The impact of changes in tobacco control funding on healthcare expenditures in California, 2012–2016

Wendy Max,[1] Hai-Yen Sung,[1] James Lightwood[2]

► Additional appendices are published online only. To view these files please visit the journal online (http://tobaccocontrol.bmj.com/content/early/recent).

[1]Institute for Health & Aging, School of Nursing, University of California, San Francisco, San Francisco, California, USA
[2]Department of Clinical Pharmacy, School of Pharmacy, University of California, San Francisco, San Francisco, California, USA

Correspondence to
Professor Wendy Max, Institute for Health & Aging, School of Nursing, 3333 California Street, Suite 340, University of California, San Francisco, San Francisco, CA 94118 USA; wendy.max@ucsf.edu

Received 7 July 2011
Accepted 20 December 2011

Published Online First
17 January 2012

ABSTRACT

Objective This study presents estimates of the impact of changes in California tobacco control funding on healthcare expenditures for 2012–2016 under four funding scenarios.

Methods Smoking prevalence is projected using a cointegrated time series regression model. Smoking-attributable healthcare expenditures are estimated with econometric models that use a prevalence-based annual cost approach and an excess cost methodology.

Results If tobacco control spending in California remains at the current level of 5 cents per pack (base case), smoking prevalence will increase from 12.2% in 2011 to 12.7% in 2016. If funding is cut in half, smoking prevalence will increase to 12.9% in 2016 and smoking-attributable healthcare expenditures will be $307 million higher over this time period than in the base case. If the tobacco tax is increased by $1.00 per pack with 20 cents per pack allocated to tobacco control, smoking prevalence will fall to 10.4% in 2016 and healthcare expenditures between 2012 and 2016 will be $3.3 billion less than in the base case. If funding is increased to the Centers for Disease Control and Prevention recommended level, smoking prevalence will fall to 10.6% in 2016 and there will be savings in healthcare expenditures of $4.7 billion compared to the base case due to the large reduction in heavy smoking prevalence.

Conclusions California's highly successful tobacco control program will become less effective over time because inflation is eroding the 5 cents per pack currently allocated to tobacco control activities. More aggressive action needs to be taken to reduce smoking prevalence and healthcare expenditures in the future.

INTRODUCTION

California has one of the longest running comprehensive tobacco control programs in the world. The California Tobacco Control Program (CTCP) was established in 1989, with a cigarette tax increase of 25 cents per pack and 5 cents per pack earmarked for tobacco control activities. The CTCP uses a comprehensive multipronged approach for preventing and reducing tobacco use with a strategy of promoting social norms that tobacco use and exposure to second-hand smoke (SHS) are not acceptable.[1] CTCP activities include a statewide anti-tobacco media campaign, school-based prevention and cessation programs, community-based interventions, a competitive grants program, healthcare provider education, restrictions on advertising and promotion and clean indoor air laws.[2] Since the program was implemented, the state has benefitted from substantial reductions in adult smoking prevalence,[3] heavy smoking prevalence,[4] adolescent smoking initiation[5] and per capita cigarette consumption,[6 7] as well as reduced lung cancer rates,[8 9] reduced heart disease mortality[6] and a reduction in healthcare expenditures due to reduced smoking-related diseases.[10] Other states' tobacco control programs have also been associated with positive outcomes, including reduced per capita cigarette consumption and healthcare expenditures in Arizona,[11] reduced teen smoking prevalence in Florida[12] and reduced adult cigarette consumption and smoking prevalence in Massachusetts.[13] While strong tobacco control programs have been shown to reduce smoking and related health and expenditure impacts, there are also troubling indications that these impacts diminish over time.[13]

Once considered a national leader in tobacco control programs, California has fallen behind in its funding of tobacco control programs. CTCP funding level has not increased since the program was implemented, and the real value of this funding has eroded over time due to inflation. The US Centers for Disease Control and Prevention (CDC) produces guidelines for the minimum tobacco control funding levels and programmatic recommendations for each state.[14] These are determined through an expert panel review of estimates of effectiveness of the components of large state tobacco control programs, particularly California and Massachusetts. In the 2007 guidelines, the CDC recommended that California spend $441.9 million, or $12.12 per capita a year,[14] but California spent only $75.0 million in fiscal year 2011 on tobacco control programs. This ranks California 23rd in funding levels among all states.[15]

The purpose of the present study was to estimate the impact of changes in California tobacco control funding on smoking prevalence and healthcare expenditures under four funding scenarios.

METHODS

We evaluate changes in smoking prevalence and smoking-attributable healthcare expenditures for 2012–2016 resulting from funding changes that would begin in 2012. The four funding scenarios are as follows:

- *Scenario 1: base case*. Tobacco control funding will continue at the current level of 5 cents per pack, and cigarette taxes remain unchanged. This is comparable to $1.50–$2.00 per capita, depending on future population growth.
- *Scenario 2: funding cut in half*. Current funding is assumed to be cut in half to 2.5 cents per pack holding cigarette taxes unchanged. This would amount to $.75–$1.00 per capita.

- *Scenario 3: dollar per pack tax increase*. The cigarette tax is increased by $1.00 per pack with an additional 20 cents per pack allocated to tobacco control programs. The resulting funding level is equivalent to $6.00–$8.00 per capita for the first year and would fall over time as cigarette consumption and tax revenue decreases.
- *Scenario 4: CDC recommended funding level*. The current funding for tobacco control programs increases to the CDC recommended level of $12.12 per capita, and cigarette taxes are unchanged.

Data sources

Several data sets were used for projecting smoking behaviour under alternative scenarios, estimating the national healthcare cost of smoking models and applying the models to California.

Behavioural Risk Factor Surveillance System

The Behavioural Risk Factor Surveillance System (BRFSS) is a telephone-based survey of adults aged 18 years and older conducted by state health departments with technical assistance provided by the CDC. It was initiated in 1984 with 15 states collecting data, and since 1995, all 50 states participate. Data collected include smoking behaviour, socio-demographic characteristics and other health risk behaviours. Each year, data on >350 000 adults are collected nationwide. The sampling design allows for producing state-specific and national estimates. Data on intensity of smoking are available in the BRFSS only through 2000.

California Health Interview Survey

The California Health Interview Survey (CHIS) has been conducted every 2 years since 2001. Interviews are conducted by phone with a sample randomly selected to represent California's population. The CHIS includes information about individuals' smoking history, risk behaviours and demographic and socioeconomic characteristics. The 2007 CHIS, the most recent year available at the time of this study, contains 51 048 adults.

Tobacco Use Supplement of the Current Population Survey

The Tobacco Use Supplement of the Current Population Survey (TUS-CPS) is a national survey of adults aged 15 years and older. It is sponsored by the National Cancer Institute and administered as part of the CPS, the US Census Bureau's continuing labour force survey. It has been conducted in selected years since 1992 collecting information on cigarette smoking history and other tobacco use. The sampling design allows for producing state-specific and national estimates.

Medical Expenditures Panel Survey and the National Health Interview Survey

The Medical Expenditures Panel Survey is a nationally representative survey containing detailed information about each individual's healthcare utilisation, expenditures and the associated International Classification of Diseases - 9th Revision (ICD-9) diagnostic codes for healthcare services used. It also contains information about health status, medical conditions and demographic and socioeconomic characteristics. Information about individual smoking history can be obtained by linking the Medical Expenditures Panel Survey and the National Health Interview Survey.

Measures

Smoking status and intensity

Smoking status was categorised as current, former and never smoking. A current smoker is someone who has smoked at least 100 cigarettes in their lifetime and who currently smokes every day or some days. A former smoker is someone who has smoked 100 cigarettes in their lifetime but does not smoke currently. A never-smoker is someone who has not smoked 100 cigarettes during their lifetime. Current smokers were further categorised by smoking intensity as light (smoking <10 cigarettes per day or non-daily smokers), moderate (10–19 cigarettes per day) or heavy (20 cigarettes per day or more) smokers.

Covariates

Demographic variables include age, gender, race/ethnicity (non-Hispanic whites, Hispanics, non-Hispanic blacks, non-Hispanic Asians and others), educational level, marital status, region (West, Midwest, Northeast, South) and health insurance coverage (the proportion of months in each year covered by private insurance, Medicare, Medicaid, uninsured and other public insurance).

Types of healthcare expenditures

Expenditures were estimated for hospitalisations, ambulatory care, prescription drugs and home healthcare. Expenditures include all direct payments for healthcare services: out-of-pocket payments and payments by private insurance, Medicaid, Medicare and other sources.[16] Healthcare expenditures were converted to constant 2009 dollars, using the medical care component of the Consumer Price Index.[17]

Projected smoking prevalence for each year and scenario

The overall current smoking prevalence and the proportions of California current smokers who were light, moderate and heavy smokers from two data sources—the 1984–2000 BRFSS and the TUS-CPS (available years 1992–2007)—were the four dependent variables. Next, median regression was used to estimate a cointegrated time series regression model[18 19] that regressed each dependent variable on the following explanatory variables: average current smoking prevalence for a group of control states (see online appendix 1 for the details of control state selection), difference in cumulative real per capita tobacco control funding between California and the control states, difference in real per capita income between California and the control states and a dummy variable indicating the data source (BRFSS vs TUS-CPS). The control states were used to model unobservable national trends that may affect smoking prevalence apart from California tobacco control expenditures, such as national trends in attitudes towards cigarette smoking, per capita income and cigarette price.[20] The coefficients of the cointegrating regression were estimated using the irrelevant instrumental variables estimator.[21] Irrelevant instrumental variables are artificially generated instruments designed to be correlated with the explanatory variables using properties of non-stationary time series and by construction, they are not correlated with regression errors.[21] Based on these estimated coefficients, we forecast the long-run total current smoking prevalence and proportions of current smokers by intensity for 2007–2016 under each of the four scenarios. These forecasts were based on the predicted values of the explanatory variables produced with a reduced form vector autoregression specification. Finally, the predicted prevalence of light, moderate and heavy smoking for 2007–2016 was calculated by multiplying the predicted proportions of current smokers by intensity by the predicted total current smoking prevalence. Further details of the prevalence estimation and projections are provided in online appendix 1.

We adjusted the prevalence projections so that the predicted 2007 smoking prevalence rates are set to equal the actual

prevalence rates estimated from the 2007 CHIS data because the smoking-attributable health expenditure estimates are based on a model that uses that data (see the Smoking-attributable healthcare expenditures analysis section). We determined the projected former and never smoking rates for 2008–2016 by allocating the change in current smoking rates between 2007 and the projection year equally to former- and never-smokers. We also examined the sensitivity of our results to two alternative assumptions regarding changes in current smoking prevalence:

- Former smoking rates remain unchanged, and all the differences are allocated to never-smokers.
- Never smoking rates remain unchanged, and all the differences are allocated to former smokers.

Smoking-attributable healthcare expenditures analysis

Smoking-attributable healthcare expenditures for adults aged 18 years and older were estimated with the econometric models that Max and colleagues have developed and refined over the past 2 decades.[22 23] The models use a prevalence-based annual cost approach and an excess cost methodology. After estimating the annual healthcare expenditures as a function of smoking status and covariates, the estimated coefficients were used to generate two sets of predicted healthcare expenditures for each smoker (ie, current light, current moderate, current heavy or former smoker): one for a factual case and one for a counterfactual case—that is, for someone who has all the same characteristics as the smoker except that they are assumed to be a never-smoker. The difference between the factual and the counterfactual predictions among all smokers is the excess cost of smoking. This excess cost divided by total predicted healthcare expenditures among all individuals (including smokers and never-smokers) is the smoking-attributable fraction (SAF). The ratio of mean predicted expenditures between smokers and never-smokers is the relative risk (RR) of healthcare expenditures.

National models of smoking-attributable healthcare expenditures were estimated first (see online appendix 2) because data on both smoking and healthcare expenditures are not available in any one data set for California. The estimated coefficients from the national models were then applied to the 2007 CHIS data to obtain California RRs and SAFs, which were forecast to 2012. These SAFs were then applied to projected state health expenditures by type of healthcare services for each year to obtain smoking-attributable healthcare expenditures. A detailed description of the model estimation and healthcare expenditure projection is included in online appendix 3.

RESULTS

Smoking prevalence

Current, former and never smoking prevalence under the four scenarios for 2010–2011 (baseline) and 2012–2016 (forecast) is shown in table 1. Current smoking prevalence rises under both the base case scenario and the funding cut scenario, rising more rapidly under the latter. Under the tax scenario, current smoking prevalence would drop dramatically during the first year and then continue to drop more gradually to 10.4% in 2016. If funding is increased to the CDC recommended level, current smoking prevalence would fall more gradually over time to 10.6% in 2016.

Looking at the impact of funding changes on total current smoking prevalence does not tell the whole story, as illustrated in figure 1, which shows the impact of funding changes on light, moderate and heavy smoking. The base case scenario results in light smoking prevalence remaining flat, while both moderate and heavy smoking prevalence increases slightly. The effect is more pronounced under the funding cut scenario, where light smoking prevalence falls slightly and the increases in moderate and heavy smoking prevalence are greater. If the tobacco tax is increased, there is an initially large reduction in the prevalence of all intensities of smoking in the first year, followed by a slight increase in light smoking prevalence and a continual decrease in moderate and especially heavy smoking prevalence. Under the CDC funding scenario, although total current smoking prevalence would fall steadily over time, the separate impacts on light, moderate and heavy smoking show mixed patterns: light smoking prevalence increases, moderate smoking prevalence drops substantially and there is a dramatic 10-fold drop in heavy smoking prevalence. This suggests that a considerable proportion of heavy and moderate smokers would reduce their cigarette consumption instead of quitting smoking. We tested for statistically significant differences in smoking prevalence by intensity (light, moderate and heavy) between the base case and the other three scenarios by year for 2012–2016 and found that the time trends of expected differences between base case and other scenarios in prevalence of light, moderate and heavy smoking were statistically significantly different at the 5% level.

Table 1 Forecasts of smoking prevalence under four scenarios of tobacco control funding: 2010–2016 (%)

	2010	2011	2012	2013	2014	2015	2016
Scenario 1: base case							
Current smoker	12.1	12.2	12.3	12.4	12.5	12.5	12.7
Former smoker	24.7	24.7	24.7	24.6	24.6	24.5	24.4
Never-smoker	63.2	63.1	63.1	63.0	63.0	62.9	62.9
Scenario 2: funding cut in half							
Current smoker	12.1	12.2	12.3	12.4	12.5	12.7	12.9
Former smoker	24.7	24.7	24.6	24.6	24.5	24.5	24.4
Never-smoker	63.2	63.1	63.1	63.0	62.9	62.9	62.8
Scenario 3: $1.00 tobacco tax							
Current smoker	12.1	12.2	10.7	10.6	10.5	10.4	10.4
Former smoker	24.7	24.7	25.4	25.5	25.5	25.6	25.6
Never-smoker	63.2	63.1	63.9	63.9	64.0	64.0	64.0
Scenario 4: CDC recommended funding							
Current smoker	12.1	12.2	11.8	11.5	11.1	10.8	10.6
Former smoker	24.7	24.7	24.9	25.0	25.2	25.4	25.5
Never-smoker	63.2	63.1	63.3	63.5	63.6	63.8	63.9

Assumes that changes in current smoking are allocated equally to former and never smoking.
Smoking prevalence rates are calibrated to the 2007 California Health Interview Survey rates.
CDC, Centers for Disease Control and Prevention.

Smoking-attributable healthcare expenditures

Smoking-attributable healthcare expenditures under the four scenarios are shown in table 2, along with the annual and cumulative savings compared to the base case scenario.

Under the base case scenario, smoking-attributable expenditures for current smokers would increase from $3.5 billion in 2011 to $4.3 billion in 2016, while expenditures for former smokers would increase from $2.8 billion to $3.2 billion over the same time period, for a total of $7.5 billion in healthcare expenditures attributable to ever-smokers in 2016.

If funding for tobacco control programs is cut in half to 2.5 cents a pack, there would be a slight worsening of the situation compared to the base case scenario. Smoking-attributable healthcare expenditures for ever-smokers would increase from $6.4 billion in 2011 to $7.6 billion in 2016. This represents an increase in smoking-attributable healthcare expenditures of $307 million over the 5 years from 2012 to 2016 compared to the base case scenario.

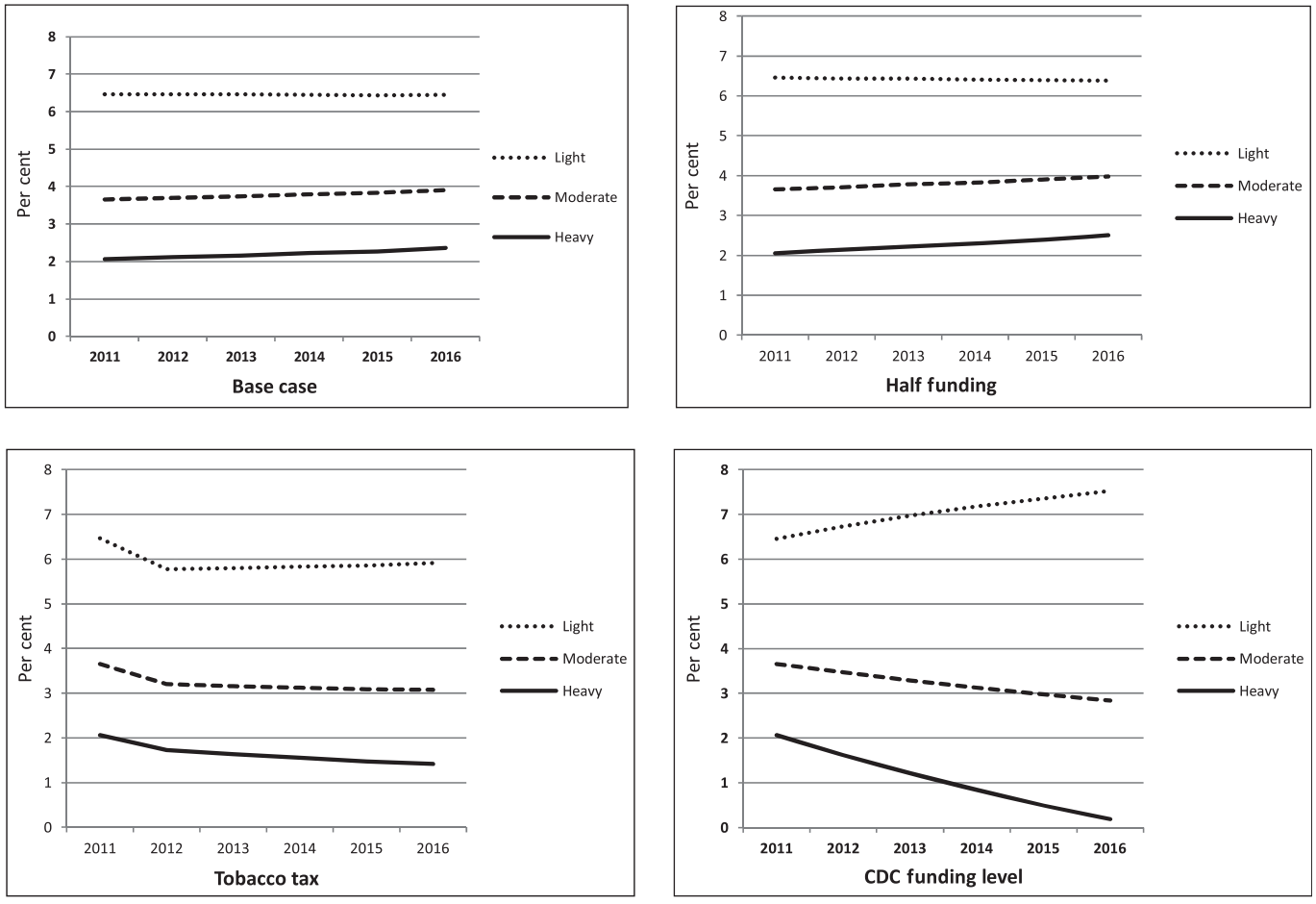

Figure 1 Smoking prevalence by intensity, four scenarios: 2011–2016. CDC, Centers for Disease Control and Prevention.

The tax increase scenario would lead to a substantial reduction in healthcare expenditures during the first year, followed by an increasing trend during 2012–2016. Compared to the base case scenario, savings per year would increase from $434 million in 2012 to $917 million in 2016, for a total savings of $3.3 billion over the 5-year period.

If funding for tobacco control programs is increased to $12.12 per capita as recommended by the CDC, there would also be a drop in healthcare expenditures in the first year, though less than under the tax increase scenario, followed by continued reduction during 2012–2016. Savings per year compared to the base case would be $310 million in 2012 and continue to increase

Table 2 Smoking-attributable healthcare expenditures under four scenarios of tobacco control funding: 2010–2016 ($ millions, 2009)

	Smoking-attributable healthcare expenditures							Savings in smoking-attributable healthcare expenditures compared to base case					
	2010	2011	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012–2016
Scenario 1: base case													
Current smokers	3498	3546	3657	3787	3940	4098	4315						
Former smokers	2812	2828	2872	2932	3006	3083	3166						
Ever-smokers (current + former)	6309	6374	6529	6719	6947	7181	7481						
Scenario 2: funding cut in half													
Current smokers	3498	3546	3677	3833	4006	4191	4435	−21	−45	−65	−93	−119	−344
Former smokers	2812	2828	2870	2927	2999	3073	3153	2	5	7	10	13	37
Ever-smokers (current + former)	6309	6374	6547	6759	7005	7264	7588	−18	−40	−58	−83	−107	−307
Scenario 3: $1.00 tobacco tax													
Current smokers	3498	3546	3131	3133	3151	3170	3237	526	654	789	927	1079	3975
Former smokers	2812	2828	2964	3040	3132	3226	3327	−92	−108	−125	−143	−162	−631
Ever-smokers (current + former)	6309	6374	6095	6173	6283	6396	6564	434	546	664	785	917	3345
Scenario 4: CDC recommended funding													
Current smokers	3498	3546	3312	3099	2906	2715	2566	345	688	1035	1383	1750	5201
Former smokers	2812	2828	2907	3003	3114	3228	3351	−35	−71	−108	−145	−185	−544
Ever-smokers (current + former)	6309	6374	6219	6102	6020	5943	5916	310	617	927	1238	1565	4657

Expenditures are excess expenditures compared to healthcare expenditures of never-smokers.
CDC, Centers for Disease Control and Prevention.

to $1.6 billion in 2016, for a total savings of $4.7 billion during 2012–2016. Compared to the tax scenario, healthcare savings are larger, even though total smoking prevalence will fall by less because the CDC funding scenario would result in a much larger reduction in heavy smoking prevalence, and the RRs of healthcare expenditures for heavy smokers are larger than the RRs for light smokers according to our estimated models.

Sensitivity analysis

We conducted a sensitivity analysis to see how our estimates of smoking-attributable healthcare expenditures under the four funding scenarios would vary with the assumption about the allocation of changes in current smoking rates to former- and never-smokers. We varied the proportion of change attributed to former smoking from 0 to 50 to 100%. Compared to the 50% case, savings estimates varied by −17% to +15%, indicating that the results are relatively insensitive to this assumption.

DISCUSSION

Our findings indicate that the CTCP has a large impact on healthcare expenditures in the state, consistent with other studies for California[10] and Arizona.[11] We find that increasing funding for the program could result in 5-year savings of as much as $4.7 billion if the CDC recommended funding level is achieved.

Lightwood *et al*[10] found that the CTCP saved $86 billion (2004 dollars) over the 16 years from 1989 to 2004, a much larger estimate than ours. There are several explanations for this difference. First, their model was based on a comparison of California with a group of 38 control states that did not have tobacco control programs, comparing the impact of the California's comprehensive tobacco control program with the complete lack of a program, whereas we compared changes in funding levels. Second, their model is based on a macroeconomic time series model that predicts aggregated California healthcare expenditures using state-level measures, while our model is based on microeconomic individual-level survey data analysis and includes individual socioeconomic characteristics. Third, their model included the impact of both active smoking and SHS exposure on healthcare expenditures and included all types of healthcare services used by adults and children in the state. We limited our analysis to healthcare expenditures attributable to active smoking for adults only, though children, adolescents and even unborn infants exposed in utero also incur excess healthcare costs as a result of smoking. Our estimates of healthcare costs included ambulatory care, prescription medications, inpatient hospitalisations and home healthcare. These categories accounted for almost 90% of healthcare costs. Including other types of costs resulting from smoking, such as nursing home care and dental care, would increase our estimates.

Our approach uses a long-run equilibrium model. The forecasts should be interpreted as indicating expected trends over 5 years, and the forecasts of year to year changes should not be over-interpreted. The short-run adjustment process may spread the change over more than one calendar year. It must be noted that the absolute levels of the forecasts are influenced by assumptions about the evolution of price, prevalence and per capita income in the control states. Thus, the forecasts are best used to compare the relative trends across scenarios for California.

Our results show an initially large reduction in smoking prevalence and smoking-attributable healthcare expenditures under the tax increase scenario. This is due to the two-prong impact of a $1.00 per pack tax increase and 20 cents per pack funding increase. The tax increase has an immediate price effect on reducing demand for cigarettes. The increased program funding would also immediately reduce smoking. However, in the longer term, it is difficult to tease out the separate effects of the tax-induced price increases and the program funding increases because they are closely interrelated. As the price increases reduce demand for cigarettes, tax revenues fall and program funding would fall. This would lead to a further change in demand, which in turn would change tax revenues and then program funding. This feedback loop makes it difficult to calculate simple measures of how much of the impact is from the tax-induced price increases and how much from the increase in program funding. Estimating the separate effect of taxes and program funding is a topic for further research.

Some limitations of our analysis should be acknowledged. First, in addition to the exclusion of the impact of SHS exposure, some age groups and some types of healthcare expenditures, we did not estimate the value of time lost from work and other productive activities due to illness or disability attributable to smoking. Second, our model is based on the well-established excess cost approach in which expenditures are compared for smokers and a hypothetical group of 'non-smoking smokers' who are the same as smokers in every way except for their smoking behaviour.[24] This approach was developed to take account of the fact that smokers and never-smokers are known to differ in ways other than smoking status. Thus, it is not appropriate to compare smokers and never-smokers by attributing all the difference in their healthcare costs to smoking only. However, there is evidence that when smokers quit, they behave differently than they did as smokers and become more similar to never-smokers,[25] for example, spending money previously used to purchase cigarettes for health improving goods and services and adopting other healthy behaviours. Assuming that smoking behaviour change will not lead to changes in an individual's other behaviours likely produces conservative estimates of the cost of smoking. The causal role of smoking in the development of 'non-smoking smoker's' other health risk behaviours is not understood well enough for a more precise analysis at this time. All these limitations suggest that we may be underestimating the impact of tobacco control funding on healthcare expenditures. Our model estimates the impact of changes on tobacco control funding in the relatively short-term. It is possible that a successful tobacco control program will result in greater longevity among quitters and smokers who smoke fewer cigarettes. This could potentially have a different impact on healthcare expenditures in the long run, as might any intervention that leads to longer life.[26] Finally, our estimates are point estimates and do not account for the sampling variability in the estimation and projection of smoking prevalence or healthcare expenditures.

CONCLUSIONS

California has one of the most successful tobacco control programs in the world. However, even if the nominal funding provided by the program is not changed, the program is in jeopardy because inflation is eroding the purchasing power of the 5 cents per pack currently allocated to tobacco control activities. Maintaining funding at the current level will lead to a gradual increase in smoking prevalence and healthcare expenditures over the next 5 years. Cutting the funding would only exacerbate the situation. If tobacco control funding is increased, smoking prevalence would decrease, especially among heavy and moderate smokers. This would lead to savings in healthcare expenditures as early as 2012. The magnitude of the changes and the timing of the changes in prevalence and healthcare expenditures depend on the amount by which tobacco control funding is changed.

What this paper adds

- Tobacco control programs implemented in many states in the USA and worldwide have successfully reduced smoking prevalence, disease rates and mortality from smoking-related diseases and healthcare expenditures. However, there has also been evidence suggesting that these programs become less effective over time.
- This study analyses the relationship between tobacco control funding and smoking prevalence and healthcare expenditures in California.
- By comparing the impact of four different funding scenarios, we found that maintaining funding at the current level will lead to an increase in smoking prevalence and healthcare expenditures due to the erosion of funding in real terms over time.
- It is necessary that funding keeps pace with inflation and that funding levels are increased in order to maintain effectiveness at reducing smoking prevalence and saving healthcare costs.

Investing in tobacco control yields substantial returns. Increasing funding per capita to the CDC recommended level in California would cost approximately $403 million per year but would reduce healthcare expenditures by $4.7 billion over the first 5 years. It is not enough to implement a strong tobacco control program. Funding levels must keep pace with inflation and be increased in order to sustain effective tobacco control programs and to continue to reduce tobacco-related illness and save healthcare dollars into the future.

Acknowledgements The authors thank Phil Gardiner, Stan Glantz and Frank Chaloupka for their helpful suggestions. John Pierce, Karen Messer and Martha White provided advice and assistance with California smoking prevalence data. We also thank Paul Tang for his help with the data analyses.

Funding This work was supported by the California Tobacco-Related Disease Research Program grant #18ST-0201.

Competing interests None.

Contributors WM obtained the funding and provided oversight on all aspects of analysis and interpretation of the data. She drafted the manuscript and approved the final version. H-YS helped design and conduct the analyses, interpret the data, prepare and revise the manuscript and approved the final version. JL designed and conducted the analyses and forecasts of smoking prevalence, helped draft the manuscript and approved the final version.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement All the data used in this study are available in public use data sets.

REFERENCES

1. **Tobacco Education Research and Oversight Committee (TEROC).** *Confronting A Relentless Adversary: A Plan for Success Toward A Tobacco-Free CALIFORNIA 2006-2008*. Sacramento, CA: California Department of Health Services, 2006. http://www.cdph.ca.gov/programs/tobacco/Documents/CTCPMasterPlan06-08.pdf (accessed 26 Sep 2011).
2. **Friend K,** Levy DT. Reductions in smoking prevalence and cigarette consumption associated with mass-media campaigns. *Health Educ Res* 2002;**17**:85—98.
3. **Messer K,** Pierce JP, Zhu SH, *et al*. The California tobacco control program's effect on adult smokers: (1) Smoking cessation. *Tob Control* 2007;**16**:85—90.
4. **Pierce JP,** Messer K, White MM, *et al*. Prevalence of heavy smoking in California and the United States, 1965-2007. *JAMA* 2011;**305**:1106—12.
5. **Messer K,** Pierce JP. Changes in age trajectories of smoking experimentation during the California Tobacco Control Program. *Am J Public Health* 2010;**100**:1298—306.
6. **Fichtenberg CM,** Glantz SA. Association of the California tobacco control program with declines in cigarette consumption and mortality from heart disease. *N Engl J Med* 2000;**343**:1772—7.
7. **Gilpin EA,** Messer K, White MM, *et al*. What contributed to the major decline in per capita cigarette consumption during California's comprehensive tobacco control programme? *Tob Control* 2006;**15**:308—16.
8. **Barnoya J,** Glantz SA. Association of the California tobacco control program with declines in lung cancer incidence. *Cancer Causes Control* 2004;**15**:689—95.
9. **Pierce JP,** Messer K, White MM, *et al*. Forty years of faster decline in cigarette smoking in California explains current lower lung cancer rates. *Cancer Epidemiol Biomarkers Prev* 2011;**19**:2801—10.
10. **Lightwood JM,** Dinno A, Glantz SA. Effect of the California tobacco control program on personal health care expenditures.*PLoS Med* 2008;**5**:1214—22.
11. **Lightwood J,** Glantz S. Effect of the Arizona tobacco control program on cigarette consumption and healthcare expenditures. *Soc Sci Med* 2011;**72**:166—72.
12. **Givel MS,** Glantz SA. Failure to defend a successful state tobacco control program: policy lessons from Florida. *Am J Public Health* 2000;**90**:762—7.
13. **Biener L,** Harris JE, Hamilton W. Impact of the Massachusetts tobacco control programme: population based trend analysis. *BMJ* 2000;**321**:351—4.
14. **Centers for Disease Control and Prevention (CDC).** *Best Practices for Comprehensive Tobacco Control Programs—2007*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2007. http://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2007/BestPractices_Complete.pdf (accessed 27 Sep 2011).
15. **Campaign for Tobacco-Free Kids.** *A Decade of Broken Promises: The 1998 State Tobacco Settlement Twelve Years Later*. 2010. http://www.tobaccofreekids.org/content/what_we_do/state_local_issues/settlement/FY2011/StateSettlementReport_FY2011_web.pdf (accessed 28 Sep 2011).
16. **MEPS-HC Summary Data Tables Technical Notes.** Rockville, MD: Agency for Healthcare Research and Quality, May 2004. http://www.meps.ahrq.gov/survey_comp/hc_technical_notes.jsp
17. **U.S. Department of Labor, Bureau of Labor Statistics.** *Consumer Price Index Detailed Report, Table 3A—Consumer Price Index for All Urban Consumers (CPI-U): US City Average, Detailed Expenditure Categories. Various Years*. http://www.bls.gov/cpi/#tables (accessed 12 Mar 2011).
18. **Engle RF,** Granger C. Co-integration and error correction: representation, estimation, and testing. *Econometrica* 1987;**55**:251—76.
19. **Maddala GS,** Kim I-M. *Unit Roots, Cointegration, and Structural Change*. Cambridge: Cambridge University Press, 1998.
20. **Pesaran M.** Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica* 2005;**74**:967—1012.
21. **Phillips P.** *Optimal Estimation of Cointegrated Systems with Irrelevant Instruments*. New Haven, CT: Cowles Foundation, Yale University, 2006.
22. **Miller LS,** Zhang X, Novotny T, *et al*. State estimates of Medicaid expenditures attributable to cigarette smoking, fiscal year 1993. *Public Health Rep* 1998;**113**:140—1.
23. **Max W,** Sung HY, Tucker LY, *et al*. The disproportionate cost of smoking for African Americans in California. *Am J Public Health* 2010;**100**:152—8.
24. **Sloan FA,** Ostermann J, Picone G, *et al*. *The Price of Smoking*. Cambridge, MA: The MIT Press, 2001.
25. **Strine TW,** Okoro CA, Chapman DP, *et al*. Health-related quality of life and health risk behaviors among smokers. *Am J Prev Med* 2005;**28**:182—7.
26. **Miller LS,** Max W, Sung H-Y, *et al*. 2010. Evaluation of the economic impact of California's tobacco control program: a dynamic model approach. *Tob Control* 2010;**10**(Suppl 1):i68—76.

The impact of changes in tobacco control funding on healthcare expenditures in California, 2012–2016

Wendy Max, Hai-Yen Sung and James Lightwood

Tob Control 2013 22: e10-e15 originally published online January 17, 2012
doi: 10.1136/tobaccocontrol-2011-050130

Notes