Original research

Economic impact of smoking on health systems in Latin America: A study of seven countries and its extrapolation to the regional level*

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ABSTRACT

Objective. *Estimate smoking-attributable direct medical costs in Latin American health systems.*
Methods. *A microsimulation model was used to quantify the economic impact of cardiovascular and cerebrovascular disease, chronic obstructive pulmonary disease (COPD), pneumonia, lung cancer, and nine other neoplasms. A systematic search for epidemiological data and event costs was carried out. The model was calibrated and validated for Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru—countries that account for 78% of Latin America's population; the results were then extrapolated to the regional level.*
Results. *Every year, smoking is responsible for an estimated US$ 33.576 billion in direct costs to health systems. This amounts to 0.7% of the region's gross domestic product (GDP) and 8.3% of its health budget. Cardiovascular disease, COPD, and cancer were responsible for 30.3%, 26.9%, and 23.7% of these expenditures, respectively. Smoking-attributable costs ranged from 0.4% (Mexico and Peru) to 0.9% (Chile) of GDP and from 5.2% (Brazil) to 12.7% (Bolivia) of health expenditures. In the region, tax revenues from cigarette sales cover just 37% of smoking-attributable health expenditures (8.1% in Bolivia and 67.3% in Argentina).*
Conclusions. *Smoking is responsible for a significant proportion of health spending in Latin America, and tax revenues from cigarette sales are far from covering the costs. The countries of the region should seriously consider stronger measures, such as an increase in tobacco taxes.*

Key words   Smoking; health economics; Latin America.

Tobacco consumption is the leading cause of preventable deaths. Current estimates project 400 million deaths from smoking-attributable diseases in adults for the period 2010-2050 (1, 2). Some 80% of these deaths will occur in low- and middle-income countries (3). In Latin America, the smoking-attributable burden of disease has not substantially changed since 2004. The proportion of disability-adjusted life years (DALY) lost each year as a consequence of tobacco consumption is still very high (4).

In addition to this significant impact in terms of death and morbidity, tobacco consumption imposes a heavy financial burden, with an estimated cost of over US$500 billion worldwide (5), mainly from direct costs to the health system and lost productivity. Revenues from tobacco taxes, totaling only US$145 billion, cover less than one-third of these costs (2). Just the direct medical costs of tobacco consumption can represent losses for countries of up to 1% of their gross domestic product (GDP) and be responsible for 15% of all health expenditures (6).

Tobacco consumption disproportionately impoverishes the poorest population, in which prevalence is higher, because of their higher spending on tobacco products, their greater inability to cover health care costs, and the premature death of family breadwinners (7). Although Latin American countries have increased health investment in recent years (8), they are currently faced with a growing incidence of chronic diseases, coupled with the persistence of the health problems of developing countries. The way health systems administer and prioritize their resources today will determine future health outcomes. Countries that succeed in reducing the prevalence of tobacco consumption can reap enormous health benefits and obtain substantial reductions in social costs and health system expenditures.

Moving forward with effective tobacco control policies requires data on the health and financial consequences of the smoking epidemic, as well as information on how these consequences are distributed among individuals, families, communities, and the countries of the region. This information is useful for raising awareness, motivating decision makers to adopt new measures or intensify existing ones, and mobilizing greater resources to control the epidemic (9).

The information presented here is the product of a collaborative study by a team of more than 40 researchers and health policymakers from universities, research centers, and public institutions in Argentina, Bolivia, Brazil, Chile, Colombia, Peru, and Mexico. The objective is to estimate the financial burden, in terms of direct medical costs, that smoking represents for the health systems of Latin America.

METHODS

The study employed a decision model developed by this group that had been widely validated and evaluated in previous studies. A more detailed description can be found in Pichon-Riviere et al. (10), in publications that used or evaluated the model (11, 12), and in technical reports with findings on the burden of disease in the countries (available from www.iecs.org.ar/tabaco). This economic model was developed to evaluate both the smoking-attributable burden of disease and the cost-effectiveness of potential interventions for prevention and control. To ensure that the model was appropriate for use in Latin America and that its results would be useful for policymaking, the project began with an analysis of the availability and quality of the epidemiological and cost information, as well as a survey on the information needs of health policymakers when deciding to implement anti-tabacco interventions.

The model chosen is a state-transition or Markov microsimulation (first-order Monte Carlo) model programmed in Microsoft Excel and Visual Basic®. For each individual, the model probabilistically incorporates the natural history, costs, and quality of life associated with the principal diseases associated with smoking in adults: coronary and non-coronary heart disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), pneumonia and influenza, lung cancer, and nine other neoplasms. The subjects are followed in hypothetical cohorts and, for each time period (annual cycles), an estimate is made of the individual risk of each event and progression of disease or death, based on the demographic characteristics of the subjects, smoker status, clinical conditions, and underlying risk equations, to ultimately obtain aggregate results in terms of health and costs.

Sources of epidemiological information

An extensive review of the scientific literature was conducted in a series of databases, including MEDLINE, EMBASE, CENTRAL, SOCINDEX, EconLit, LILACS, NBER, CRD, International Tobacco Health Conference Paper Index, and the Cochrane Tobacco Addiction Review Group. This review was supplemented with a search of the gray literature to identify relevant information in ministries of health and finance, the Pan American Health Organization (PAHO), conference summaries, etc. The most recent information on smoking prevalence was obtained from Global Adult Tobacco Surveys (GATS), when available, or from national risk factor surveys. The research groups in each country provided additional information on demographic data, vital statistics, hospital discharges, and other local data to feed the model.

Due to the lack of good-quality information on the incidence of events and conditions in the region, and to develop a common methodology applicable to all the countries, the risks for each condition considered were estimated for each country, based on its mortality statistics. This methodological approach is usually employed in epidemiological and economic models used by the World Health Organization (WHO) in tools such as DisMod II, WHO-CHOICE, or GLOBOCAN (13–15). The incidence of acute events in the population by sex and age was estimated as:

$$R_{pob} = \frac{R_{muerte}}{L}$$

where R_{muerte} is mortality and L the estimated case-fatality of the event. Based on this calculation, the annual incidence in non-smokers is estimated as:

$$R_{no-fum} = \frac{R_{pob}}{(RR_{fum * f_{fum}}) + (RR_{ex-fum * f_{ex-fum}}) + f_{no-fum}}$$

where R_{pob} is the incidence in the population, RR_{fum} and Rr_{ex-fum} are the relative risk of the event in smokers and former smokers, (16) and f represents the proportions for each smoking category. In the case of cancers, the incidence by age (i) was estimated as:

$$Rdx_i = \left(\sum_{n=0}^{10} Rm_i \times P_n \right) \times \frac{1}{1-S_{10}}$$

where $R_{m(i+n)}$ is mortality at age $i+n$; P_n is the conditional probability of dying in year n after diagnosis, and S_{10} is the proportion of survivors after year 10. For less common cancer diagnoses, the incidence was estimated directly using GLOBOCAN data (14).

Sources of cost information

For each of the 15 health events included in the model, an estimate was made of the direct medical costs that make up the expenditure on all health resources used in medical care during the year in which the event occurred. For cardiovascular events and cancers, the costs of long-term follow-up (second and subsequent years) were also estimated.

In all the countries, a literature search was initially conducted to identify local studies reporting the costs of the events or relevant unit costs. Furthermore, a common costing methodology was developed that included the possibility of estimating these costs through a microcosting or macrocosting, approach, depending on the availability and quality of the information in each case. A common MS Excel® spreadsheet was designed for each event to facilitate the calculations, identifying the quantity, use rate, and unit cost of every health resource used in medical care for each event.

Ad hoc microcosting exercises were constructed, based on communications with experts, clinical guidelines, and a review of use and fee records of health care facilities.

Lung cancer costs were estimated for each country using the methodology described above. Cost estimates for the other cancers were based on the lung cancer costs. To this end, a methodology based on an expert consensus was adopted that employed the modified Delphi method. In this exercise, a group of oncology experts estimated the ratio between each of the total costs of treatment for each cancer and the cost of lung cancer.

When sufficient information was unavailable locally, extrapolation was used to approximate the costs of the events. In this case, the average of the proportion represented by the cost of the event over the per capita gross domestic product (GDP) in Argentina, Chile, and Mexico was used, and over this average proportion, the per capita GDP of the country of interest (Bolivia, Colombia, or Peru) was applied to obtain the required estimates.

All costs were first estimated in local currency, updated to 2015. For costs prior to 2015, the consumer price indexes (CPI) published by the statistics institutes of each country were used to make the adjustment. The costs were then converted to current 2015 dollars using the exchange rates published by each country's central bank (Table 1).

Calibration and validation

In each country, calibration was done by comparing the specific mortality rates predicted by the model in each sex and age group with the vital statistics. Variations of less than 10% were considered acceptable and, in the case of larger variations, the risk equations were modified until estimates fell within the desired

TABLE 1. Summary of the main parameters incorporated in the model (costs expressed in 2015 US$)

	Countries							Source
	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	
Population (≥ 35 years, in millions of individuals)	18.7	3.5	88	8.5	19.2	46.8	11.7	(a-g)
Prevalence of smoking (%)								
Men	29.6	20.0	21.6	44.2	19.5	24.8	27.6	(h-n)
Women	20.9	17.0	13.1	31.7	7.4	7.8	12.7	
Mortality (per 10 000 individuals)								
Acute myocardial infarction	39.6	39.7	84.5	34.2	111.5	105.8	66.0	
Other cardiovascular causes	111.6	18.9	37.5	75.3	31.6	17.7	30.5	
Stroke (CVA)	48.2	36.9	69.4	59.8	55.8	46.2	51.7	
Pneumonia/influenza	88.4	123.5	94.5	55.6	31.2	28.9	210.0	(m-u)
Chronic obstructive pulmonary disease (COPD)	3.1	16.6	48.8	3.3	2.6	6.6	1.8	
Lung cancer	10.1	10.5	9.7	9.1	7.5	5.2	12.0	
Other cancers	2.3	4.2	3.7	3.7	2.8	1.5	4.2	
Direct medical costs of events (US$)								
Acute myocardial infarction	4 104	5 114	5 596	4 431	4 830	5 419	2 921	
Other cardiovascular causes	3 078	3 835	5 596	3 035	1 932	3 566	2 030	
Annual monitoring of the cardiovascular patient	1 624	2 024	621	1 622	438	1 386	1 285	
Stroke (CVA)	5 435	5 232	4 719	4 978	2 738	4 604	5 549	
Annual monitoring of the patient, post-CVA	1 866	1 797	446	1 710	804	729	881	
Pneumonia/influenza	275	276	433	264	410	1 464	191	
Mild COPD	160	63	469	281	138	335	160	
Moderate COPD	379	181	914	620	361	1 001	419	
Severe COPD	5 562	3 969	2 905	6 890	4 361	10 322	4 787	
Lung cancer								
First year	22 013	8 863	15 052	24 409	13 223	15 415	15 450	
Second and subsequent years[a]	28 464	11 460	6 773	31 561	11 858	19 931	19 977	

(*Continuing*)

TABLE 1. (Cont.)

Mouth cancer								
First year	15 850	6 381	11 707	17 574	9 520	11 099	11 124	(v)
Second and subsequent years [a]	10 816	4 355	5 268	11 993	4 506	7 574	7 591	
Esophageal cancer								
First year	18 491	7 445	14 277	20 503	11 107	12 948	12 978	
Second and subsequent years [a]	12 524	5 042	6 424	13 887	5 217	8 770	8 790	
Stomach cancer								
First year	18 051	7 267	18 435	20 015	10 843	12 640	12 669	
Second and subsequent years [a]	13 663	5 501	8 296	15 149	5 692	9 567	9 589	
Pancreatic cancer								
First year	14 969	6 027	14 184	16 598	8 991	10 482	10 506	
Second and subsequent years [a]	10 247	4 125	6 383	11 362	4 269	7 175	7 192	
Kidney cancer								
First year	15 850	6 381	4 581	17 574	9 520	11 099	11 124	
Second and subsequent years [a]	11 101	4 469	2 061	12 309	4 624	7 773	7 791	
Revenues from excise taxes on tobacco (millions of current US$)	2 018.1	21.4	3 170.3	1 405.1	185.1	2 323.2	75.1	(w)
GDP (millions of current US$)	540 197.5	34 175.8	2 346 118.2	258 061.5	377 739.6	1 282 720.0	202 902.8	(x)
Total health expenditure (% GDP)	7.3	6.1	9.7	7.7	6.8	6.2	5.3	

CVA= stroke; COPD=chronic obstructive pulmonary disease; GDP= gross domestic product; US$=United States dollars.

The US$-local currency exchange rates were obtained from the central bank of each country and are as follows: US$ 1 = Arg 8.8096; Bolivia 6.96; Brazil 3.3646; Chile 626.87; Colombia 2 576.05; Mexico 15.2647; and Peru 3.0806.

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(b) Instituto Nacional de Estadísiticas de Bolivia. http://www.ine.gob.bo/indice/visualizador.aspx?ah=PC20117.htm. Accessed in February 2015.

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(f) Consejo Nacional de Población de México. Proyecciones de población. Available from: http://www.conapo.gob.mx/es/CONAPO/Proyecciones_Datos. Accessed in February 2015.

(g) Instituto Nacional de Estadística e Informática de Perú. Estimaciones y proyecciones de población, 1950-2050. Available from http://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib0466/Libro.pdf. Accessed in February 2015.

(h) Ministerio de Salud de la Nación Argentina. Tercera Encuesta Nacional de Factores de Riesgo, 2013.

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(k) Ministerio de Salud de Chile. Encuesta Nacional de Salud, 2009-2010. Available from: http://web.minsal.cl/portal/url/item/bcb03d7bc28b64dfe040010165012d23.pdf. Accessed in November 2012.

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(m) Organización Panamericana de la Salud, Instituto Nacional de Salud Pública de México. Encuesta Global de Tabaquismo en Adultos, 2009. Cuernavaca: Instituto Nacional de Salud Pública, Organización Panamericana de la Salud; 2010. Available from: http://www.who.int/tobacco/surveillance/gats_rep_mexico.pdf. Accessed 12 November 2012.

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(o) Ministerio de Salud de Argentina. Dirección de Estadística e Información en Salud (DEIS). Base de datos de mortalidad 2010. Buenos Aires: Ministerio de Salud, DEIS; 2010.

(p) Mortality Information System, Brazilian Unified National Health System (SIM-SUS. Departamento de Informática do SUS. Available from: http://www.datasus.gov.br. Accessed in February 2013.

(q) Instituto Nacional de Estadísiticas de Bolivia. Available from: http://www.ine.gob.bo/. Accessed in February 2015.

(r) Ministerio de Salud de Chile. Departamento de Estadísticas e Información de Salud (DEIS). Base de datos defunciones 2009. Available from: http://www.deis.cl. Accessed in November 2012.

(s) Departamento Nacional de Estadística de Colombia (DANE). Proyecciones de población, 2012.Available from: http://190.25.231.242/cgibin/RpWebEngine.exe/PortalAction?&MODE=MAIN&-BASE=CG2005BASICO&MAIN=WebServerMain.inl. Accessed in November 2012.

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(u) Oficina General de Estadística e Informática. Ministerio de Salud de Perú. Datos de 2010. Available from: http://www.minsa.gob.pe/portada/estadistica/publicaciones.htm. Accessed in February 2015.

(v) Own estimate, based the information sources and methods described under the cost estimation heading in the METHODS section.

(w) Estimate for 2015, based on data from the countries. Argentina: Informe de Recaudación de la Administración Federal de Ingresos Públicos (AFIP). Bolivia: own estimate based on Boletín de Ingresos Tributarios 2013 of the Ministry of Economy and Finance. Brazil: Arrecadão de Tributos Federais 2014/2015 de la Receita Federal. Chile: Serie de Ingresos Tributarios Anuales del Servicio de Impuestos Internos (SII). Colombia: estimate by Fundación Anáas, based on DANE, DIAN, and Ministry of the Treasury. Mexico: Ingresos Presupuestarios del Gobierno Federal, Secretaría de Hacienda y Crédito Público (SHCP). Peru: estimation by National Standing Committee to Fight Smoking (COLAT) according to the National Superintendency of Tax Administration (SUNAT).

(x) World Development Indicators, The World Bank. Available from: http://data.worldbank.org/data-catalog/world-development-indicators. Accessed in November 2015.

[a] Up to a maximum of five years. In the sixth year, survivors are assumed to have completed their treatment.

range. External validation was done by comparing the results of the incidence and mortality predicted by the model for different conditions with clinical and epidemiological studies that had not been used in the model's equations.

Estimation of the burden of disease

The burden of disease was estimated as the difference in events and costs between the results predicted by the model for each country with the current smoking prevalence and the results predicted for a cohort of non-smokers in the same country. The model does not include a direct estimate of the effects of passive smoking and perinatal disease; these were estimated as an additional burden of 13.6% in men and of 12% in women, based on approximations from other studies (17). Data was collected and the model calibrated for seven countries in the region representing 78.3% of Latin America's population. The results obtained in these seven countries were used to extrapolate the expected burden of disease in the rest of the region proportionally to the population.

RESULTS

The literature search and data collection in each of the countries made it possible to identify the parameters to incorporate in the model. These, together with their sources, are summarized in Table 1, which presents data on smoking prevalence, mortality from the 15 events included for each country, and the cost of the events, national revenues from tobacco taxes, GDP, and the percentage of health expenditure.

Once the calibration process in each country had concluded, the average rate of each event predicted by the model was found to be within 10% of the corresponding rate reported in the national statistics. Evaluation of the correlation between the observed and expected results yielded R^2 values ranging from 0.700 to 0.999 (perfect adjustment = 1), indicating a high degree of correlation. The external validation also showed a very good correlation between the predicted results and those observed in the studies.

The results showed that health problems associated with tobacco consumption represented a direct cost to Latin America's health systems of US$87 billion. Smoking was responsible for 39% of this total, representing an attributable cost of US$33.576 billion. Table 2 presents the data stratified by sex and country. The proportion of the cost of diseases associated with tobacco consumption that is directly attributable to smoking ranged from 28% in Bolivia to 49% in Chile and was generally higher in men than in women. This reflects differences in smoking prevalence rates, among other factors. In Mexico, for example, only 19% of

TABLE 2. Direct medical costs of health problems associated with smoking and fraction attributable to smoking by gender in Latin America (millions of US$, 2015)

| | Total | Attributable to smoking | | | | | |
| | | Men | | Women | | Total country | % (Total country/ Total) |
		US$ (millions)	%	US$ (millions)	%		
Argentina	10 101.92	2 653.09	43	1 133.67	29	3 786.77	37
Bolivia	944.73	147.00	31	116.99	24	264.00	28
Brazil	28 372.69	8 756.90	49	3 184.19	30	11 941.09	42
Chile	4 527.13	1 457.27	52	758.51	43	2 215.78	49
Colombia	6 998.18	1 486.36	37	653.37	21	2 139.72	31
Mexico	14 970.24	4 147.97	42	962.14	18	5 110.11	34
Peru	2 177.08	566.30	45	257.39	27	823.69	38
Rest of countries[a]	18 898.98	5 333.11	45	1 961.25	27	7 294.35	39
Total	86 990.95	24 547.99	45	9 027.51	27	33 575.50	39

[a] Estimate based on data from the seven countries included in the model.
US$=United States dollars.

TABLE 3. Direct medical costs attributable to smoking, by cause and country (millions of US$, 2015)

| | Heart disease | | CVA | | COPD | | Pneumonia/ influenza | | Lung cancer | | Other cancers | | Passive smoking and other causes | | Total | |
	Subtotal	%	Subtotal	%	Subtotal	%	Subtotal	%	Subtotal	%	Subtotal	%	Subtotal	%	Total	%
Argentina	1 109.00	29.3	282.98	7.5	572.01	15.1	7.06	0.2	704.52	18.6	672.10	17.7	439.09	11.6	3 786.77	100.0
Bolivia	71.04	26.9	78.58	29.8	34.63	13.1	2.76	1.0	15.44	5.8	31.42	11.9	30.13	11.4	264.00	100.0
Brazil	3 615.22	30.3	749.11	6.3	3 598.95	30.1	54.91	0.5	819.50	6.9	1 713.87	14.4	1 389.52	11.6	11 941.09	100.0
Chile	462.60	20.9	256.90	11.6	516.41	23.3	1.64	0.1	370.32	16.7	352.17	15.9	255.73	11.5	2 215.78	100.0
Colombia	839.18	39.2	211.27	9.9	430.23	20.1	3.90	0.2	165.03	7.7	242.17	11.3	247.95	11.6	2 139.72	100.0
Mexico	1 775.60	34.7	151.11	3.0	1 680.59	32.9	31.19	0.6	419.68	8.2	452.28	8.9	599.67	11.7	5 110.11	100.0
Peru	101.52	12.3	99.04	12.0	242.00	29.4	4.67	0.6	93.42	11.3	187.68	22.8	95.37	11.6	823.69	100.0
Rest of countries[a]	2 213.23	30.3	507.64	7.0	1 963.62	26.9	29.46	0.4	718.27	9.8	1 913.53	13.9	848.60	11.6	7 294.35	100.0
Total	10 187.38	30.3	2 336.62	7.0	9 038.44	26.9	135.59	0.4	3 306.16	9.8	4 665.22	13.9	3 906.08	11.6	33 575.50	100.0

[a] Estimate based on data from the seven countries included in the model.
CVA=stroke; COPD=chronic obstructive pulmonary disease.

the costs of the related health problems are attributable to smoking in women, while in Chile, the figure is 53% in men.

For further details on which pathologies account for the highest proportions of attributable costs, Table 3 presents a breakdown of the costs by category. It can be observed that for the region as a whole, heart disease and COPD were responsible for the highest proportion of smoking-attributable health costs, with 30% and 27%, respectively. The two pathologies account more than US$19 billion, followed by neoplasms (nearly 24% and US$8 billion) and CVA (7% and US$2.3 billion). Passive smoking accounted for approximately 12% and US$4 billion in direct costs.

At the country level, there were significant differences in the distribution of the smoking-attributable direct costs for different categories of health problems. Except in Bolivia, Chile, and Peru, heart disease was responsible for the highest proportion of smoking-attributable health costs. There was even greater variation in the way the rest of the causes were distributed. The cause with the second greatest burden in most cases was COPD, although with significant differences from country to country (representing nearly one-third of the attributable expenditure in Mexico and only 13% in Bolivia). The extent of the next most important causes (CVA and neoplasms, especially lung cancer) also varied from country to country. For example, lung cancer was responsible for less than 6% of the smoking-attributable expenditure in Bolivia, but for nearly 20% in Argentina.

Figure 1 presents the proportion of costs attributable to each pathology in each country and at the regional level.

To demonstrate the magnitude of smoking-attributable direct medical costs in the different countries, as well as the effectiveness of tax strategies for recovering part of those costs, Table 4 presents the costs in absolute terms and as a proportion of the total health expenditure of every country represented, the proportion of the total GDP of each country that they imply, and finally, the proportion of the costs recovered through taxes. The impact of smoking was homogeneous across the seven countries: nearly 10% of total health expenditure (6 to 13%) is attributable to this addiction, or approximately 1% (0.4 to 0.9%) of GDP. Moreover, we see that in no country do the revenues from taxes on tobacco products offset the health

FIGURE 1. Proportional distribution of expenditure attributable to smoking, by cause and country.
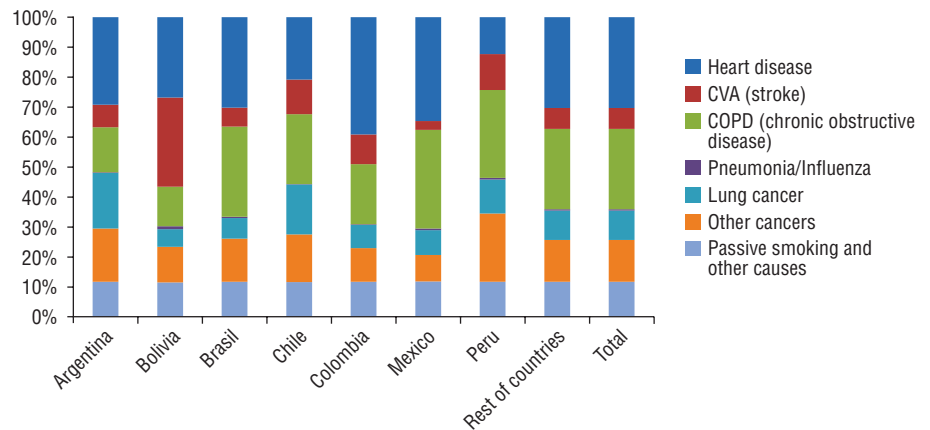
* Estimate based on data from the seven countries included in the model

TABLE 4. Smoking-attributable direct medical expenditures by country and their relation to health expenditure, gross domestic product, and tax revenues

	Smoking-attributable expenditures (millions of US$)[a]	As a percentage of total health expenditures (%)	As a percentage of GDP (%)	Percentage of expenditures recovered through taxes (%)
Argentina	3 786.76	9.6	0.7	53.3
Bolivia	264.00	12.7	0.8	8.1
Brazil	11 941.09	5.2	0.5	26.5
Chile	2 215.78	11.2	0.9	63.4
Colombia	2 139.72	8.3	0.6	8.7
Mexico	5 110.11	6.4	0.4	45.5
Peru	823.69	7.7	0.4	9.1
Rest of countries	7 294.35	11.9	0.7	N/D
Total Latin America [a]	33 575.50	8.3	0.7	35.0

[a] Estimate based on the seven countries included in the model.

expenditures that smoking generates in the health system. The proportion of health expenditures recovered through taxes varies widely: only Chile and Argentina manage to recover over 50% (62% and 67%, respectively), while the figure in Mexico is 45%, in Brazil 27%, and in Colombia, Bolivia, and Peru, less than 10%.

DISCUSSION

Our estimates show that smoking consumes nearly US$34 billion of Latin America's health budgets every year. This in itself is enormous sum, as well as a significant proportion of the countries' health budgets, ranging from 5.2% in Brazil to 12.7% in Bolivia. These values are comparable to those obtained in other studies that also showed high proportions of health expenditure directly attributable to smoking: 5% in the United

Kingdom (18), from 6% to 18% in different U.S. states, and 6.8% in Taiwan (20).

As observed elsewhere in the world, cardiovascular disease, COPD, and cancer were the leading causes of this expenditure (21, 22). There are few direct evaluations of the financial burden imposed by smoking in the region, although there are some assessments of the impact of specific measures to combat smoking, such as the smoke-free law in Mexico (23), which has yielded positive results in terms of the burden of disease and its associated costs. Another study in that country found that tobacco taxes were effective in terms of health benefits for the population, were less costly than other interventions, and were highly cost-effective (24). A study in Argentina in 2005 showed smoking-attributable health expenditures equivalent to 15.6% of total health expenditure (25).

At the global level, there is abundant literature showing that smoking-attributable medical costs can have a significant impact on national economies, consuming 0.1% to 1.1% of total GDP (6). Our findings show that this situation is repeated in Latin America, where 0.7% of GDP, on average, is lost to the treatment of health problems caused by smoking (from 0.4% in Mexico to 0.9% in Chile). Globally, it is estimated that revenues from tobacco taxes cover barely one-quarter of the medical and social costs generated by smoking (2). Although many decision makers still consider tobacco taxes to be an important source of income for their country's economy, we see that the revenues do not offset even the medical expenditures that the countries of the region must defray. In Latin America, these tax revenues, on average, cover barely one-third of the health expenditures produced by smoking (from 9% in Peru to 67% in Argentina). It should be underscored that this study estimated only the direct medical costs generated by tobacco consumption, which are only a small portion of the total financial burden imposed by smoking on countries. If the cost of lost productivity and other social costs are added to the direct medical costs, the financial burden of smoking may be even double or triple (2, 5, 6, 26). An earlier study in Argentina showed that the future income lost from tobacco-attributable premature death alone represented 0.17% of GDP annually (27).

The many ways in which tobacco consumption can undermine the health of individuals and society make it a complex problem to address. The model presented here includes the main health problems associated with smoking in adults, but the effects of passive smoking and perinatal and other effects (such as losses from fires) were not directly included. An estimation of the impact of these factors on public health expenditure was included, based on estimates from other studies; however, the potential inaccuracies in the estimates undoubtedly constitute a limitation of this research. Furthermore, the model does not include certain conditions, such as breast cancer or kidney failure, which were recently identified as potentially associated with smoking (28). Despite the effort to include the best available information, the lack of good-quality epidemiological and cost information in the region is another factor that increases the uncertainty of the results. It should also be borne in mind that the regional results of this study are derived from detailed analysis of seven countries, which, while representing more than 78% of Latin America's population, may not accurately reflect the other countries in the region. The authors of this article are currently working to expand this study to five additional countries (Costa Rica, Ecuador, Honduras, Paraguay, and Uruguay), in order to fine tune these regional estimates. Despite these limitations, the results presented in this article offer a robust estimate of the financial burden of smoking in Latin America, given the large number of countries and medical conditions included, the effort made to obtain the best sources of information in each country, the application of a uniform and replicable methodology, and the model's accuracy in reflecting the epidemiology of the region.

CONCLUSIONS

Smoking is responsible for a significant proportion of health expenditure in the region. Tax revenues from the sale of tobacco products are far below the levels needed to cover this expenditure. Taking action to combat smoking in Latin America implies attacking a problem that consumes 10% of the region's health resources and generates a heavy burden of disease. Every country in the region should seriously consider intensifying measures such as increasing tobacco taxes and adopting the other measures spelled out in the WHO Framework Convention on Tobacco Control to reduce consumption, the burden of disease, and health expenditures.

Conflicts of interest. None declared by the authors.

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RESUMEN

Impacto económico del tabaquismo en los sistemas de salud de América Latina: un estudio en siete países y su extrapolación a nivel regional

Objetivo. Estimar los costos médicos directos atribuibles al tabaquismo en los sistemas de salud de América Latina.

Métodos. Se utilizó un modelo de microsimulación para cuantificar el impacto económico en enfermedad cardiovascular y cerebrovascular, enfermedad pulmonar obstructiva crónica (EPOC), neumonía, cáncer de pulmón y otras nueve neoplasias. Se realizó una búsqueda sistemática de datos epidemiológicos y de costos de los eventos. El modelo se calibró y validó para Argentina, Bolivia, Brasil, Chile, Colombia, México y Perú, países que representan el 78% de la población de América Latina; luego se extrapolaron los resultados a nivel regional.

Resultados. Cada año el tabaquismo es responsable de 33 576 millones de dólares en costos directos para el sistema de salud. Esto equivale a 0,7% del producto interno bruto (PIB) de la región y a 8,3% del presupuesto sanitario. La enfermedad cardiovascular, la EPOC y el cáncer fueron responsables de 30,3%, 26,9% y 23,7% de este gasto, respectivamente. El costo atribuible al tabaquismo varió entre 0,4% (México y Perú) y 0,9% (Chile) del PIB y entre 5,2% (Brasil) y 12,7% (Bolivia) del gasto en salud. En la región, la recaudación impositiva por la venta de cigarrillos apenas cubre 37% del gasto sanitario atribuible al tabaquismo (8,1% en Bolivia y 67,3% en Argentina).

Conclusiones. El tabaquismo es responsable de una importante proporción del gasto sanitario en América Latina, y la recaudación impositiva por la venta de cigarrillos está lejos de llegar a cubrirlo. La profundización de medidas como el aumento de impuestos al tabaco debería ser seriamente considerada por los países de la región.

Palabras clave   Hábito de fumar; economía de la salud; América Latina.