few studies have specifically examined elasticity among population subgroups, such as Latino smokers, Farrelly and Bray\(^6\) estimated that overall price elasticity of demand for cigarettes among Latino smokers was as large as −1.89, and Latino participation elasticity, −1.31. These figures imply that for every 1% increase in the price of cigarettes, Latino smoking participation (prevalence) decreases by 1.3%. Further, Townsend et al.\(^{27}\) presented evidence that responsiveness to price (elasticity) was inversely related to socioeconomic status (SES). The Townsend group’s overall price elasticity estimates ranged between nonsignificant for the highest two quintiles of SES, to −1.0 for the lowest quintile.\(^{16},\(^27\) Table 1 presents a range of elasticity estimates, along with the Latino and lower SES estimates. Given that Latinos tend to be disproportionately represented in lower SES groups compared to non-Latino whites, Townsend’s\(^{16},\(^27\) results provide further support for Farrelly and Bray’s\(^6\) estimates of Latino elasticity.

Based on the Latino and lower SES elasticity estimates from the literature, we used a conservative range of overall Latino demand elasticity estimate between −0.8 and −1.2 to estimate the expected changes in Latino smoking prevalence that would result from two alternative excise tax increases: $0.50/pack and $1.00/pack. We assumed throughout our modeling that participation elasticity was 50% of overall elasticity of demand. Because it is much more complicated to model changes in consumption than to model changes in prevalence, the initial work we report here takes the most conservative approach and assumes consumption levels among those who continued to smoke did not change as a result of a price increase.

For all cases we used a baseline average cigarette price per pack in California of $2.50. We also assumed that the tax increase would be completely passed on as a price increase. Thus a $0.50 tax increase would represent a 20% price increase. With an assumed overall elasticity of −1.0, for

**Table 1. Selected econometric estimates of the price elasticity of demand for cigarettes**

<table>
<thead>
<tr>
<th>Study</th>
<th>Overall adult price elasticity estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lewit and Coate(^1)</td>
<td>−0.89</td>
</tr>
<tr>
<td>Becker et al.(^2)</td>
<td>−0.40 (short run)</td>
</tr>
<tr>
<td>Keeler et al.(^3)</td>
<td>−0.20 to −0.36 (short run)</td>
</tr>
<tr>
<td>NCI expert panel(^4)</td>
<td>−0.5 to −0.5</td>
</tr>
<tr>
<td>Farrelly and Bray(^6)</td>
<td>−1.89 (Latino smokers)</td>
</tr>
<tr>
<td>Townsend et al.(^16)</td>
<td>−1.0 (lowest quintile SES smokers)</td>
</tr>
</tbody>
</table>

NCI, National Cancer Institute; SES, socioeconomic status.
example, the expected change in Latino smoking prevalence would then be 50% of −20% (i.e., −10%). Table 2 presents the expected changes in prevalence under each combination of elasticity estimates and tax increases.

Table 2. Expected changes in smoking prevalence

<table>
<thead>
<tr>
<th>Elasticity</th>
<th>$0.50/pack increase</th>
<th>$1.00/pack increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total elasticity = −0.8</td>
<td>−8%</td>
<td>−16%</td>
</tr>
<tr>
<td>(Participation elasticity = −0.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total elasticity = −1.0</td>
<td>−10%</td>
<td>−20%</td>
</tr>
<tr>
<td>(Participation elasticity = −0.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total elasticity = −1.2</td>
<td>−12%</td>
<td>−24%</td>
</tr>
<tr>
<td>(Participation elasticity = −0.6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Evaluating the potential change in Latino smoking prevalence for a single year was possible because the number of HALex scores for Latinos across all age group/gender combinations for years ranging from 18 to 19 years through 1994 because the 1989 NHIS did not include smoking data. As input, we provided four types of data specific to the California Latino population:

- Latino mortality data from the 1996 California state vital records
- Latino smoking prevalence by gender and age (35–64 vs ≥65) from the 1996 California Tobacco Surveys (CTS)
- Latino population estimates by gender and 5-year age categories from the 1996 CTS
- Average years of life remaining, by gender, for each 5-year age category of the California Latino population, derived from SAMMEC-supplied 1991 U.S. figures for “other” ethnicity, rather than the SAMMEC figures for whites or blacks. (People of “other” races constitute a heterogeneous group, which could include Latinos, but also likely includes individuals from a multitude of different racial/ethnic groups and is not directly comparable to the White or Black categories. Using White as the race category in the years-of-life-remaining component of our SAMMEC calculations resulted in Latino QALY estimates that were minimally different: only 1.8% to 2.5% higher.)

Estimating Latino-Specific Quality-of-Life Effects

We followed Erickson et al.’s method developed by the National Center for Health Statistics, Centers for Disease Control and Prevention, to estimate the morbidity consequences of smoking using the Health and Limitations Index (HALex) measure of years of healthy life. Obtaining stable HALex scores for Latinos across all age group/gender combinations for a single year was possible because the number of Latinos interviewed for the NHIS was sufficient in any given year. Thus, we aggregated the NHIS data for Latinos across 1987, 1988, and 1990 to 1994 to estimate the effect of tobacco use on health-related quality of life for Latinos in age categories ranging from 18 to 19 years through ≥85 years. (We did not use the continuous series of NHIS data from 1989 through 1994 because the 1989 NHIS did not include smoking information.) This approach weights the YPLLs by health-related quality of life to produce an estimate of health benefits in QALYs. A more detailed description of this approach is provided in Kaplan et al.24

In order to develop confidence intervals, Monte Carlo simulation was performed using the Crystal Ball 4.0 software program.30 For simulation purposes we considered it highly plausible to assume that QALYs are normally distributed. Each simulation used 10,000 trials.

Model Cases and Assumptions

In addition to examining the effect of a $0.50/pack or $1.00/pack tax increase in the first year after the tax increase (Case I), we also considered the potential effect 75 years later (Case II). We selected the time point of 75 years into the future because it is reasonable to assume that by then everyone aged ≥85 would have been subject to the increased tax during the years they initiated smoking. Case I assumed that in the year after the tax, some smokers will quit (cessation) and that each age group of adult Latino smokers experiences the same proportionate decrease that year. Case II assumed the tax is adjusted as necessary for inflation to maintain a real price change of $0.50/pack or $1.00/pack throughout the 75-year period, and that the Latino population size is constant over the 75-year period.

Results

The base case model suggests that in the first year (Case I), the $0.50 tax would produce approximately 2985 Latino QALYs. This is equivalent to 3317 QALYs per 1 million Latino smokers annually. For Case II, in 75 years, the tax would produce 4147 Latino QALYs or 4606 QALYs per 1 million Latino smokers annually. For simulation purposes we considered it highly plausible that QALYs are normally distributed. For example, under the assumption of a $1.00 tax and a −1.0 total elasticity (−0.50 participation elasticity) in Case I, the model suggests that about 8262 (95% CI, 3502–13020) additional QALYs would be produced in the Latino population. Under Case II, the annual QALY yield would be about 8262 (95% CI, 3502–13020) among Latinos.

In previous work, we showed that the tax would produce an immediate gain for the total population of California of 8389 QALYs/year, and a gain of 14,936 QALYs/year after 75 years. These are equivalent to 2055 and 3658 QALYs per 1 million smokers/year after 1 and 75 years, respectively. Table 3 compares the QALYs among the general population and among California Latinos.

Benefits from reductions in tobacco consumption derive from two sources: improved life expectancy (the mortality component) and improved health-related quality of life (the morbidity component). Our simulations suggest that the majority of the benefits come from improved quality of life. In the short run, approximately 26% of the benefits resulted from decreased
mortality and 74% resulted from improvements in quality of life. In the long run, about 36% of the benefits reflected changes in mortality, and 64% from improved quality of life.

**Discussion**

Opponents of cigarette excise tax increases have consistently argued that the burden of the new tax would fall disproportionately on low-income people, many of whom are also minorities. Given the evidence that low-income and minority smokers are more sensitive to cigarette prices, however, it is arguable that these groups would quit smoking in greater numbers than higher-income or non-Latino white smokers. Building on this argument, our research suggested that the 1999 cigarette excise tax and corresponding retail price increases would produce substantial improvements in the health status of the California Latino population.

We estimated that the increase in cigarette prices in 1999 produced over 3300 QALYs/year per 1 million Latino smokers in the short run, and over 4600 QALYs/year per 1 million Latino smokers in the long run.

**Table 3. Comparison of Latino QALY estimates to general population QALY estimates**

<table>
<thead>
<tr>
<th>Combinations of tax amount and Latino/general elasticity estimates</th>
<th>Total QALYs saved annually (QALYs/million smokers)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CASE I</strong></td>
<td></td>
</tr>
<tr>
<td>Latino population after 1 year</td>
<td>General population after 1 year</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -0.8/0.2 \text{ elasticity}^b$</td>
<td>2428 (2697)</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -1.0/0.4 \text{ elasticity}^b$</td>
<td>2985 (3317)</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -1.2/0.6 \text{ elasticity}$</td>
<td>3636 (4039)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -0.8/0.2 \text{ elasticity}$</td>
<td>4869 (5409)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -1.0/0.4 \text{ elasticity}$</td>
<td>6071 (6744)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -1.2/0.6 \text{ elasticity}$</td>
<td>7317 (8128)</td>
</tr>
<tr>
<td><strong>CASE II</strong></td>
<td></td>
</tr>
<tr>
<td>Latino population after 75 years</td>
<td>General population after 75 years</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -0.8/0.2 \text{ elasticity}^b$</td>
<td>3362 (3735)</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -1.0/0.4 \text{ elasticity}^b$</td>
<td>4147 (4606)</td>
</tr>
<tr>
<td>$0.50 \text{ tax, } -1.2/0.6 \text{ elasticity}$</td>
<td>5035 (5593)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -0.8/0.2 \text{ elasticity}$</td>
<td>6698 (7440)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -1.0/0.4 \text{ elasticity}$</td>
<td>8262 (9178)</td>
</tr>
<tr>
<td>$1.00 \text{ tax, } -1.2/0.6 \text{ elasticity}$</td>
<td>10219 (11331)</td>
</tr>
</tbody>
</table>

$^a$ Numbers in parentheses indicate QALYs/million smokers.

$^b$ Indicates base case.

QALY, quality-adjusted life year.
year per 1 million Latino smokers in the long run. Our estimates suggest that the per capita QALY benefits for California Latinos are about 60% higher in the short term and 26% higher in the long term, compared to the California population as a whole. Thus, our results suggest that cigarette excise taxes could produce proportionately greater health benefits for Latinos and that Latinos experience the greatest proportional benefits immediately. The difference between our estimates of the gains in QALYs/year per 1 million smokers in the general population versus the gain per 1 million Latino smokers is driven primarily by the differences in cigarette price sensitivity in the two populations. It is also influenced, however, by differences in smoking prevalence, mortality patterns, quality-of-life estimates, and population age distribution.

Although Latino smokers who continue to smoke may pay a larger percentage of their income for cigarettes, they may also be more likely to quit smoking as a result of an increase in cigarette prices. Thus, we argue that the Latino population may gain proportionately more health than the non-Latino white population because they may quit in greater numbers in response to increased excise taxes. Although there is potentially a greater benefit to this population, the excise tax may still be considered regressive for those who remain smokers.

There are several important limitations in our study. First, our models are predicated on projected changes in Latino smoking prevalence that could be expected, given the available data, on the price elasticity of demand for cigarettes among Latinos and lower SES groups. If Latinos are not more responsive than the overall population to changes in cigarette prices, our estimates of the reductions in Latino smoking prevalence caused by the excise tax increases would be substantially smaller, and therefore the Latino QALYs gained would also be lower. The elasticity estimates we used in our models were conservative, relative to the only evidence available about Latino price elasticity in the literature. Thus, we feel that our models are based on reasonable assumptions.

Second, our model assumes that the proportion of Latino citizens in California will remain constant. Absent reliable demographic projections, this assumption was necessary. The most likely scenario is that the Latino population will continue to grow and this will make our long-term estimates even more conservative. On the other hand, the Latino population is also expected to become more affluent. Greater economic resources may make Latinos less sensitive to product pricing.

Further, the SAMMECT model, which we used to estimate the changes in mortality that would result from the expected changes in smoking prevalence, has been criticized because its attributable-risk formulas are based on the relationships between smoking preva-

ence data and mortality data from the same period in time. It is likely that the mortality observed during that period was because of smoking prevalence rates from earlier decades. Nonetheless, SAMMECT continues to be used widely in the public health community, and this program and similar models are the basis of many estimates of the social costs of smoking.10,14,15

Another potential limitation related to SAMMECT is that the attributable risks for smoking-related mortality were calculated based on non-Latino population data for smoking-related diseases. It was beyond the scope of this paper to adjust these data for the Latino population. There are also some important limitations in our estimates of QALYs. Several different methods for estimating QALYs are available, and method selection is a matter of some debate. Despite these limitations, the general conclusions of our simulation models likely hold, and have important public policy and public health implications.

In summary, our research suggests that the health benefits of tobacco excise taxes are substantial for Latinos. Further, Latinos may experience proportionately greater benefits from tobacco excise taxes than the population as a whole.

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References
13. Bartlett JC, Miller LS, Sloss EM, Wasserman J. The effects of excise taxes on smoking prevalence rates from earlier decades. Nonetheless, SAMMECT continues to be used widely in the public health community, and this program and similar models are the basis of many estimates of the social costs of smoking.10,14,15
15. Miller LS, Zhang X, Novotny TE, Rice DP, Max WB. State estimates of