Estimating the burden of smoking:
premature mortality, morbidity, and costs

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Abstract

Estimation of the burden of disease attributable to smoking has now become standard in documenting the impact of the tobacco epidemic and in motivating tobacco control. This paper addresses the methods used to estimate the attributable burden of mortality and the related estimation of morbidity and economic costs. Estimates of attributable mortality and morbidity for the Americas range widely, reflecting the maturity of the tobacco epidemic. The estimates are highest for the United States, and lower for Mexico and other countries of the Americas.

Keywords: tobacco use; smoking; economic costs; mortality; morbidity; United States; Mexico

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Resumen

La medida del impacto de la epidemia de tabaquismo y la promoción del control del tabaco ha sido el estándar para estimar la carga total de enfermedades atribuible al consumo de tabaco. Este artículo estudia los métodos usados para estimar la mortalidad atribuible al consumo de tabaco, así como su morbilidad y los costos económicos. La mortalidad y morbilidad atribuible para la población de los Estados Unidos varía ampliamente, lo que refleja la madurez de la epidemia de tabaquismo. Las estimaciones para los Estados Unidos son altas, y más bajas para México y otros países de América.

Palabras clave: consumo de tabaco; fumar; costos económicos; mortalidad; morbilidad; Estados Unidos; México

Estimation of the disease burden associated with causal risk factors is now a common practice in translating epidemiological evidence into policy. The general approach was first developed to describe how much lung cancer is caused by cigarette smoking. In 1953, Levin published a landmark paper, "The occurrence of lung cancer in man", that described one still used indicator of disease burden, the population attributable risk.[1] Levin had carried out one of the five case-control studies of lung cancer reported in 1950 and

he carefully tracked the subsequent studies.[2] In the 1953 paper, he noted that the accumulating evidence "...left little doubt that a definite association exists." He went on to propose three measures of the association of smoking with lung cancer; his third measure is now referred to as the population attributable risk. He described the index as follows: "...the indicated maximum proportion of lung cancer attributable to smoking...based on the assumption that smokers, if they had not become smokers, would have had the same incidence of lung cancer

as that found among non-smokers. This assumes that other etiological factors are equal in the two groups..." He then calculated a statistic that he referred to as "S", now generally termed the population attributable risk, based on data from four case-control studies. For each study's data, the calculation indicated that the majority of lung cancer cases were attributable to smoking, leading to his finding that: "If the latter figure is correct (note: referring to the highest estimate of 92% from the studies of Doll and Hill[3] and Wynder and Graham[4]), elimination of smoking would almost eliminate lung cancer."

Estimation of the burden of disease attributable to smoking, and to other causes of disease, has now become standard practice in public health and in translation of research findings into public policy. With regard to smoking, the estimation of disease burden has been used to indicate the urgency of preventive action and the potential magnitude of the burden of disease to be prevented. The general conceptual approach has been expanded to include the economic costs of the morbidity and mortality caused by smoking. The monetization of these costs provides evidence that can be compared to other costs familiar to policy-makers, such as the costs of health care overall or the tax revenues gained from tobacco sales. Estimates of the health costs of smoking have also been used as evidence in litigation against the tobacco industry in the United States, as the basis for recovery of costs spent on treatment of tobacco-caused illness.[5]

This paper provides an overview of the estimation of the burden of tobacco attributable mortality and morbidity with a focus on the Americas. It begins with a review of methodological approaches for estimation of the attributable mortality and morbidity and for estimation of the costs of tobacco-caused morbidity and premature mortality. The paper then reviews some of the estimates of burden and costs that have been made for the Americas, including Mexico. This paper is selective in its coverage of this topic; the 2004 report of the U.S. Surgeon General [6] and the 2004 report of the Global Bur-den of Disease project[7] provide comprehensive coverage of attributable risk estimation and Warner *et al.* address methods for cost estimation.[8]

Estimation of premature mortality and morbidity caused by smoking

The population attributable risk, as originally proposed by Levin is calculated as:

$$PAR = \frac{P_E(RR-1)}{1+P_E(RR-1)}$$

where P_E is the prevalence of the exposure and RR is the relative risk estimated for the risk factor, *e.g.*, smoking. The dependence of PAR on RR and P_E is obvious (see Table I). This formula can be extended to incorporate multiple categories of the exposure. For smoking, for example, it could include strata reflecting smoking status (never, current, or former) or other metrics of smoking exposure (amount smoked or duration of smoking).[9] The example calculations provided in the table demonstrate that a highly prevalent risk factor, even with a relatively weak association, can make a substantial contribution to disease occurrence. Similarly, a factor strongly associated with disease occurrence may make a substantial contribution to disease burden, even if the exposure is relatively uncommon.

While the calculation of PAR, as expressed above, is straightforward, there are substantial subtleties in its interpretation that have been addressed in the epidemiological literature. Greenland and Robbins[10] and others have considered some of the issues around interpretation of the concept of "attributable". For the diseases that it causes, smoking is not a "necessary" cause in the conceptual model of component causes proposed by Rothman.[11] Hence, removing smoking, equivalent to reducing P_E to zero, would not prevent the occurrence of all of the diseases caused by smoking, since lung cancer does occur in never smokers. Because smoking

Table I

POPULATION ATTRIBUTABLE RISK (PAR) IN PERCENT FOR VARIOUS VALUES OF RELATIVE RISK AND EXPOSURE PREVALENCE

		Relative Risk (RR)				
		1.5	2.0	4.0	10.0	20.0
	5	2.4	4.8	13.0	31.0	48.7
Prevalence of exposure (P_E), %	25	11.1	20.0	42.9	69.2	82.6
	50	20.0	33.3	60.0	81.8	90.5
	75	27.3	42.9	69.2	87.1	93.4

is not a necessary cause, some of the cases of disease in smokers reflect the action of other causal factors. For example, some deaths from coronary heart disease in smokers would have occurred absent smoking. For the purpose of burden calculation, the estimation is directed at those deaths that have occurred in excess because of smoking, but not at all deaths in a particular category of disease for which smoking is a cause.

The formula proposed by Levin has been widely used for calculating smoking-attributable morbidity and mortality. The U.S. Centers for Disease Control and Prevention (CDC) has developed software for its application, Smoking-Attributable Mortality, Morbidity, and Economic Costs (SAMMEC) to facilitate estimation.[12] In its application to smoking, the PAR is estimated for the various causes of death that are causally associated with smoking. Most often, an estimate of current prevalence, possibly with stratification of ever smokers as current or former, is used to estimate P_E. The RR estimates generally used in the United States and embedded in SAMMEC have come from the cohort study of over one million Americans carried out by the American Cancer Society, generally referred to as Cancer Prevention Study (CPS) II.[13] This cohort was enrolled in the early 1980s and smoking histories were obtained at that time, but not subsequently for the majority of cohort members. Consequently, the RR estimates used for PAR estimation have come from the first years of follow-up of the cohort to limit misclassification of smoking status as current smokers in the cohort becoming former smokers, paralleling the trend in the US over the same period. The cause-specific PARs are then applied to the numbers of deaths in the corresponding categories of the International Classification of Disease to obtain the numbers of premature deaths attributable to smoking.

For example, the 2004 report of the U.S. Surgeon General reports 11.9 million smoking-attributable deaths in total for the period 1965-1999 based on this method. There is substantial variation in the numbers by cause-of-death, reflecting the varying baseline rates of disease and the RR estimates (Table II). Cardiovascular diseases dominate the total because of the much higher absolute rates of cardiovascular disease compared to cancer and chronic obstructive lung disease during this period.

There are several strong assumptions embedded in using the SAMMEC approach for calculating smoking-attributable mortality. These include:

- In using current smoking prevalence for P_E, there is an assumption that the burden estimated reflects the current smoking profile rather than past or cumulative smoking of the population of interest.

- In using the RR estimates from CPS II, there is an assumption that these estimates can be extended to the population as a whole for the time period of interest. The population's distribution of amount smoked and duration of smoking might differ from that of CPS II participants.

Peto and colleagues[14] have proposed an indirect approach that uses the lung cancer mortality rate as an overall population measure of exposure to smoking. Because most lung cancer cases are caused by smoking in most countries, the lung cancer mortality rate is reflective of prior smoking and associated risk for disease. The absolute excess mortality rate for lung cancer is calculated with reference to the never smoker rate in CPS II. Using the lung cancer rate as the reference, the relative impact of smoking is calculated for other diagnostic categories, including upper aerodigestive cancers, other cancers, chronic airways obstruction, other respiratory diseases, and vascular diseases. The comparative impact of smoking on these diseases, compared to lung cancer, provides a smoking impact ratio used for PAR estimation. The most recent calculations based on this method were reported by Peto *et al.* in 2006.[15]

Beyond the attributable number of premature deaths, the burden of a risk factor is further characterized by the associated morbidity, generally expressed as years of potential life lost (YPLL) and as disability adjusted life years (DALYs).[16] The YPLL captures the extent to which disease is premature, while the DALY extends the estimation of morbidity to capture the consequences of disease occurrence for healthy life expectancy. Further details on estimation of YPLLs and DALYs are provided in the WHO health statistics and health information systems for the Global Burden of Disease.[17]

Estimation of the health costs of smoking

Estimation of the health costs of smoking is also grounded in the concept of excess risk. The calculations have the objective of estimating the additional costs of health care incurred because some people smoke within a population. The costs might be extended to include those from lesser work productivity and greater absenteeism from work and from life shortening. The argument has been made that the shorter lifespan of smokers, on average, benefit nonsmokers, since smokers draw less from pension funds or social security systems. This has been cynically referred to as "the death benefit", coming to nonsmokers from smokers, a line of reasoning that was set aside in the litigation in the United States. One

Table II
SMOKING-ATTRIBUTABLE MORTALITY IN THE UNITED STATES, 1965-1999, STRATIFIED BY GENDER*

Disease category (ICD-9 code)[†]	Males	Females	Total
Neoplasms[‡]			
Lip, oral cavity, pharynx (140–149)	145 100	36 200	181 300
Esophagus (150)	151 000	38 500	189 500
Stomach (151)	97 000	14 400	111 300
Pancreas (157)	116 500	77 100	193 500
Larynx (161)	85 000	14 600	99 600
Trachea, bronchus, lung (162)	2 286 800	812 200	3 099 000
Cervix uteri (180)	NA[§]	18 000	18 000
Urinary bladder (188)	113 900	29 700	143 600
Kidney, other urinary (189)	74 700	8 200	82 900
Acute myeloid leukemia (205.0)	21 800	4 800	26 600
Total	3 091 600	1 053 700	4 145 400
Cardiovascular diseases[‡]			
Ischemic heart disease (410–414)			
Aged 35–64 years	1 302 400	335 700	1 638 100
Aged ≥65 years	1 214 800	646 100	1 860 900
Other heart disease (390–398, 415–417, 420–429)	608 300	253 800	862 100
Cerebrovascular disease (430–438)			
Aged 35–64 years	170 400	156 100	327 200
Aged ≥65 years	175 200	134 200	309 400
Atherosclerosis (440)	145 800	61 800	207 500
Aortic aneurysm (441)	203 300	75 100	278 500
Other arterial disease (442–448)	33 000	22 300	55 300
Total	3 853 200	1 685 800	5 539 000
Respiratory diseases[‡]			
Pneumonia, influenza (480–487)	287 300	127 100	414 400
Bronchitis, emphysema (490–492)	459 000	169 800	628 800
Chronic airways obstruction (496)	694 400	419 000	1 113 400
Total	1 440 700	715 800	2 156 500
Perinatal conditions			
Short gestation/low birth weight (765)	16 700	13 300	29 900
Respiratory distress syndrome (769)	10 800	6 700	17 500
Other respiratory conditions in newborns (770)	20 600	15 400	36 000
Sudden infant death syndrome (798.0)	6 140	4 800	10 900
Total	54 200	40 200	94 400
All conditions	8 439 700	3 495 500	11 935 200

Note: All figures are rounded and hence do not add up.

* Estimates exclude deaths from residential fires caused by smoking and deaths from secondhand smoke exposure.
† International Classification of Diseases, 9th Revision.
‡ Among persons aged ≥35 years.
§ NA = Not applicable.

Source: Adapted from the 2004 report of the U.S. Surgeon General[6]

simulation study from the Netherlands showed that health care costs would be increased for the long run by successful smoking cessation.[18] Regardless, the tobacco industry profits without contributing to pay the costs of care for the diseases that its products cause.

In the United States, substantial emphasis was given to the health costs of smoking because of litigation directed at recovering expenditures for health care for disease caused by smoking.[8] During the 1990s, most states brought lawsuits against the tobacco industry to recover funds expended by the states for treatment of disease caused by smoking. Calculations were also made at the national level for the litigation brought by the U.S. Department of Justice against the tobacco industry.[19]

The target for estimation is the smoking-attributable fraction (SAF) of costs, analogous to the population attributable risk. In considering the health care expenditures attributable to smoking, the total costs for a particular smoker include: those costs for people like the smoker but who do not smoke; the additional, general costs for a smoker; and the additional costs for smoking-caused disease. In total, the latter two cost components constitute the smoking-attributable fraction or the SAF. Ideally, the SAF is estimated from data acquired during tracking of a representative cohort of smokers and non-smokers with acquisition of information on all health expenditures. In the United States, the National Medical Expenditure Survey was used for this purpose in a number of estimates made for litigation and other purposes by the various states of the United States.[20,21] This survey, carried out most recently in 1987, collected information on medical expenditures, diseases, and smoking so that the association of smoking with expenditures could be estimated. Zeger *et al.*[22] describe the use of this survey to calculate expenditures for the litigation in the State of Minnesota. Subsequently, the Medical Expenditure Panel Survey has been implemented in the United States and its data offer an updated resource for cost estimation.[19]

Estimates of burden and costs for the Americas

Diverse estimates of the smoking-attributable burden of disease have been reported for the Americas, other than those made by the U.S. CDC for the United States (Table III). The 1992 report of the U.S. Surgeon General, *Smoking and Health in the Americas*, provided estimates for 1985 for various countries in the Americas, including Mexico.[23] The methodology conceptually followed the SAMMEC approach, using CPS II RR estimates but with adjustment for the maturity of the smoking epidemic in each individual country based on the country's lung cancer mortality rate. For example, for Mexico, the RRs were scaled by a factor of 0.376, based on the lung cancer rate for Mexico. Table III provides estimates by sex; the report also provides overall estimates that are adjusted upwards for potential sources of uncounting. Overall, an estimated 526 000 deaths were attributed to tobacco use in the Americas of which 14 200 were in Mexico and 390 200 were in the United States, with the remainder coming from the other countries. The substantially lower estimate for Mexico reflects differences in population size and age structure, the maturity of the epidemic, and smoking prevalence and amount smoked. These estimates for 1985 cannot be considered as applicable to the current situation.

Using the approach of Peto *et al.*,[14] Ezzati and Lopez[24] provided estimates for the Americas by WHO subregion (AMR A comprises Canada, Cuba, and the U.S.; AMR B includes Mexico and other middle-income countries; and AMR C includes the low-income countries). The total figure, 873 000, represents an increase of about 75% from the 1985 estimate, but the methods are different. The overall total is still driven by the United States.

The INTERHEART study provides estimates for myocardial infarction, based on a uniform protocol applied in 52 countries.[25] The researchers used case-control data to estimate PAR values: 38.3% for South America and 26.1% for North America.

Beyond the estimates made for the United States (Table II), estimates have been made for a number of specific countries in the Americas, including Mexico (Table IV). Three sets of estimates of smoking-attributable mortality have been made for Mexico: 1) Those for 1985 included in the 1992 Surgeon General's Report;[23] 2) for 1992, using SAMMEC and scaling with the lung cancer mortality rate for Mexico;[26] and 3) for 2004, using the methods of the Global Burden of Disease project.[27] The estimates cannot be directly compared, given the differing methods and data sets used for estimation. They show that smoking has remained a far weaker cause of mortality in Mexico compared to the United States across the two decade span from 1985 to 2004. The comparative and sub-national analyses reported by Stevens *et al.* are particularly useful for current planning. Other risk factors—high blood glucose, obesity, high blood pressure, and alcohol—presently contribute more to premature mortality than smoking. This pattern of attributable mortality implies a need to assure that smoking does not increase, even as resources are directed to these currently stronger contributors to disease burden.

A variety of estimates of health costs are also available (Table V). Overall, the cost estimates indicate that expenditures are substantial. In the United States, with historically high smoking and attributable burden, the

Table III
SMOKING-ATTRIBUTABLE MORTALITY (SAM) BY REGIONS AND COUNTRIES OF THE AMERICAS

Source	Location	SAM in thousands of deaths (proportion of total adult mortality)	
		Male	Female
Ezzati and Lopez, 2004[7]	AMR-A	352 (28%)	294 (21%)
Year of study 2000	AMR-B	163 (15%)	58 (6%)
Ages ≥30	AMR-D	5 (3%)	1 (1%)
	Latin America	52 066 (7.1%)	12 247 (2.1%)
	Andean Area	3 584 (3.3%)	1 716 (1.8%)
	Colombia	1 784 (4%)	977 (2.5%)
	Peru	184 (0.9%)	NA
	Venezuela	1 434 (6.3%)	739 (3.9%)
	Southern Cone*	19 754 (12.4%)	2 308 (1.8%)
	Argentina	14 370 (13.1%)	1 473 (1.6%)
Surgeon's General report, 1992[23]	Chile	2 549 (8.3%)	727 (2.9%)
Year of study 1985	Brazil	17 945 (7.5%)	4 156 (2.3%)
Ages ≥35	Central America‡	431 (1.3%)	140 (0.5%)
	Mexico	4 920 (3.7%)	2 052 (1.8%)
	Latin Caribbean	3 432 (8.6%)	1 877 (3.6%)
	Cuba	4 517 (14.6%)	1 671 (6.9%)
	Caribbean	1 030 (6.2%)	218 (1.5%)
	North America§	214 696 (19.9%)	95 562 (9.5%)
	Canada	19 147 (21.1%)	6 631 (8.8%)
	USA	195 519 (19.8%)	88 928 (9.6%)
	All regions of Americas	267 792 (14.6%)	108 027 (6.7%)

AMR-A: Canada, Cuba, USA
AMR-B: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
AMR-D: Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru

* Includes Falkand Islands
‡ Excludes Belize
§ Includes Bermuda and St. Pierre and Miquelon

costs approximate 6-8% of medical expenditures.[8] These estimates are relatively robust to the estimation method. For Mexico, several estimates have been made based on review of case records at the Instituto Mexicano del Seguro Social (IMSS). At the national level, an estimated 4.3% of the IMSS budget was expended for disease costs related to smoking.[28]

Conclusions

Estimation of the burden of disease is now a well established tool for translating scientific findings into policy-relevant information. The major indicators used include morbidity, mortality, and costs. There is a long tradition of estimating the numbers of smoking-caused deaths that dates back to the 1953 paper by Levin. Three approaches have been applied based on the concept of the population-attributable risk: 1) use of the CPS II RR estimates in SAMMEC, developed by the U.S. CDC; 2) use of the lung cancer mortality rate with scaling of the CPS II RR estimates, as proposed by Peto *et al.*; and 3) the estimates made by for the Global Burden of Disease project, as proposed by Ezzati and Lopez. Cost estimates have been made using the same underlying concept. The uncertainties inherent in these estimates are recognized; in fact, the U.S. CDC is currently reas-

Table IV

Country-specific estimates of smoking-attributable morbidity and mortality

Source	Location	Total	Male	Female
		Smoking-attributable DALYs, years		
Oliveira *et al.*, 2008[30] Year of study 2000 Ages ≥30	State of Rio de Janeiro, Brazil	813 052	461 944	351 108
		Population attributable risk, %		
Ossip-Klein, *et al.*, 2008[31] Year of study 2003	Dominican Republic	NA	36.6	24.4
Kuri-Morales *et al.*, 2002[32] Year of study 1998	Mexico City, Mexico	45[a]	NA	NA
		Smoking-attributable YPLLs, years		
Correa *et al.*, 2009[33] Year of study 2003 Ages ≥35	16 Brazilian capitals	419 935	279 990	139 945
Rehm *et al.*, 2007[34] Year of study 2002	Canada	515 607	199 191	316 417
CDC, 1995[35] Year of study 1992	Mexico	40 168[‡]	25 172[‡]	14 996[‡]
Dietz *et al.*, 1991[36] Year of study 1983	Puerto Rico	19 445	15 120	4 325
CDC SAMMEC[12] Year of study 2004 Ages ≥35	United States	5 392 787	3 191 883	2 200 904
		Smoking-attributable mortality, number of deaths (proportion of total adult mortality)		
Correa *et al.*, 2009[33] Year of study 2003 Ages ≥35	16 Brazilian capitals	24 222 (13.6%)	16 896 (18.1%)	7 326 (8.7%)
Baliunas *et al.*, 2007[37] Year of study 2002	Canada	37 209 (16.6%)	23 766 (21%)	14 443 (12.2%)
Perez *et al.*, 2009[38] Years of study 1995 and 2007	Cuba	11 951 (15%) 15 083 (18%)	8 061 (19%) 10 443 (24%)	3 890 (11%) 4 640 (12%)
Ossip-Klein *et al.*, 2008[31] Year of study 2003	Dominican Republic	2 254	1 468	785
Tapia Conyer *et al.*, 1994[26] Year of study 1986 Ages >20	Mexico	17 405	NA	NA
CDC, 1995[35] Year of study 1992	Mexico	10 253	6 875	3 378
Stevens *et al.*, 2008[27] Year of study 2004	Mexico	24 336 (5.2%)	15 840 (6%)	8 815 (4.3%)
Dietz *et al.*, 1991[36] Year of study 1983	Puerto Rico	2 468 (11.5%)	1 819 (30.9%)	649 (14.6%)
CDC, 2008[39] Years of study 2000-2004 Ages ≥35	United States	NA	269 655	173 940
Rodu and Cole, 2007[40] Years of study 1987 and 2002 Ages ≥35	United States	402 000 322 000	556 000[§] 329 000[§]	175 000[§] 122 000[§]
CDC SAMMEC[12] Year of study 2004 Ages ≥35	United States	379 725	226 471	153 254

SAM=smoking-attributable mortality, PAR=population attributable risk; YPLL=years of potential life lost; DALYs=disability-adjusted life years
* PAR % for cardiovascular disease
‡ YPLL before age 65 years
§ Deaths per 100 000 person-years adjusted to the U.S. 2000 standard population

Table V
COUNTRY-SPECIFIC ESTIMATES OF SMOKING-ATTRIBUTABLE EXPENDITURES (SAE)

Source	Location, year of study	Total SAE	Comment
Single *et al.*, 1998[41]	Canada, 1992	$9.56 billion CAD (1.39% of GDP)	
Rehm *et al.*, 2007[34]	Canada, 2002	$17 billion CAD (total cost per capita: $541 CAD)	
Reynales-Shigemasu *et al.*, 2005[42]	Morelos, Mexico, 2001	$124 million MP (7.3% of annual budget) *AMI**: $80 thousand MP *COPD**: $73 thousand MP *LC**: $102 thousand MP	*Cost of diagnosis and first year of treatment
Arredondo *et al.*, 2002[43]	Mexico 2001	*COPD:* $28.5 thousand USD *CVD:* $2.533 million USD *LC:* $1.491 million USD *Full course of nicotine gum:* $79.4 thousand USD	
	2002	*COPD:* $29.1 thousand USD *CVD:* $2.626 million USD *LC:* $1.569 million USD *Full course of nicotine gum:* $83.7 thousand USD	Exchange rate: $9.40 MP per $1 USD
	2003	*COPD:* $35.4 thousand USD *CVD:* $2.643 million USD *LC:* $1.683 million USD *Full course of nicotine gum:* $114 thousand USD	
Reynales-Shigematsu *et al.*, 2006[28]	Mexico, 2004	$7.1 billion MP (4.3% of annual expenditures) *AMI:* $7.11 billion MP *Cerebrovascular disease:* $3.42 billion MP *COPD:* $1.47 billion MP *LC:* $102 million MP	Random sample of clinical files (n=1 596). In Spanish
Dietz *et al.*, 1991[36]	Puerto Rico, 1983	$55.9 million USD Total male: $38.8 million USD Total female: $17.1 million USD	
CDC, 2002[44]	United States, 1995-1999	$157.7 billion USD Per smoker = $3.4 thousand USD	
CDC, 2008[39]	Untied States, 2000-2004	$193 billion USD	
CDC SAMMEC[12]	United States, 2004	$96 billion USD+	+SAE based on Centers for Medicaid & Medicare Services, 1999.

CAD = Canadian Dollars; MP = Mexican Pesos; USD = United States Dollars; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease; LC = lung cancer; AMI = acute myocardial infarction

sessing its approach in an effort to update the RR estimates and to more clearly address uncertainty.

Estimation of attributable risks and costs has proved valuable in the United States for informing the public and policy makers as to the magnitude of the disease burden caused by cigarette smoking. The repeated designation of smoking as the cause of the largest number of avoidable premature deaths has been effective in motivating action. The cost estimates figured prominently in litigation by the States, and are also useful for motivating health care systems to seriously address tobacco use among enrollees.

There is the potential for improving estimates of the burden of smoking across the Americas. A number of countries, including Mexico and Brazil, are carrying out the new Global Adult Tobacco Survey (GATS), which will provide national data on prevalence. National cohort studies for estimation of RRs are lacking, however, and are needed given the limited applicability of the CPS II estimates across the Americas.

The available data indicate the potential for health benefits from tobacco control across the Americas. The magnitudes of the benefits vary widely from countries with only a few percent of deaths attributable to smok-

ing to the far higher U.S. estimates. Those countries that have ratified the Framework Convention on Tobacco Control, including Mexico, have made a commitment to a national program for tobacco control. These efforts will need to be sustained for decades.[29]

Declaration of conflicts of interest

I declare that I have no conflicts of interest.

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