The cost of smoking in California, 1993

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Abstract

The aim of the study was to develop estimates of the economic impact of smoking in each of California's 58 counties. Estimates are presented in 1993 dollars. Three measures of the economic impact of smoking were estimated. Direct cost represents the amount spent on hospital admissions, physician services, nursing home care, medications, and other services used due to smoking-related illness. Morbidity cost is the value of lost productivity resulting from smoking-related loss of work days and days not spent in other productive activity. Mortality loss results from premature death due to smoking-related illness and represents the value of productivity loss. The methodology for estimating cost involved three steps. First the smoking attributable fraction (SAF), that is, the proportion of cases or deaths that results from smoking, was estimated for each region of California for each smoking related disease. Second, the SAF was applied to the number of deaths, days lost from work or productive activity (disability), or health care expenditures. Finally, smoking related deaths or disability were valued using the human capital approach. The total cost of smoking in California was estimated to be \$10.0 billion, amounting to \$314 per Californian and \$2014 per smoker.

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Keywords: smoking costs; direct costs; morbidity costs; mortality costs; methods of cost estimation

Introduction

Cigarette smoking is a major cause of illness, disability, and premature death in California and in the United States. The health hazard of cigarette smoking has been well documented. More than 25 years ago, public interest and scientific debate prompted the Surgeon General of the Public Health Service to appoint an Advisory Committee on Smoking and Health to study the effect of smoking on the health of the US population. Since the landmark report of the Committee, published in 1964,¹ dramatic changes have occurred in the scientific knowledge base of the health hazards of smoking, in the public's knowledge of the dangers of smoking, and in the use of tobacco products.

Although there has been a substantial decline in smoking in recent years, 23 % of men and 17 % of women in California are current

smokers.² Many more people are former smokers. One way to document and assess the effect of smoking on the State is to translate into economic terms the human suffering, illness, premature mortality, and productivity loss caused by smoking. Cost estimates of smoking translate the adverse health effect of smoking into dollar terms, the universal language of decision makers and the policy arena. These estimates can be used to: (1) define the impact of cigarette smoking on health care delivery and financing and on the productivity of the population; (2) provide a basis for evaluating economic interventions, such as increases in cigarette taxes and financial incentives for not smoking; (3) provide the basis for health policy and health planning relative to tobacco control initiatives; (4) provide important testimony before state and local legislative bodies in support of non-smoking laws; and (5) provide an economic framework for programme evaluation.

California has been in the forefront of the nation in the enactment of local ordinances to control smoking in the workplace, restaurants, and public places. As of 1994, 16 counties mandate 100 % smoke-free workplaces, including restaurants, and two more exclude restaurants; 350 cities in California have enacted local ordinances to control smoking and tobacco sales in public settings.³ On 1 January 1995, a statewide law was enacted mandating smoke-free workplaces. The counties without ordinances need estimates of the economic burden of smoking to facilitate their efforts to limit smoking in public places in their jurisdictions.

This paper presents estimates of the economic cost of smoking for the state of California including estimates for each of the state's 58 counties. Estimates were originally made for 1989, and have been updated to reflect 1993 costs. Further details about the methodology and findings are contained in the original report.⁴

PREVIOUS SMOKING COST ESTIMATES FOR CALIFORNIA

Several recent reports have estimated the economic cost of smoking for California. These reports relied heavily on the national smoking attributable cost estimation methods developed by Rice and her colleagues in their 1986 landmark report.⁵ First, Kaplan and Wright⁶ prepared a report entitled *Health and economic impact of smoking: 1985*. They estimated that the total burden of smoking to Californians in 1985 amounted to \$7.1 billion. Deaths due to smoking numbered 31 072, years of potential

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life lost (YPLL) to 80 years of age amounted to 310 018, and productivity losses totalled \$2.3 billion. Kaplan and Wright also presented mortality and hospital discharge rates for all smoking related diseases in each county in California. The total economic cost of smoking in each county was not estimated.

The second cost of smoking estimates for the state were reported in the recent US Department of Health and Human Services report to Congress on *Smoking and health*⁷ which reported the following statistics for the California in 1985: total cost of smoking amounted to \$5.8 billion, deaths due to smoking numbered 28 533, and YPLL to life expectancy totalled 331 415.

Although both the reports described above used a similar approach for estimating the economic cost of smoking in California and the same relative risks of smoking associated diseases to estimate the number and cost of smoking related deaths, the results for the same year are significantly different. The number of deaths differs by 2539, or 9%, and costs by \$1.3 billion, or 23%. The reasons for the significantly differing results between the two studies are that different estimating procedures were employed. Both studies used aggregate approaches to estimating costs, but there were major differences in these approaches.

The third study of the cost of smoking in California, conducted by the authors,⁴ reported total costs amounting to \$7.6 billion in 1989, distributed as follows: direct costs \$2.4 billion, morbidity costs \$860 million, and mortality costs \$4.4 billion. Deaths attributed to smoking amounted to 42 207 and YPLL to life expectancy totalled 642 793.

The fourth report, prepared by the California Chronic and Sentinel Diseases Surveillance Program of the California Department of Health Services⁸ estimated a total of 42 177 deaths attributable to smoking in California in 1988, resulting in 416 813 years of life lost before the age of 80 years, and total mortality costs of over \$5.8 billion. For the 58 counties in California, only deaths, years of life lost, and resulting productivity losses were estimated.

The current study systematically develops detailed estimates for 1993 for each component of cost and employs the most recent applicable and reliable data available that are unique to California.

Methodology

The adverse health effect of smoking imposes an enormous economic burden on society, encompassing the costs associated with the use of medical resources and the value of losses in productivity due to illness and premature death. The cost of smoking in California includes three components: direct, morbidity, and mortality costs. The direct cost is comprised of payments, including expenditures for hospital and nursing home care, physician and other professional services, and drugs. The morbidity cost is the value of productivity lost

by persons unable to perform their usual activities or unable to perform them at full effectiveness due to illness resulting from smoking. The mortality cost is the value of productivity lost due to premature death resulting from smoking-attributable disease.

PREVALENCE *v* INCIDENCE BASED APPROACH

The prevalence based approach is used to estimate the cost of smoking in California. This method provides an estimate of the direct and indirect economic toll incurred during 1993 as a result of the prevalence of illness and the number of deaths due to smoking in that year. That is, the cumulative impact of smoking on health is considered. An alternative approach, the incidence-based approach, estimates the lifetime costs of smokers. Because state policy decisions are based on the immediate impact on smoking-related costs, the prevalence approach is used for this study. The incidence approach would be appropriate if one were comparing smokers and non-smokers across their lifetimes.

VALUING LIFE

Economists generally employ two methods of valuing human life. One is the human capital approach, refined by Rice⁹ and her colleagues.¹⁰ The second is the willingness-to-pay approach, first proposed by Schelling¹¹ and Mishan.¹² In the human capital approach, a person is seen as producing a stream of output that is valued at market earnings and the value of life is the discounted future earnings stream. Morbidity and mortality destroys labour, a valuable economic resource, by causing persons to lose time and effectiveness from work and other productive activities, forcing them out of the labour force completely, or bringing about premature death. Disease thus creates an undeniable loss to individuals and society, and it is this loss that the human capital approach attempts to measure.¹³ This method has some disadvantages. Because it values life using market earnings, it yields low values for children and the retired elderly. It also undervalues life if labour market imperfections exist and wages do not reflect true abilities. In addition, psychosocial costs, such as pain and suffering, are components of the burden of illness omitted from the human capital computation of indirect costs.

The willingness-to-pay approach values life according to what individuals are willing to pay for a change that reduces the probability of illness or death. This method could be helpful in indicating how individuals value health and life, in deriving social preferences regarding public policy, and in assessing the burden of pain and suffering, which have an intangible quality not amenable to evaluation in terms of the monetary value of resources used or forgone. A review by Robinson¹⁴ makes a strong case that the willingness-to-pay method is a fundamentally "incorrect" method of valuing life for cost-effective public policy. Robinson concludes that it is subjective and

suffers from circularity because the values placed by individuals on government health programmes are clearly influenced by those policies.

The human capital approach is still most often used in cost-benefit and cost-effectiveness analyses that seek to evaluate alternative demands for scarce health resources and promote economic rationality in health services policy, planning, and management. This approach is used in the current study of the cost of smoking in California.

INTERNALISED COSTS AND EXTERNALITIES

For policy purposes, it may be useful to know who bears the costs of smoking. Economists distinguish between costs that are internalised, that is, born by the smoker, and those that impose uncompensated burdens or externalities on others. Because data on payer source were not available for California, and because our purpose was to measure the total burden of smoking regardless of who bears this burden, we did not make this distinction.

DISCOUNT RATE

A discount rate is used to convert a stream of earnings into a present value equivalent. The rate used reflects the trade off between the value of a dollar today and a dollar tomorrow. The higher the discount rate, the lower the present value of a given stream of earnings. The calculation of the present value of lifetime earnings raises questions about the importance of discounting and choosing the appropriate discount rate. From the economist's viewpoint, the arithmetical sum of lifetime earnings overstates the present value of an individual. Determining the present value of the future earnings stream is the correct way to measure economic value over a period of time; discounting converts a stream of earnings into its present value. Economists agree that comparisons of streams of earnings over varying time spans should employ the process of discounting and that benefits of public projects for which cost of illness estimates are used should be discounted at the social rate of time preference, which states society's preference for present versus future consumption. Unfortunately, the social rate of time preference is unobservable and the actual value is uncertain.¹³ Discount rates between 2 and 6% are commonly used today, reflecting the subjective judgement of the analyst. Our estimates employ a mid-range estimate of 4%, with sensitivity analyses comparing the estimates resulting from using rates of 2% and 6%.

SAMMEC II

Estimates of the cost of smoking were generated using the computer software package SAMMEC II – Smoking Attributable Mortality, Morbidity, and Economic Costs.¹⁵ SAMMEC operates within the framework of LOTUS 1–2–3 with input data provided for this study for California. The methodology of SAMMEC uses

an epidemiological relative risk based approach to the estimation of prevalence costs. The estimates generated are limited by the specificity of the input data available for the region under study. The program was used to generate estimates for 18 regions in California. The regions consist of the 10 largest counties plus eight regions comprised of groups of the remaining 48 counties. The regional estimates were then disaggregated into 58 county estimates.

SMOKING ATTRIBUTABLE FRACTIONS

The estimation of the three measures of economic burden is based on a common methodology. It is first necessary to estimate the smoking attributable fraction (SAF) for each smoking related disease. The SAF is the proportion of cases or deaths that can be attributed to smoking. Two types of data are used in the calculation of the SAF: relative risk and the smoking prevalence rate. Relative risk is the ratio of rates of illness or death in the exposed population compared to the non-exposed population. The smoking prevalence rate is the percentage of smokers in the group under study, in this case California smokers. Current smoking rates for California are from a survey of cigarette smoking behaviours and attitudes among Californians conducted between June 1990 and July 1991 by the University of California, San Diego and Westat Corporation under contracts with the California Department of Health Services and the County of Los Angeles.² Separate samples were drawn to be representative of each of the 10 counties in California with the largest population, and the remaining counties were grouped into eight regions with separate samples for each region. Smoking use rates for the eight regions were applied to each of the counties within the regions.

Given relative risk and smoking prevalence rates, the smoking attributable fraction is calculated using an adaptation of the standard epidemiological formula for attributable risk.¹⁶ That is,

$$\text{SAF} = \frac{[(p_0 + p_1(\text{RR}_1) + p_2(\text{RR}_2)) - 1]}{[(p_0 + p_1(\text{RR}_1) + p_2(\text{RR}_2))]}$$

where

p_0 = percentage of never-smokers in region

p_1 = percentage of current smokers in region

p_2 = percentage of former smokers in region

RR_1 = relative risk for current smokers relative to never smokers

RR_2 = relative risk for former smokers relative to never smokers

The SAF is then applied to the cost component being estimated to determine what proportion of costs can be attributed to smoking. Costs were updated to 1993 using the percent change in national health expenditures for direct costs, and the percent change in the index of hourly earnings for indirect costs. The estimation of each component is discussed next.

DIRECT COST

The smoking attributable direct cost is the proportion of health care expenditures that results from smoking. Two measures of relative risks are estimated, based on 1987 National Health Interview Survey data: the relative rates of hospital admission and physician visits for current, former, and never-smokers. Only persons of 35 years and older with neoplasms, cardiovascular disease, and respiratory diseases were included. The relative rates of hospital admission were used to calculate the SAF for hospital care, nursing home care, and other professional services. The relative rates of physician visits were used to calculate the SAF for physician visits and medication costs. The SAF was then applied to state level expenditures.

MORBIDITY COST

The smoking attributable morbidity cost is the value of lost income and productivity for persons who are unable to work or participate in productive activities due to smoking related illness. Two morbidity indicators – work loss days and bed disability days – are used to estimate the SAF. Data from the 1987 National Health Interview Survey were used to estimate the work loss days per 100 currently employed persons and bed disability days per 100 persons keeping house for current, former, and never-smokers. Relative rates of disability for current smokers and former smokers compared with never-smokers were calculated. These relative risk rates were then used to calculate the SAF.

Because region level data on morbidity costs are not available, these two measures were next converted to a rate per 1000 persons, which was applied to region population to estimate total work loss and bed disability days (total disability days). Next, total disability days were multiplied by the SAF to obtain an estimate of smoking related disability days. Finally, smoking related disability days were multiplied by mean daily productivity losses, which consider both labour market earnings and an imputed value for housekeeping services.

MORTALITY COST

Estimating mortality cost consists of first determining which deaths are attributable to smoking related diseases, and then valuing the resulting loss of lives.

Deaths attributed to smoking

Deaths attributed to smoking are the proportion of total deaths that can be regarded as causally linked to smoking. The relative risks used for the calculation of the SAF are taken from the 25th Anniversary Report of the Surgeon General of the United States.¹⁷ SAMMEC includes relative risk estimates for 22 smoking related diseases of adults (that is, 35 years and over) and relative risk estimates for four perinatal conditions (that is, children under one year of age conditions).¹⁵ Also

included are deaths from passive smoking and burns.

Productivity losses

Productivity losses are the current monetary value of future output lost due to premature death from smoking. If individuals had not died prematurely, they would have continued to be productive for a number of years. The estimated losses or value to society of all deaths is the product of the number of deaths attributed to smoking and the discounted value of an individual's earnings with sex and age taken into account. This method of derivation takes into consideration life expectancy for different age and sex groups, changing patterns of earnings at successive ages, varying labour force participation rates, imputed value for housekeeping services, and the appropriate discount rates to convert a stream of costs or benefits into its present worth.

Results**PREVALENCE**

In 1992, 4.3 million Californians smoked.² This includes 204000 adolescents aged 12 to 17: 93000 boys and 111000 girls. More men than women smoked (2398000 v 1926000) and most adult smokers were aged 25–44 years. Over six million additional Californians were former smokers, who may continue to experience the health effects of smoking.

TOTAL COST

The total cost to California of the health effects of smoking in 1993 amounted to \$10.0 billion, the equivalent of \$314 per resident and \$2014 per smoker, as shown in table 1. The direct costs represented 36 % of the total, morbidity costs were 10 %, and mortality costs were 54 %.

The cost of smoking for males in 1993 was \$7.0 billion compared to \$3.0 billion for females, as shown in table 1 and in the figure. The higher costs for males reflect the fact that men are more likely to be current or former smokers, and that men are more likely to be in the labour market and have higher earnings. On a per smoker basis, the total cost for men is nearly twice the cost for women, and the health care costs alone are 1.7 times greater for men than for women.

DIRECT COST

The direct costs were \$3.6 billion, with more than two thirds of these direct costs (70 %) going for expenditure on hospital admissions. Smoking is responsible for 1 in 20 hospital dollars and 1 in 20 dollars spent on nursing home care in the state. While the direct costs for men were over twice that of women, smoking related expenditures per smoker were greater for women for physician services, nursing home care, and medications. This reflects the greater longevity of women and the fact that they tend to visit physicians more often.

Table 1 Cost of smoking by type of cost and gender, California, 1993

Type of cost and gender	Amount (thousands)	Percent distribution	Per resident	Per smoker
Total	\$9960844	100.0	\$313.80	\$2014.00
Direct cost	3584107	36.0	112.91	724.69
Hospital	2522226	25.3	79.46	509.97
Physician	615241	6.2	19.38	124.40
Nursing home	229874	2.3	7.24	46.47
Medication	180354	1.8	5.68	36.47
Other professional	36412	0.4	1.15	7.37
Indirect cost	6376737	64.0	200.89	1289.32
Morbidity	1040673	10.4	32.78	210.42
Mortality*	5336064	53.6	168.11	1078.90
Men, Total	6984360	100.0	439.54	2509
Direct cost	2450906	35.1	154.24	880.51
Hospital	1951109	27.9	122.79	700.98
Physician	293934	4.2	18.50	105.60
Nursing home	101274	1.5	6.37	36.38
Medication	83915	1.2	5.28	30.14
Other professional	20673	0.3	1.30	7.42
Indirect cost	4533455	64.9	285.30	1628.72
Morbidity	679457	9.7	42.76	244.11
Mortality*	3853997	55.2	242.54	1384.62
Women, Total	2976483	100.0	187.74	1376
Direct cost	1133202	38.1	71.48	524.05
Hospital	571117	19.2	36.02	264.11
Physician	321307	10.8	20.27	148.59
Nursing home	128600	4.3	8.11	59.47
Medication	96439	3.2	6.08	44.60
Other professional	15739	0.5	0.99	7.27
Indirect cost	1843282	61.9	116.26	852.42
Morbidity	361216	12.1	22.78	167.04
Mortality*	1482066	49.8	93.48	685.38

Note: Numbers may not add to total due to rounding.
* Discounted at 4%.

Figure 1 Cost of smoking by type of cost and gender, California 1993 (billions)

MORBIDITY COST
Morbidity costs of \$1.0 billion indicate that smokers lose many days from productive activities. Losses amounted to \$244 per male smoker and \$167 per female smoker.

MORTALITY COSTS
The value of lost productivity from smoking related deaths in 1993 dollars was \$5.3 billion, or \$125830 per death using a discount rate of 4%. This amounts to \$168 for each resident of the state and \$1079 for each smoker. At a discount rate of 2%, the values are \$6.2 billion or \$149000 per death; and at 6% the values are \$4.6 billion and \$111000 respectively. Fully 44% of the losses are from deaths due to cardiovascular diseases, followed by neoplasms (40%), and respiratory disease (13%).

COST BY COUNTY
Table 2 contains estimates of the total and per resident direct, morbidity, and mortality costs updated to 1993 for each of California's 58 counties. The total cost of nearly \$10 billion is distributed unequally among counties. The three counties that incur the greatest smoking related costs – Los Angeles, San Diego, and Orange – are all large populous southern California counties with relatively high smoking prevalence rates. They account for 45% of the state population, and nearly half of the state smoking costs, and Los Angeles County total costs are four times those of San Diego County, the second most costly county. At the other extreme, the counties that incurred the lowest costs (excluding statistically unreliable estimates) are sparsely populated mountain counties – Mariposa, Colusa, and Plumas counties.

Table 2 Cost of smoking by California county, 1993

County	Total	Total cost (\$thousands)			Cost per resident (\$)			
		Direct	Morbidity	Mortality*	Total	Direct	Morbidity	Mortality
California	9960844	3584107	1040673	5336064	314	113	33	168
Alameda	479272	158364	42998	277910	358	118	32	208
Alpine†	189	122	66	1	157	102	55	1
Amador	11063	3676	1549	5838	335	111	47	177
Butte	66379	22222	7853	36304	336	112	40	184
Calaveras	13909	3930	1643	8336	376	106	44	225
Colusa	7002	1952	692	4359	398	111	39	248
Contra Costa	242915	75169	28756	138990	282	87	33	161
Del Norte	9002	2382	845	5776	316	84	30	203
El Dorado	34751	12118	5076	17556	244	85	36	123
Fresno	206591	78386	21528	106677	279	106	29	144
Glenn	9396	2537	897	5962	355	96	34	225
Humboldt	50338	12413	4393	33532	398	98	35	265
Imperial	35536	10351	3616	21568	270	79	27	164
Inyo	8834	2446	855	5534	470	130	45	294
Kern	185100	51905	18135	115060	303	85	30	188
Kings	32669	8770	3065	20834	290	78	27	185
Lake	23206	6526	2309	14371	414	117	41	257
Lassen†	6299	2815	1002	2482	215	96	34	85
Los Angeles	3111867	1241010	279748	1591110	338	135	30	173
Madera	30216	9690	2657	17869	289	93	25	171
Marin	73987	25497	9940	38550	306	106	41	160
Mariposa	4670	1538	645	2487	288	95	40	154
Mendocino	28483	9087	3215	16181	339	108	38	192
Merced	57357	19787	5428	32143	293	101	28	164
Modoc†	3544	1163	412	1969	344	113	40	191
Mono†	1992	1071	375	546	183	98	34	50
Monterey	89982	30109	10568	49305	238	80	28	130
Napa	37189	11454	4468	21267	316	97	38	181
Nevada	25194	8561	3575	13057	293	99	42	152
Orange	758892	312023	74979	371890	295	121	29	144
Placer	54238	16402	6857	30980	275	83	35	157
Plumas	7173	2528	896	3749	338	119	42	177
Riverside	399849	117204	40462	242184	299	88	30	181
Sacramento	393089	151339	36981	204769	349	135	33	182
San Benito	10624	3293	1159	6172	259	80	28	151
San Bernardino	470239	147318	44974	277948	298	93	29	176
San Diego	788658	278470	137759	372429	296	104	52	140
San Francisco	342444	150644	27942	163857	457	201	37	219
San Joaquin	158011	38732	16189	103090	304	75	31	198
San Luis Obispo	62818	20897	7116	34806	272	90	31	151
San Mateo	196051	60574	23805	111672	287	89	35	164
Santa Barbara	95807	33180	11292	51334	247	86	29	132
Santa Clara	408911	157301	46385	205225	260	100	29	130
Santa Cruz	63261	22529	7899	32833	266	95	33	138
Shasta	62852	16183	5722	40947	387	100	35	252
Sierra†	1612	355	149	1107	474	105	44	326
Siskiyou	19596	5222	1848	12526	431	115	41	275
Solano	102242	27132	10662	64448	274	73	29	173
Sonoma	122190	37884	14758	69548	293	91	35	167
Stanislaus	137301	45284	12439	79579	334	110	30	194
Sutter	23235	5545	2314	15377	322	77	32	213
Tehama	21420	5637	1993	13790	395	104	37	254
Trinity†	5483	1629	578	3277	403	120	42	241
Tulare	108611	29808	10413	68391	313	86	30	197
Tuolumne	18774	4961	2079	11734	356	94	39	223
Ventura	171195	60191	20490	90514	244	86	29	129
Yolo	45770	12362	4374	29034	306	83	29	194
Yuba	23565	4430	1852	17282	372	70	29	273

Note: Numbers may not add to total due to rounding.
* Discounted at 4%.
† Coefficient of variation for these counties exceeds 30%; estimates may not be reliable.

Considerable variation in smoking cost per resident occurs (based on statistically reliable estimates) among the 58 counties in California, ranging from \$470 per resident in Inyo County to \$238 per resident in Monterey County.

LIMITATIONS OF THE DATA

While these estimates are based on the best available data for California, a number of limitations must be acknowledged. If smokers are less health conscious than other Californians, then other risk factors such as obesity and alcohol consumption may account for some of smokers' health care costs. Smoking behaviour needs to be modelled in more detail; ideally a measure of pack-years of exposure

should be developed. Furthermore, socio-economic status and access to health care should be considered. Scientists are only beginning to understand the full impact of exposure to secondhand smoke on health. While there are no datasets for California that permit one to incorporate all these factors into a more detailed model of smoking behaviour, better data do exist at the national level. In our ongoing analysis of the health effects of smoking in the USA, based on the National Medical Expenditure Survey,¹⁸ we found that after modelling the interrelationships among the factors discussed above, the cost of smoking is much greater than previously estimated. For example, national medical expenditures attributed to smoking comprised 7.1% of total

personal health care spending; our comparable estimate for California is 5.1 %, indicating that the direct cost estimates presented here are understated. As better data become available for California, the estimates can be refined.

Discussion

While the prevalence of smoking has been declining over time, 4.3 million Californians still smoke. The health effects of smoking cost Californians nearly \$10 billion in 1993 or \$314 for each resident of the state. These estimates are conservative for several reasons. We have not taken into account property losses to fire caused by smoking, automobile accidents, or the non-health-sector costs, such as transportation to providers, and costs incurred by industry for environmental and safety investments. More importantly, we have used the human capital approach in this study rather than the willingness to pay approach which would yield much higher estimates for values of life. Based on 29 studies, Miller¹⁹ estimated that the willingness to pay to save one life ranged from \$1.0 million to \$3.0 million in 1985, with a mean of \$1.95 million. In 1985, the present value of lifetime earnings for males aged 25–29 amounted to \$749 695 and for females aged 20–24 it amounted to \$578 481; the amounts were lower for all other age groups.²⁰

Large county differentials exist in both total costs of smoking and cost per resident. Given the limited resources available for tobacco control policies, policy makers should target programmes to those counties where there is the greatest potential to reduce costs.

Several proposals have been put forward at the federal level to increase the tax on cigarettes in order to finance major health care reform. Proposition 99, which raised the tax per pack of cigarettes in California from 10 cents to 35 cents per pack on 1 January 1989 does not come close to taxing the full costs of smoking. If California smokers were to pay for the cost of health care related to smoking, the price of each pack of cigarettes would have to increase by \$1.82. If productivity losses were also included, the price per pack would rise by an additional \$3.24 to a total of \$5.06 per pack. If costs were born by smokers, each smoker would have to pay \$2014 per year, including \$725 in health care costs alone.

The question has been raised as to whether smokers are paying for their smoking habits and therefore should not be taxed further. Two recent studies compared medical costs of smokers with savings resulting from their shorter life expectancy. Hodgson²¹ concludes that on balance, "smokers incur higher expenditures for medical care over their lifetimes than never-smokers". Manning and colleagues used data from the National Health Interview Survey and the Rand Health Insurance Experiment to estimate the cost imposed by smokers on others, including increased medical care and life insurance as well as reduced Social Security and pension payments.²² They find that at a discount rate of 5 %, the net cost

is 15 cents per pack of cigarettes. Both of these studies looked at lifetime costs while our study uses a prevalence approach so that our results cannot be compared with their findings. Data are not available in California to permit us to distinguish the costs that are not internalised by the smoker, but our other work suggests that 43 % of the direct costs are born by public sources.¹⁸

Cigarette sales in California amounted to \$3.9 billion in 1993, compared to \$10.0 billion for the adverse health costs of smoking. While sales and smoking prevalence are declining over time, it will be many years before the health costs decline because of the cumulative and in many cases irreversible impact of smoking on health.

Because cigarette smoking is known to be the leading preventable cause of illness and premature death, policy makers must continue to push legislation and ordinances that encourage people to quit or to never take up smoking in the first place. Estimates such as those presented in this paper are useful in the discussion of the form these tobacco control policies should take.

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- 1 US Department of Health, Education, and Welfare. *Smoking and health. Report of the advisory committee to the Surgeon General of the Public Health Service*. Washington, DC: Public Health Service, Centers for Disease Control, 1964. (DHHS Publication No (PHS) 1103.)
- 2 Pierce J, Farkas A, Evans N, Berry C, Choi W, Rosbrook B, et al. *Tobacco use in California 1992. A focus on preventing uptake in adolescents*. Sacramento, CA: California Department of Health Services, 1993.
- 3 Americans for Nonsmokers' Rights. *Unpublished data on tobacco control ordinances*. Berkeley, CA, 1994.
- 4 Rice D, Max W. *The cost of smoking in California, 1989*. Sacramento, CA: California Department of Health Services, 1992.
- 5 Rice D, Hodgson T, Sinsheimer P, Browner W, Kopstein A. The economic costs of the health effects of smoking, 1984. *Milbank Memorial Fund Q* 1986; 64: 489–547.
- 6 Kaplan G, Wright W. *Health and economic impact of smoking, California, 1985*. Sacramento, CA: California Department of Health Services, 1988.
- 7 US Department of Health and Human Services. *Smoking and Health: a national status report. A report to Congress*. Rockville, MD: US Public Health Service, 1990. (DHEW Publication No (CDC) 87-8396, Revised 02/90.)
- 8 California Department of Health Services. *Health and economic impact of smoking: California, 1988*. Sacramento, CA: California Chronic and Sentinel Diseases Surveillance Program, 1992. (Technical Report No 5.)
- 9 Rice DP. Estimating the cost of illness. *Health Economics Series*, No 6. Publication No 947-6. Washington, DC: US Department of Health, Education, and Welfare.
- 10 Rice DP, Hodgson TA, Kopstein AN. The economics of illness: a replication and update. *Health Care Financing Rev* 1985; 7: 61–80.
- 11 Schelling TC. The life you save may be your own. In: Chase SB, ed. *Problems in public expenditures analysis*. Washington DC: Brookings Institution, 1968: 127–76.
- 12 Mishan EJ. *Cost-benefit analysis*. Boston, MA: Unwin Hyman, 1988.
- 13 Hodgson TA, Meiners M. Cost-of-illness methodology: a guide to current practices and procedures. *Milbank Memorial Fund Q* 1982; 60: 429–62.
- 14 Robinson JC. Philosophical origins of the economic value of life. *Milbank Memorial Fund Q* 1986; 64: 133–55.
- 15 Shultz J, Novotny T, Rice D. *SAMMEC II: Computer software and documentation*. Atlanta, Georgia: Centers for Disease Control, Office on Smoking and Health, 1990.
- 16 Lilienfeld A, Lilienfeld D. *Foundations of epidemiology*. Oxford: Oxford University Press, 1980.
- 17 US Department of Health and Human Services. *Reducing the health consequences of smoking: 25 years of progress. A report of the Surgeon General, 1989*. Atlanta, Georgia: Centers for Disease Control, Office on Smoking and Health, 1989. (DHHS Publication No (CDC) 89-8411.)
- 18 Bartlett J, Miller L, Rice D, Max W. Medical care expenditures attributable to cigarette smoking – United States, 1993. *Morbidity and Mortality Weekly Report* 1994; 43(26): 469–72.

- 19 Miller TR. *Narrowing the plausible range around the value of life*. Washington, DC: Urban Institute, 1989.
- 20 Rice DP, MacKenzie EJ and Associates. *The cost of injury in the United States. A report to Congress 1989*. San Francisco, CA: Institute for Health and Aging, University of California and Injury Prevention Center, The Johns Hopkins University, 1989.
- 21 Hodgson TA. Cigarette smoking and lifetime medical expenditures. *Milbank Q* 1992; 70: 81-125.
- 22 Manning WJ, Keeler EB, Newhouse JP, Sloss EM, Wasserman J. The taxes of sin. Do smokers and drinkers pay their way? *JAMA* 1989; 261: 1604-9.