Smoke-free air interventions in Seven Latin American Countries: Health and Financial Impact to Inform Evidence-Based Policy Implementation

Ariel Bardach[1-2], María Belén Rodríguez[1], Agustín Ciapponi[1-2], Federico Augustovsky[1-2], Alcaraz Andrea[1], Natalie Soto[1], Sacha Virgilio[1], Luz Myriam Reynales Shigematsu[3], Javier Roberti[1-2], Andrés Pichón-Riviere[1-2]

1.Institute for Clinical Effectiveness and Health Policy (IECS), Argentina

2.National Scientific and Technical Research Council (CONICET)- Argentina

3.National Institute of Public Health, Mexico

Corresponding author: Ariel Bardach, Email: abardach@iecs.org.ar

ABSTRACT

Introduction: Disease burden due to tobacco smoking in Latin America remains very high. The objective of this study was to evaluate potential impact of implementing smoke-free air interventions on health and cost outcomes in Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru, using a mathematical model.

Methods: We built a probabilistic Montecarlo microsimulation model, considering natural history, direct health system costs and quality of life impairment associated with main tobacco-related diseases. We followed individuals in hypothetical cohorts and calculated health outcomes on an annual basis to obtain aggregated 10-year population health outcomes (deaths, events) and costs. To populate the model, we completed an overview and systematic review of literature. Also, we calibrated the model comparing the predicted disease-specific mortality rates with those coming from local national statistics.

Results: With current policies, over 10 years, of 137,121 deaths and 917,210 events could be averted, adding 3.84 million years of healthy life and saving USD 9.2 billion in these seven countries. If countries fully implemented smoke-free air strategies, it would be possible avert nearly 180,000 premature deaths and 1,2 million events, adding 5 million healthy years of life and saving USD 13.1 billion in direct healthcare.

Conclusion: Implementing the smoke-free air strategy would substantially reduce deaths, diseases, and health care costs attributed to smoking. Latin American countries should not delay the full implementation of this strategy.

Implications: Tobacco smoking is the single most preventable and premature mortality cause in the world. The Framework Convention on Tobacco Control, supported by the World Health Organization, introduced a package of evidence-based measures for tobacco control. This study adds quality evidence on the potential health effects and savings of implementing smoke-free air policies in countries representing almost 80% of the LAC population.

What this study adds:

Smoking remains a leading risk factor for early death and disability in more than 100 countries with 11.5% deaths and 6% of disability-adjusted life-years worldwide [1]. We found that the full implementation of smoke-free policies would lead to a total economic benefit of US$ 13.1 billion in the seven countries.

INTRODUCTION

Smoking is responsible for six million deaths every year and, by 2020, this toll is expected to rise to seven and a half million, killing one billion people in the twenty-first century.[2,3] People killed by tobacco-related disease lose approximately 20 years of life expectancy compared with persons who have never smoked.[4] Moreover, tobacco is responsible for a large proportion of disability-adjusted life years (DALYs); ranging, in the studied countries, from 11.3% in Uruguay to 2.1% in Ecuador.[5] In Latin America, smoking is associated with one million deaths per year, the third leading risk factor for death and lost years of healthy life and contributes to poverty with decreased productivity and an impact on out-of-pocket expenses.[6]

Worldwide, diseases and premature death are caused by second-hand smoke (SHS), a mixture of mainstream smoke exhaled by the smoker, and side stream, released from the cigarette, containing toxicants and carcinogens.[7-9] In 2001, the Pan American Health Organization (PAHO) launched the Smoke-Free Americas initiative to promote smoke-free communities, workplaces and homes; in 2005, the World Health Organization Framework Convention on Tobacco Control (WHO-FCTC) entered into force, with 181 countries committed, 30 of these are in the Americas.[4,10] Almost every nation in the Latin American region has signed the FCTC, but many are still lacking a strong tobacco-control policy.[4,10] Smoking-related diseases cause a significant economic burden on individuals and health systems, which can reach US$ 500 billion annually worldwide, including productivity loss, illnesses and premature deaths, and representing up to 1.5% of the GDP of some high-income nations and up to 15% of all national health expenditures.[4,11,12] In fact, in Latin America, smoking accounts for about US$ 34 billion every year, and it represents 5.2% of the health budget in Brazil and up to 12.7% in Bolivia.[13]

Smoke-free policies, cornerstone of the FCTC, limit where smokers can smoke and therefore reduce involuntary exposure to toxic second-hand tobacco smoke, reduce tobacco consumption, and promoted quitting.[14] Mexico introduced implemented state-wide smoke-free air regulations in 2009 and by 2013, smoke-free policy coverage reached 40% of total population.[15] In Argentina 21.8% of workers are still exposed to SHS, according to the National Survey of Risk Factors, 2018.[16] The implementation of 100% smoke-free interventions in all closed public access sites and workplaces is the only way to ensure that all people are protected from tobacco smoke. It has been estimated that comprehensive smoke-free laws after the adoption of MPOWER policy resulted in 5.4 million less smoking-attributable deaths from 2007 and 2014.[17]

However, misinformation, prejudice, lack of quality information at a country-level and pressure from interest groups have delayed the implementation and enforcement of measures in the region.[6,18] Our objective is twofold: to report the tobacco-related burden of mortality, disease and direct costs imposed on the health systems in Latin America as well as to predict the health and financial impact of implementing smoke-free policies throughout the region.

METHODS

The analysis was conducted using a probabilistic state-transition microsimulation model (i.e. individual-based Markov model, or first-order Monte Carlo technique) developed specifically to estimate the burden of smoking-attributable disease and the cost-effectiveness of tobacco control policies and interventions.[19] The model was validated and used to estimate the burden of disease attributable to smoking and the potential impact of different interventions.[13,20-25] We performed a comprehensive analysis of epidemiological and cost data and policy-makers' information needs for the implementation of smoke-free air intervention.

The model considers the natural history, costs and quality of life losses associated with main tobacco-related diseases (coronary and non-coronary heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, pneumonia, influenza, lung cancer and nine other neoplasms). We applied the International Society for Pharmacoeconomics and Outcomes Research criteria for model development and reporting.[26]

Simulating each individual's lifetime, we followed up individuals in hypothetical cohorts and calculated health outcomes on an annual basis to obtain aggregated long-term population health outcomes and costs. For acute events, we calculated age and gender-specific absolute risks based on mortality rates and the lethality of the event. Then, we calculated the baseline risk for non-smokers based on smoking prevalence per age and sex, and relative risk of smoking on that disease. For cancers, we obtained incidence statistics for each age, sex and country, using the Global Cancer Observatory (Globocan).[27]

The main outcomes are life years, quality-adjusted life years, disease events, hospitalisations, disease incidence and disease costs. We calculated years of life lost (YLL) due to smoking-related diseases at a population level as the sum of years of life lost due to premature death (PYLL); and years of life lost due to living with a poor quality of life (YLL-QL). Tobacco control policies have an effect mediated by a reduction in consumption; this lower consumption at the country level is a consequence of a reduction in number of cigarettes smoked per smoker, lower tobacco prevalence due to an increase in quitting rates (short term) and lower tobacco initiation rates in the medium and long term.

Effectiveness achieved by current measures for the smoke-free environments was adjusted according to degree of compliance, assuming that degree of compliance reflected the proportion of benefit achieved relative to the comparator (no intervention or previous step within the possible measures) as follows:

$$Efr = Com + (Eft - Com) * Gc$$

Where ***Efr*** is actual effectiveness achieved by current measures under current degrees of compliance (measured as a relative percentage in the reduction in prevalence); ***Com*** is effectiveness of the comparator; ***Eft*** is the theoretical effectiveness that current measures could achieve under the maximum level of compliance; and ***Gc*** is the degree of compliance of current measures (measured as a ratio of 0 to 1).

Using the simulation of each individual's lifetime, individuals in hypothetical cohorts were followed-up, and health outcomes were calculated for each subject on an annual basis to obtain aggregated population health outcomes and costs. The model updates the values of input parameters for each subject on a yearly basis and calculates event rates for outcomes based on the covariables and underlying risk equations. The model estimates individual lifetime risks of occurrence of each event, disease progression and death, based on the subject's demographic attributes, smoking status and clinical conditions.[19,20,24,25,28] To estimate the potential impact of tobacco control policies we analysed three scenarios in each country. We assumed a lineal evolution from the first scenario to the second one within five years, and then to the third scenario between years six to ten.

a. Short-term scenario (1 year): we assumed that a 50% reduction in consumption would have an impact on prevalence (Ip=0.5) and that a reduction in current smoking prevalence would lead to an increase in former smokers. This conservative scenario is more likely to occur in the short term (1 year), as it does not include effects that the intervention may have in preventing people from starting to smoke or the health benefits of smoking fewer cigarettes for those who continue smoking.

b. Mid-term scenario, (2 to 5 years): similar to the previous scenario, but it incorporates potential effects of reduction in the number of cigarettes smoked. Although this is a controversial point and this reduction in risk varies according to each disease, we assumed that a reduction in consumption implies a reduction in excess risk of smoking [29,30]. This risk reduction was only applied to up to 75% of the total of excess risk separating a smoker from a former smoker, as the 25% additional risk is assumed to be eliminated only when a person becomes a former smoker. This 75% maximum benefit that a smoker could obtain from reduced consumption is based on the maximum difference in the risk of lung cancer (82%), ischemic heart disease (57%) and COPD (80%) between high-intensity and low-intensity smokers compared to former smokers.[14]
c. Long-term scenario: maximum effect over ten years. Like scenario b, but with a 75% reduction in consumption affecting prevalence (Ip=0.75); population of former smokers remains constant in relation to the baseline, with a decrease in prevalence and an increase in non-smokers population.

As for the effectiveness analysis of the smoke-free measurement package, reduction in risk in non-smokers by reducing second-hand exposure to tobacco smoke was also considered. We estimated the new prevalence of expected active smoking as a result of implementing the interventions, for each sex and age group, as follows:

$$Prevalencepost = Prevalencepre - (Em * Ip * Prevalencepre)$$

Where ***Prevalencepre*** is the prevalence of smokers before implementing the intervention, ***Em*** is the effectiveness of the intervention measured in terms of relative reduction in consumption; and ***Ip*** is the proportion of variation in consumption that impacts on smoking prevalence, assuming 0.50 for the short-term and mid-term scenarios, and 0.75 for the long-term scenario.

Model calibration and validation process

To calibrate the model, we compared disease specific mortality rates for each sex and age group with local statistics; predicted rates within 10% of the references were considered acceptable. In case of greater deviation, we modified risk equations. External validation was accomplished by checking the model results against those results of other epidemiological and clinical studies not used for equation estimation and development.

Cost data

Direct medical costs during the year the event occurred were estimated for chronic conditions; costs of follow-up were also estimated. A literature search was conducted to identify reported costs of events. A common costing methodology was developed to estimate costs through a micro-costing or macro-costing approach, depending on the availability and quality of information. A Microsoft Excel spreadsheet was designed for each event, identifying frequency, use rate and unit cost of health resources employed for each event. *Ad hoc* micro-costing exercises were constructed based on communications with experts, clinical guidelines and a review of healthcare facility records. Costs of malignancies other than lung cancer were based on lung cancer costs and on an expert consensus obtained through a Delphi method exercise. Where sufficient local information was unavailable, extrapolation was used to approximate costs of events; the average of the proportion represented by the cost of the event over the per capita GDP in Argentina, Chile and Mexico was used, and over this average proportion, per capita GDP of the country of interest was applied to obtain estimates. All costs were first estimated in the local currency in 2015. Then, these costs were converted to US dollars using the 2015 exchange rates published by each country's central bank.

Inclusion of passive smoking and perinatal effects

Given that the model does not directly calculate the consequences of passive smoking and perinatal effects, based on the results of previous studies, it was estimated that these causes impose an additional burden of 13.6% for men and 12% for women.[31] Main parameters included in the model are shown in Table 1.

Estimates for impact of smoke-free air intervention

Effectiveness of current smoke-free policies depends on their implementation level, assuming that the level reflects the degree of implementation compared to no intervention or to an inferior level of implementation. We adjusted effectiveness to the level of measures that were effectively implemented in each country, independently of its legislation. We estimated the new smoking prevalence that was expected as a result of implementing the intervention, for each sex and age group. To obtain data on the benefits of implementing smoke-free policies to populate the simulation model, we performed a three-stage systematic review; including a review of documents published on international organizations and internet sites related to tobacco control, an overview of systematic reviews on the effectiveness of smoke-free interventions in any country and, finally, a systematic review of this intervention in Latin American countries (see supplementary file for the detailed methodology of these approaches).

For the first stage, we searched in seven key organizations/documents related to public health and tobacco control: MPOWER, Tobacco Atlas, FCTC, Pan-American Health Organization (PAHO), International Tobacco Control Policy Evaluation Project (ITC Project): Global Adult Tobacco Survey (GATS) and Tobacco Free Kids. Specifically, we searched for the definitions and effectiveness of smoke-free air interventions, reported effectiveness of the different levels of implementation, specific level of implementation reported for each country included, and methodology used in the classification of policy implementation. Secondly, we performed an overview of systematic reviews on the effectiveness of smoke-free air interventions. Finally, we performed a systematic review on the effectiveness of smoke free interventions in the seven countries of interest.

The following electronic databases were used: MEDLINE, EMBASE, CENTRAL, SOCINDEX, EconLit, LILACS, NBER, CRD and Cost Effectiveness Analysis Registry, the International Tobacco Health Conference Paper Index and Cochrane Tobacco Addiction Review Group register. Grey literature was reviewed from ministries of health, ministries of finance, PAHO and databases containing regional congress proceedings. Updated information on tobacco use prevalence was obtained from local tobacco GATS surveys, where available, or national risk factor surveys. Researchers from the participating countries provided additional information on civil registrations, vital statistics and hospital discharge databases to estimate specific case fatality rates.

Findings from the Levy systematic review show that the complete implementation of smoke-free strategies reduces tobacco consumption by 8.4% (range 4.2 to 12.6), a moderate implementation could reduce consumption by 2.8% (range 1.4 to 4.2), whereas a minimal implementation could diminish consumption by 1.4% (range 0.7 to 2.1).

We have incorporated a sensitivity analysis on the uncertainty regarding the effectiveness of the intervention (the most important input of the model in this analysis) and all results include the base case estimate and the lower and upper values.

RESULTS

The overview yielded two relevant systematic reviews and data from two key resources.[12,14,32,33] After identifying 77 studies from 21 countries, Frazier et al. found clear evidence of a positive impact of national smoking free-air bans on reducing mortality for associated smoking-related illnesses and improving cardiovascular health outcomes; indeed, a legislative smoking ban led to improved health outcomes through reduction in second-hand smoking.[32] Another review including 37 studies showed evidence that smoke-free policies reduced tobacco use among workers when implemented in worksites or by communities.[14]

The systematic review of smoke free-air policies in Latin America yielded four studies reporting the effects of smoke-free policies in the region at different levels.[34-37] In Uruguay, the simultaneous implementation of the measures set out in the WHO-FCTC was an effective strategy to reduce the prevalence of tobacco use in a short period of time.[34] In Argentina, an immediate decrease in acute coronary syndrome admissions was observed after implementing smoke-free laws compared with no change.[35] In Mexico City, support for smoke-free laws increased once these laws were implemented by a greater rate of change than in other cities.[36] Shan et al. found that greater exposure to tobacco control polices was significantly associated with quitting.[37] Figure 1 shows the flow chart of both reviews.

We found that Argentina, Brazil, Chile, Colombia and Peru have a complete level of implementation of smoke-free policies, whereas Bolivia and Mexico have a moderate level of implementation of smoke-free policies.

With the current level of implementation of smoke-free policies in the seven countries (Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru) over the next 10 years, a total of 137,121 deaths and 944,868 events could be averted. Specifically, 399,581 cardiac diseases, 111,842 cerebrovascular diseases, 235,115 COPD cases, and 61,208 cases of cancer could be averted; moreover, 3.84 million years of life could be added. Averted events could represent savings totalling USD 9.6 billion over the same period. With the largest population in the group of studied countries, Brazil could avert 80,489 deaths, 610,276 events, with over 2.4 million years lived, and 5.7 billion in savings. Argentina and Chile come in second and third places in the number of averted deaths, with 19,261 and 12,897, respectively (see Table 2).

Bolivia and Mexico have a 30% of implementation of the moderate level of smoke-free policies, corresponding to 3-5 and 6-7 of public places in MPOWER tool, respectively. If these two countries advanced to a full implementation of this moderate ban, in the next 10 years, Bolivia would avert an additional 466 deaths, 1,660 events, would add 11,957 years lived, and save US$ 28.1 million whereas Mexico would avert an additional 3,104 deaths, 17,756 events, add 84,794 years lived and save US$ 283.6 million in health costs (data not shown in tables). Argentina, Brazil, Chile, Colombia and Peru are already in the complete level of ban policies, with 60% implementation, and could potentially advance to a total accomplishment of the full ban. In the case that smoke-free strategies were fully implemented across all countries, these could avert 178,615 premature deaths, 492,115 cardiac events, 144,829 cerebrovascular events, 311,129 COPD, 77,399 cancer diagnosis over ten years. A total of 5.0 million years of life would be added and a total of US$ 13.1 billion in direct healthcare expenses of diseases attributable to smoking would be saved (Table 3). Brazil would lead in number of averted deaths with 80,489 but followed by Argentina and Mexico with 28,657 and 25,683, respectively. The same occurs with savings; Brazil would save US$ 5.7 billion, followed by Mexico and Argentina with US$ 2.6 billion and US$ 2.4 billion, respectively.

DISCUSSION

Our findings show that smoking represents a significant health and economic burden in seven countries in Latin America, with 345,373 deaths, 2.2 million disease events, and US$ 25.4 billion health expenses. Article 8 of WHO-FCTC requires adoption and implementation of measures to reduce exposure to tobacco smoke in indoor workplaces, public places, and public transport. However, disparities in the enforcement of this Article suggest that these benefits are not being fully realized.[38] The benefits of smoke-free workplace policies extend to changing societal norms around SHS exposure in the home in LMICs. Smoke-free policies serve to disrupt smoking and SHS exposure, contributing to effective tobacco control.[39]

As mentioned, if the smoke-free strategy were fully implemented, the seven countries could avert nearly 180,000 premature deaths, almost 500,000 cardiac events, almost 150,000 cerebrovascular events, and almost 80,000 new cancer diagnosis over ten years. Studies throughout Latin America provide support for the results of our study, both in terms of the estimation of the overall burden and the potential outcomes of the implementation of smoke-free strategies. Using the SimSmoke model, it has been projected that as a result of the highest level MPOWER measures adopted between 2007 and 2014, worldwide, almost 22 million premature smoking-attributable deaths would be averted and the most deaths were averted due to adoption of increased cigarette taxes, closely followed by comprehensive smoke-free laws; however, nearly half of the world's population remains uncovered by even a single MPOWER policy.[17]

Evidence shows comprehensive smoke-free laws have an immediate and substantial effect of reducing hospital admissions due to acute myocardial infarction.[40,41] In Chile, a significant abrupt reduction was observed in urban municipalities.[40] The same effect was observed in Uruguay.[41] It has also been shown that in high-, low- and middle-income countries, associations between being employed in a smoke-free workplace and living in a smoke-free home exist, suggesting that the accelerated implementation of comprehensive smoke-free public place policies is likely to result in population health gains in these settings.[42] The lowest prevalence rates of SHS exposure in the workplace were found in Uruguay (16.5%), Mexico (18.6%) and Brazil (23.3); and men were more exposed to SHS at their workplaces than women.[43] Of note, an abrupt ban could potentially lead to some distress and stigmatization of heavy smokers; consequently, measures should be accompanied with programs to help people quit or other interventions for coping with the situation.[44 45]

A successful smoke-free implementation may require engagement by national and local health authorities, NGOs, external funders, and other stakeholders; in Colombia, for example, implementation was possible despite scarce government resources and enforcement agencies focused on public security.[46] Indeed, compliance with legislation relate to the enforcement infrastructure, the local government efforts in training enforcement agents.[47] On the other hand, tobacco companies implement tactics to fight tobacco control strategies such as influencing through front groups, allying with third parties, lobbying, media campaigns, legal challenges, commissioning research, hiring consultants, using financial incentives, and proposing alternative legislation; indeed their most successful tactics are specifically oriented to tax-policy; confusing debates, stimulating smuggling to support their claims, and working to divert funds.[48] For this reason, governments should continue to pursue evidence-based measures to reduce smoking, excluding tobacco companies from any policy involvement; health organisations should continue to press for action while scientists should reject involvement with the tobacco industry.[49]

Our study has some limitations. We estimated direct medical costs related to smoking, a part of total financial burden of tobacco, but not indirect costs. The model did not include certain conditions related to exposure to exposure such as breast cancer, diabetes, liver cancer or kidney failure. It was not always possible to include high-quality epidemiological information to populate the model, due to its scarcity. Also, changes in demographic, economic and healthcare system characteristics over time were not included in the model. However, our findings offer a robust estimate of financial burden of smoking in seven countries of Latin America, with the best available sources of information in each country, applying a uniform and replicable method, and including a sensitivity analysis for the effectiveness of the intervention.

The challenges in implementing smoke-free policies that affect Latin America are not unique to the region; weak legislation, lack of compliance, the need for monitoring laws, and tobacco industry attempts to undermine progress.[50] The number of countries in the Americas with national regulations that establish 100% smoke-free environments in any public place and in closed work and on public transport was 16 by 2016.[51] Sharing expertise across the region, funding of civil society, and the commitment by governments to implement the FCTC will be critical to future progress. Given the immense progress made in the region since 2006, when the first Latin American country became smoke-free, and the global momentum for smoke-free workplaces and public places, Latin America is well positioned to become one day a 100% smoke-free region.[50]

In conclusion, our results suggest that smoke-free strategies can successfully contribute to the reduction of the overall burden of tobacco use and should be strongly considered by policymakers throughout Latin America.

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Table 1. Main parameters considered for the simulation model

Indicator	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Population (2015)	43,416,755	10,724,705	207,847,528	17,948,141	48,228,704	127,017,224	31,376,670	3,431,555
Smoking prevalence[1]								
Male	23.4	20.1	18.0	35.2	20.1	19.8	23.5	27.7
Female	18.6	17.7	11.3	31.3	9.9	6.4	15.3	17.7
Crude mortality rate (Male / Female per 10,000)[2]								
Acute myocardial infarction	46.1 / 33.1	8.4 / 5.5	16.0 / 11.0	8.3 / 4.9	19.0 / 13.7	19.9 / 13.9	74.6 / 57.3	8.2 / 5.0
Other cardiovascular causes	118.7/104.5	0.9 / 0.5	3.8 / 2.9	7.4 / 8.4	2.3 / 1.7	2.2 / 3.1	51.8 / 57.2	26.5 / 27.9
Cerebrovascular disease	52.5 / 43.9	8.4 / 8.0	8.8 / 7.9	9.8 / 9.6	8.5 / 9.3	8.1 / 8.1	52.6 / 50.7	8.8 / 11.4
Pneumonia/influenza	104.4 / 72.4	17.4 / 15.9	9.1 / 8.5	4.2 / 4.0	3.6 / 3.1	4.0/ 3.1	221.0/199.0	5.9 / 6.2
COPD	4.3 / 1.9	1.1 / 1.3	6.6 / 4.5	3.7 / 2.8	7.9 / 5.8	7.5 / 5.6	33.2 / 25.3	9.0 / 3.2
Lung cancer	15.6 / 4.6	3.7 / 3.1	4.3 / 2.5	3.9 / 2.2	3.3 / 1.9	2.5 / 1.2	13.5 / 10.4	12.6 / 3.5
Estimated direct health costs of smoking-related conditions in USD millions								
Acute myocardial infarction	3,242	5,114	5,006	3944	3,835	4,848.6	2,663	13,188
Other cardiovascular causes	2,432	3,835	1,881	2702	1,534	3,190.4	1,850	12,584
Annual cardiovascular follow-up.	1,283	2,024	409	1444	34,795	1,240.6	1,171	4,082
Cerebrovascular disease[3]	4,294	5,232	4,304	4431	2,174	4,119.1	5,058	9,601

Indicator	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Pneumonia/influenza	217	276	361	235	325	1,309.9	174	1,220
COPD[4]	4,394	3,969	4,824	6133	3,463	9,236.2	4,363	386
Lung cancer[5]	17,392	8,862	12,279	21727	10,499	13,792.6	14,081	40,122
Mouth cancer[5]	12,523	6,381	9,602	15644	7,560	9,930.6	9,251	28,888
Oesophageal cancer	14,610	7,444	12,161	18251	8,820	11,585.7	11,828	33,703
Stomach cancer[5]	14,262	7,267	15,074	17816	8,610	11,309.9	11,546	32,900
Pancreatic cancer[5]	11,827	6,026	11,616	14774	7,140	9,378.9	9,575	2,728
Kidney cancer[5]	12,523	6,381	4,632	15644	7,560	9,930.6	10,138	28,888
Tax revenue on smoking[6]	1,926.2	21.5	9,511	1,346.5	174	2,237.4	73.5	211.4
GDP (2015)[6]	583,168.6	33,197	1,774,725	240,215.7	292,080.1	1,144,331.3	192,083.7	53,442.7
GDP per capita (2015)[6]	13,432	3,095	8,539	13,384	6,056	9,009	6,122	15,574
Price elasticity of demand	-0.299	-0.85	-0.48	-0.45	-0.780	-0.45	-0.7	-0.55
Total health expenditure (% GDP)	4.8	6.3	8.3	7.8	7.2	6.3	5.5	8.8

Abbreviations: COPD, chronic obstructive pulmonary disease; GDP, gross domestic product.

Key: 1. Population ≥35 years expressed in millions; 2. Mortality rate per 10.000 people; 3. Values include first and following years, as a summary, only first year is included in table. 4. COPD mild, moderate and serious included. 5. Treatment costs of following years are included. 6. In millions of US dollars; exchange rate as mean in December 2015 according to central banks of each country.

Table 2. Ten-year Cumulative benefits to be obtained by currently adopted smoke-free air strategy

Country Point Estimate (Lower and Upper values)	Averted deaths	Averted events					Years lived due to prevented premature death and disability	Savings in USD millions
		Cardiac disease	cerebrovascular disease	COPD	Cancer	Total events		
Argentina	19,261	30,505	11,051	27,657	8,899	97,373	463,005	1,582
	(9,761; 28,500)	(15,459; 45,137)	(5,600; 16,353)	(14,016; 40,925)	(4,510; 13,168)	(49,345; 144,082)	(234,636; 685,107)	(801.8; 2,341.0)
Bolivia	807	470	888	1,286	233	3,684	20,724	48.6
	(405; 1,206)	(236; 702)	(446; 1,921)	(645; 1,921)	(117; 349)	(1,849; 5,505)	(10,403; 30,964)	(24.4; 72.6)
Brazil	80,489	299,264	59,189	133,364	37,969	610,276	2,403,991	5,739
	(40,995; 118,483)	(152,421; 440,530)	(30,146; 87,129)	(67,925; 196,317)	(19,339; 55,893)	(310,826; 898,351)	(1,224,400; 3,538,773)	(2,923.1; 8,448.4)
Chile	12,897	16,226	15,095	29,330	5,204	78,752	337,615	1,291
	(6,569; 18,984)	(8,264; 23,885)	(7,688; 22,220)	(14,938; 43,175)	(2,650; 7,660)	(40,110; 115,925)	(171,954; 496,984)	(657.5; 1,900.4)
Colombia	11,035	34,823	15,424	18,015	4,262	83,559	287,500	424.6
	(5,585; 16,349)	(17,625; 51,593)	(7,807; 22,852)	(9,118; 26,691)	(2,157; 6,315)	(42,292; 123,800)	(145,514; 425,957)	(214.9; 629.1)

Mexico	5,381	13,897	3,382	11,364	2,023	36,046	146,965	491.6
	(2,701; 8,039)	(6,976; 20,763)	(1,698; 5,054)	(5,704; 16,979)	(1,015; 3,022)	(18,094; 53,857)	(73,771; 219,583)	(246.8; 734.5)
Peru	7,251	4,396	6,813	14,099	2,618	35,178	177,923	375,7
	(3,684; 10,702)	(2,233; 6488)	(3,461; 10,055)	(7,163; 20,809)	(1,330; 3,864)	(17,872; 51,918)	(90,392; 262,595)	(190,9; 554,5)
Total	137,121	399,581	111,842	235,115	61,208	944,868	3,837,723	9,576.80

Abbreviations: COPD, chronic obstructive pulmonary disease; USD, United States Dollars

Table 3. Ten-year Cumulative benefits to be obtained by implementing complete smoke-free air strategy

Country Point Estimate (Lower and Upper Values)	Averted deaths	Averted events					Years of life due to premature death and disability	Savings in *USD millions*
		Cardiac disease	cerebrovascular disease	COPD	Cancer	Total events		
Argentina	28,657	45,386	16,443	41,150	13,240	144,876	688,882	2,353.9
	(13,786; 46,433)	(21,834; 73,539)	(7,910; 26,642)	(19,796; 66,676)	(6,369; 21,453)	(69,694; 234,743)	(331,394; 1,116,743)	(1,132.4; 3,814.1)
Bolivia	3,852	2,244	4,239	6,137	1,113	17,586	98,917	232.0
	(1,901; 5,863)	(1,107; 3,414)	(2,092; 6,451)	(3,028; 9,339)	(549; 1,694)	(8,677; 26,762)	(48,803; 150,529)	(114.5; 353.1)
Brazil	80,489	299,264	59,189	133,364	37,969	610,276	2,403,991	5,739.2
	(40,995; 118,483)	(152,421; 440,530)	(30,146; 87,129)	(67,925; 196,317)	(19,339; 55,893)	(310,826; 898,351)	(1,224,400; 3,538,773)	(2,923.1; 8,448.4)
Chile	12,897	16,226	15,095	29,330	5,204	78,752	337,615	1,291
	(6,569; 18,984)	(8,264; 23,885)	(7,688; 22,220)	(14,938; 43,175)	(2,650; 7,660)	(40,110; 115,925)	(171,954; 496,984)	(657.5; 1,900.4)

Colombia	18,151	57,279	25,370	29,632	7,011	137,444	472,903	698.5
	(8,706; 29,270)	(27,473; 92,368)	(12,169; 40,912)	(14,213; 47,784)	(3,363; 11,306)	(65,924; 221,640)	(226,823; 762,594)	(335.0; 1,126.4)
Mexico	25,683	66,329	16,145	54,239	9,654	172,050	701,476	2,346.4
	(12,671; 39,083)	(32,725; 100,938)	(7,965; 24,569)	(26,760; 82,540)	(4,763; 14,691)	(84,885; 261,820)	(346,090; 1,067,486)	(1,157.7; 3,570.7)
Peru	8,886	5,387	8,348	17,277	3,208	43,106	218,026	460.4
	(4,347; 14,310)	(2,635; 8,676)	(4,084; 13,445)	(8,451; 27,823)	(1,569; 5,167)	(21,086; 69,420)	(106,651; 351,117)	(225.2; 741.4)
Total	178,615	492,115	144,829	311,129	77,399	1,204,090	4,921,810	13,121

Abbreviations: COPD, chronic obstructive pulmonary disease; USD United States dollars

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Figure 1. Flowcharts of overview and systematic review