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Original Article

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Unlocking the power of tobacco taxation to mitigate the social costs of smoking in Mexico: a microsimulation model

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Abstract

Despite being the most cost-effective tobacco control policy, tobacco taxation is the least implemented component of the World Health Organization MPOWER package to reduce smoking worldwide. In Mexico, both smoking prevalence and taxation have remained stable for more than a decade. This study aims to provide evidence about the potential effects of taxation to reduce the burden of tobacco-related diseases and the main attributable social costs in Mexico, including informal (unpaid) care costs, which are frequently ignored. We employ a first-order Monte Carlo microsimulation model that follows hypothetical population cohorts considering the risks of an adverse health event and death. First, we estimate tobacco-attributable morbidity and mortality, direct medical costs and indirect costs, such as labour productivity losses and informal care costs. Then, we assess the potential effects of a 50% cigarette price increase through taxation and two alternative scenarios of 25% and 75%. The inputs come from several sources, including national surveys and vital statistics. Each year, 63 000 premature deaths and 427 000 disease events are attributable to tobacco in Mexico, while social costs amount to MX$194.6 billion (US$8.5)—MX$116.2 (US$5.1) direct medical costs and MX$78.5 (US$3.4) indirect costs—representing 0.8% of gross domestic product. Current tobacco tax revenue barely covers 23.3% of these costs. Increasing cigarette prices through taxation by 50% could reduce premature deaths by 49 000 over the next decade, while direct and indirect costs averted would amount to MX$87.9 billion (US$3.8) and MX$67.6 billion (US$2.9), respectively. The benefits would far outweigh any potential loss even in a pessimistic scenario of increased illicit trade. Tobacco use imposes high social costs on the Mexican population, but tobacco taxation is a win-win policy for both gaining population health and reducing tobacco societal costs.

Keywords: Tobacco taxation, burden of disease, healthcare costs, productivity loss, informal care, Mexico

Introduction

Efforts to strengthen tobacco control remain crucial to deter the tobacco epidemic. Tobacco use is the second leading risk factor for attributable deaths—accounting for 15.4% of all deaths in 2019—and the third cause of disability globally (GBD 2019 Risk Factors Collaborators, 2020). While there have been important reductions in smoking prevalence over the past three decades overall, most countries have not attained reductions able to compensate for population growth and progress has slowed down, especially in the last 5 years (Reitsma *et al.*, 2021). The economic burden of the tobacco epidemic is also substantial. The healthcare costs of treating smoking-attributable diseases are estimated at US$422 billion or 5.7% of global health expenditure and, along with productivity losses from morbidity and premature mortality, reach US$1436 billion or 1.8% of the annual world's gross domestic product (GDP) (Goodchild *et al.*, 2018). However, despite being the most cost-effective tobacco control policy (World Health Organization, 2011; U.S. National Cancer Institute, World Health Organization, 2016), tobacco taxation is the least implemented component of the World Health Organization (WHO) MPOWER package to reduce smoking, as only 13% of the world's population is covered by the highest standard consisting of tax rates of ≥75% of the price of the

Key messages

- The burden of smoking in Mexico is considerable. Every year, tobacco causes 63 000 premature deaths and the main tangible costs attributable to tobacco are estimated at MX$194.6 billion (US$8.5) (MX$116.2/US$5.1 direct costs and MX$78.5/US$3.4 indirect costs).
- Last year, important progress was made in tobacco control by implementing 100% smoke-free environments throughout the country and a complete ban on advertising, but fiscal policy has lagged behind despite being the most cost-effective measure to combat the epidemic.
- A 50% cigarette price increase could reduce premature deaths by 49 000 over the next decade, while direct and indirect costs averted would amount to MX$155.5 billion (US$6.8). Importantly, a quarter of the indirect costs averted correspond to the costs of informal care of those who become ill due to tobacco, a burden that falls heavily on women. In other words, tobacco taxes could also contribute to reducing this inequality gap.

most popular cigarette brand (World Health Organization, 2021).

In Mexico, tobacco causes 58 200 premature deaths every year (GBD 2019 Risk Factors Collaborators, 2020), and following a decreasing trend in the 2000s, smoking prevalence has remained at its 2009 level (∼17%) (Zavala-Arciniega *et al*., 2020; Shamah-Levy *et al*., 2022), which implies that the number of current smokers has increased over the last decade. In addition, previous studies have shown that tobacco-attributable treatment costs are considerable (US$4800 million/year or MX$75 600 million) (Pichon-Riviere *et al*., 2020) and present significant geographical variation due to differences in the tobacco epidemic across regions (Saenz-de-Miera *et al*., 2022). Indirect costs (mainly labour productivity losses) have been much less analysed, although they are very likely considerable as found in other contexts (Bundhamcharoen *et al*., 2016; Hoang Anh *et al*., 2016; Amarasinghe *et al*., 2018; Ju-Fang *et al*., 2020; Shrestha *et al*., 2022). On the other hand, general progress in tobacco control had been practically nil in the past decade (Reynales-Shigematsu *et al*., 2019), until last year when the implementation of 100% tobacco-free environments throughout the country and a complete ban on advertising were legislated (Secrataria de Salud, 2022). Before these modifications, only 15 states had local regulations to fully protect non-smokers from tobacco smoke, and some exceptions for advertising persisted, which had left the country behind in relation to the rest of the region (Organización Panamericana de la Salud, 2023). In terms of tobacco taxes, it was also recently that some progress was made. In 2020, the specific component of the excise tax (IEPS) was adjusted for the accumulated inflation since the last tax increase in 2011, and an annual automatic adjustment mechanism was established for subsequent years. These changes implied a specific tax increase from 35 cents per cigarette in 2019 to 49.44 cents in 2020, 51.08 cents in 2021, 54.84 cents in 2022 and 59.11 cents in 2023. However, the tobacco tax burden is currently 55.4% (considering both the specific component and the ad valorem component of 160% of the price to the retailer) and the combined burden of the excise tax plus value added tax (IEPS + VAT) is 69.2%, still well below the WHO standard (World Health Organization, 2021).

A growing number of tobacco demand studies have documented the effectiveness of increasing excise taxes to reduce consumption (Chaloupka *et al*., 2012)—which, in fact, underpin Article 6 of the WHO Framework Convention on Tobacco Control and the central role of taxation within the MPOWER strategy (World Health Organization, 2003; 2021). Simulation models have also provided broader evidence on the effectiveness of taxation to reduce smoking-attributable deaths and increase tax revenue (Goodchild *et al*., 2016; Fleischer *et al*., 2017). There is limited research, however, on other important impacts of tobacco taxes, such as those related to the large indirect costs attributable to tobacco use. Using an extension of a microsimulation model that was developed to understand the health and financial consequences of tobacco use in Latin American countries (Pichon-Riviere *et al*., 2020), this study evaluates the essential role that tobacco tax increases could have in reducing premature deaths as well as both the healthcare (direct) costs and productivity losses (indirect costs) attributable to smoking in Mexico. Moreover, we consider the potential effects of such policy on the costs associated with the care of those who become ill from tobacco, which have been largely neglected. Tobacco-related diseases normally require prolonged care that can reach up to 2086 h/year for severe chronic obstructive pulmonary disease (COPD) patients (Espinola *et al*., 2023), and most caregivers are women who disproportionately bear this burden. In addition, we analyse how a potential change in illicit trade would affect the main results, although there is no robust evidence of a direct association between increased excise taxes and cigarette smuggling. With these estimates that delve into the granular effects of tobacco taxation, we aim to contribute to better understanding the benefits of strengthening this policy to reduce the burden of tobacco-related diseases and advance towards the achievement of global goals on non-communicable diseases (NCDs) (World Health Organization, 2013; United Nations General Assembly, 2015), specifically goal three of the 2030 Agenda for Sustainable Development that includes target 3.4 to reduce premature mortality from NCDs by one-third by 2030 (United Nations General Assembly, 2015).

Methods

The model

We use a first-order Monte Carlo microsimulation model that follows hypothetical cohorts from 35 years to death in annual cycles, considering the risks of occurrence of an adverse health event and death, which are based on demographic characteristics, clinical conditions and underlying risk equations. Since health events are not mutually exclusive, the model allows for multiple events each year. The aggregate results come from the simulation of each individual's lifetime. Selected diseases include the main tobacco-related diseases: acute myocardial infarction (AMI), non-AMI coronary event, stroke, COPD, pneumonia, lung cancer and other nine types of cancer (Appendix Table A1).

This model has been employed to estimate disease events, premature deaths and healthcare costs attributable to tobacco in 12 Latin American countries, including Mexico (Pichon-Riviere *et al*., 2020). It has also been used to evaluate the potential effects of different tobacco control policies such as the implementation of 100% smoke-free environments (Bardach *et al.*, 2020), health warnings and plain packaging (Alcaraz *et al.*, 2020), advertising bans (Bardach *et al.*, 2021) and tobacco tax increases (Pichon-Riviere *et al.*, 2020). The extension of the model to estimate indirect costs has just been recently employed (Pinto *et al.*, 2019; Pichon-Riviere *et al.*, 2023).

Technical details, including calibration and validation methods, are described elsewhere (Pichon-Riviere *et al.*, 2011); the rest of this section briefly explains the main procedures to estimate the tobacco-attributable disease burden, direct and indirect costs and the potential effects of tobacco taxation. The reference year for the estimates is 2020; all monetary figures are in Mexican pesos of that year and were converted to US dollars using the corresponding exchange rate from the central bank (Banco de México, 2020). Details on model inputs are provided in the 'Model parameters' section.

Tobacco-attributable disease burden

To estimate disease events (acute and chronic) and premature deaths attributable to tobacco use, the results predicted by the model when the current smoking prevalence was considered were compared with what would be observed if all individuals were non-smokers. Since the model does not directly consider the effects of passive smoking and perinatal diseases (low birth weight, low birth stature, respiratory distress syndrome and sudden infant death syndrome), it was assumed that these causes impose an additional burden of 13.6% for men and 12% for women (Centers for Disease Control and Prevention, 2008).

To calibrate and test the validity of the model, we compared the estimates of disease-specific deaths by age and sex with figures from official mortality records in Mexico (Dirección General de Información en Salud, 2020a). Variations within a 15% margin were considered acceptable; in other cases, the risk equations were adjusted to provide more accurate results.

Healthcare costs

To estimate direct costs, annual treatment costs per disease for Mexico were incorporated into the model (Pichon-Riviere *et al.*, 2013). In other words, when the simulations predicted the occurrence of an adverse health event over the individual's lifetime, the costs of medical treatment during the first year (and subsequent, if appropriate) were considered. As noted earlier, the total direct cost results from aggregating the individual costs for a calendar year.

Labour productivity losses

Following the human capital approach (Krol and Brouwer, 2014), we considered labour productivity losses associated with (1) tobacco-attributable premature deaths and (2) reductions in productivity caused by tobacco-attributable diseases. In the first case, the costs were calculated as the present value of future wages that individuals would have obtained if they had not died prematurely. Specifically, we used the actuarial formula of the value of a statistical life (VSL) (Lev and Schwartz, 1971):

$$\mathrm{VSL}_j = \sum_t^T \mathrm{prob}(\mathrm{alive})_{j,t+1} * \mathrm{wage}_j * \left(\frac{1+g}{1+r}\right)^{T-t}$$

where prob (alive) is the probability of individual j of being alive at time $t+1$, wage is an estimate of the individual's annual labour income (according to sex and age), g is the expected growth rate of labour income, r is the discount rate and T is the official retirement age. Thus, the estimate of the VSL for individual j of a given sex and age at baseline is the sum of the products for each age up to the official retirement age. In the second case, we assumed that labour productivity reductions were equivalent to drops in the quality of life due to the health condition attributable to smoking. Hence, the value of lost productivity due to disability is the difference between the total labour income of a healthy person and the income of a person suffering from a disease attributable to smoking weighted by their level of utility.

Informal care costs

The model also calculated the costs of informal (unpaid) care provided to individuals with tobacco-attributable diseases, usually by female relatives or friends. First, based on the relevant literature, the average number of informal care hours for each disease was identified (Espinola *et al.*, 2023). Second, the hourly wages of residential care and healthcare workers in Mexico were used as a proxy for the opportunity cost of informal caregivers. Finally, following the same procedure for the calculation of direct costs, when the simulations predicted an adverse health event, disease-specific costs of informal care were considered.

Effect of tobacco taxation

We modelled a one-time 50% cigarette price increase, equivalent to raising the specific tobacco tax by 1.15 pesos (from 49.44 cents per cigarette at baseline to 1.64 cents) if the tax is fully passed onto consumers. Two alternative scenarios considered a price increase of 25% and 75%. To determine the potential effects of this intervention on the burden of morbidity and mortality and direct and indirect costs, the expected change in smoking prevalence was first estimated as follows:

$$\mathrm{Prev}_{\mathrm{post-tax}} = \mathrm{Prev}_{\mathrm{pre-tax}} + \left(\varepsilon * \Delta P * I * \mathrm{Prev}_{\mathrm{pre-tax}}\right)$$

where $\mathrm{Prev}_{\mathrm{post-tax}}$ is the post-tax smoking prevalence, $\mathrm{Prev}_{\mathrm{pre-tax}}$ is the smoking prevalence at baseline, ε is the price elasticity of the demand for cigarettes, ΔP is the percentage change in price and I is the proportion of the change in cigarette demand that is expected to affect smoking prevalence. For the last parameter, I, three scenarios were considered: (1) a short-term scenario that assumes that 50% of the reduction in cigarette demand corresponds to a drop in smoking prevalence that increases the number of former smokers ($I = 0.5$); (2) a mid-term scenario that adds the benefits derived from the reduction in the number of cigarettes smoked by those who continue smoking, specifically, it assumes a 75% reduction in the excess risk of smokers with respect to former smokers and (3) a long-term scenario that assumes that 75% of the reduction in cigarette demand corresponds to a fall in smoking prevalence that increases the number of never smokers ($I = 0.75$). The potential effects of the cigarette price increase were calculated for a 10-year period, in which a linear progression from Scenarios 1–3 was assumed. In other words, previously obtained estimates of the burden of disease and associated costs based on the current smoking prevalence were compared with those predicted based on the post-tax smoking prevalence. The present value of direct costs for a 10-year period was estimated using a discount rate of 5% (Haacker *et al.*, 2020).

The expected effect on tobacco tax revenue was also estimated as follows:

$$\Delta R = \Delta C * \frac{(\Delta P}{Tax)}$$

where ΔR is the percentage change in tobacco tax revenue, ΔC is the expected percentage change in cigarette consumption, ΔP is defined as earlier and Tax is the (post-increase) tobacco excise tax as a percentage of price.

Finally, although there is no robust evidence of the association between tobacco tax increases and the extent of the illicit tobacco trade, a sensitivity analysis was carried out in which the post-tax smoking prevalence was adjusted by a potential substitution of licit by illicit cigarettes using the following formula:

$$\text{Prev}_{\text{post-tax}} = \text{Prev}_{\text{pre-tax}} + [((1-\alpha) * \varepsilon) + (\alpha * \xi)] * \Delta P * I * \text{Prev}_{\text{pre-tax}}$$

where ξ is a proxy of the cross-price elasticity between licit and illicit cigarettes taken from a recent study for Colombia (Maldonado *et al.*, 2020), α is a weight given by the size of the illicit cigarette market in Mexico and the rest is defined as earlier.

Model parameters

Data came from a variety of sources, including national surveys, vital statistics and hospital discharge records, among others. Below is a brief description of the model parameters and data sources (Table 1).

Smoking prevalence

The prevalence of current smokers (those who currently smoke or have smoked in the past 30 days, either daily or occasionally), former smokers (those who do not currently smoke but have smoked in the past) and never smokers (those who have never smoked) by age (from 35 years) and sex was taken from the National Health and Nutrition Survey (ENSANUT) 2018–19 (Instituto Nacional de Salud Pública, 2020). The ENSANUT is a face-to-face, nationally representative survey that uses probabilistic, multistage sampling procedures to select households; up to one adult aged ≥20 years is interviewed per household (n = 43 070). This survey is the main source of information for monitoring the health and nutritional status of the Mexican population, as well as healthcare utilization, and employs internationally standardized questions to measure smoking prevalence (Global Adult Tobacco Survey Collaborative Group, 2012).

Mortality

Absolute risk estimates by age and sex for acute and chronic conditions were based on mortality data. Cause-specific deaths by age and sex for 2018 were taken from vital statistics (Dirección General de Información en Salud, 2020a), which are of high quality according to international assessments (Mathers *et al.*, 2005).

Lethality rates

Hospital discharge records from the public sector for 2017 were employed to calculate lethality rates, which are required for the risk equations (Dirección General de Información en Salud, 2020b). Specifically, the share of discharges of deceased patients by age (>35 years) and sex for each cause was estimated. Public sector hospitals include all hospitals administered by the Ministry of Health, social security institutions (IMSS and ISSSTE) and other public institutions with specific insurance schemes such as the government oil company (PEMEX) and the Ministry of the Navy. Nearly 80% of the population is treated in public hospitals (Shamah-Levy *et al.*, 2020).

Population

Population data to adjust all the estimates to the baseline year, 2020, come from the National Population Council (CONAPO), the institution responsible for calculating yearly population projections in Mexico (Consejo Nacional de Población, 2019).

Healthcare costs

Annual treatment costs per event for each cause considered are based on a detailed review of the cost of illness literature for Mexico (Appendix Table A2). The estimates employed cover the main healthcare providers, social security institutions and the Ministry of Health (Shamah-Levy *et al.*, 2020). All figures were converted into Mexican pesos of 2020 using the National Consumer Price Index (INPC) (Instituto Nacional de Estadística y Geografía, 2020).

Wages

Annual wages at baseline by age and sex were calculated using Mincer equations (Appendix Table A3) (Harberger and Guillermo-Peón, 2012):

$$\ln(\text{wage})_i = \alpha + \beta_k X_i + \gamma_r + \varepsilon_i$$

where $\ln(\text{wage})_i$ is the natural logarithm of labour income from the main occupation of individual i, X is a vector of individual-level characteristics that include age and age^2 (used as a proxy of experience) and education (1 = never attended, 2 = primary incomplete, 3 = primary complete, 4 = secondary incomplete, 5 = secondary complete, 6 = superior incomplete and 7 = superior complete), γ_r are regional fixed effects and ε_i is an individual-specific error term. Data for these estimates came from the National Occupation and Employment Survey (ENOE) 2020, which is a nationally representative survey that uses probabilistic, multistage sampling procedures to select households for face-to-face interviews (Instituto Nacional de Estadística y Geografía, 2021). The expected growth rate of wages was assumed to be equal to the long-term growth rate of GDP per capita reported by the World Bank (2021).

Informal care time

The number of hours of informal care required for each disease considered comes from a systematic review of the specialized literature conducted in PubMed and LILACS (Appendix Table A4). Details on search strategies and validation procedures are described elsewhere (Espinola *et al.*, 2023).

Table 1. Model parameters

Population (>35years)[a]					
Total				51 797 589	
Men				24 301 205	
Women				27 496 384	
Smoking status (>35 years)[b]					
		Smoker	Former smoker	Never smoker	
Total		15.49%	21.71%	62.80%	
Men		24.97%	33.83%	41.20%	
Women		7.88%	11.98%	80.13%	
Mortality rate (p/100 000),[c] lethality,[d] direct costs (MX$)[e] and informal care time (h p/year)[f] for main diseases					
		Mortality	Lethality	Treatment costs	Informal care time
AMI		193.79	23.64%	100 477.74	374
Stroke		66.97	13.18%	85 361.61	555
COPD	Mild	45.77	7.12%	6205.45	0
	Moderate			18 563.00	250
	Severe			191 403.05	2086
Lung cancer	First year	13.47	15.98%	285 825.86	1290
	Year 2+			369 576.91	
				96 765.87	
				(4244.12)	
Caregiver hourly wage (MX$ (US$))[g]				22.51	
				(0.99)	
Long-term wage growth[h]				1.70%	
Discount rate[i]				5%	
Price elasticity of the demand for cigarettes[j]				−0.45	
Tobacco excise tax (percentage of price)[k]				55.4%	
Tobacco tax revenue (MX$ (US$) in millions)[l]				42 484	
				(1863.33)	
Illicit trade (percentage of total cigarette consumption)[m]				8.8%	
Cross price elasticity between licit and illicit cigarettes[n]				0.17	
GDP (MX$ (US$) in trillions)[h]				23.43	
				(1.03)	
Retirement age[o]				65 years	
Exchange rate[p]				22.8	

[a]Consejo Nacional de Poblacion (2019).
[b]Own estimates based on data from the National Health and Nutrition Survey 2018–19 (Instituto Nacional de Salud Pública, 2020).
[c]Own estimates of crude mortality rates per 100 000 population >35 years based on mortality records (Dirección General de Información en Salud, 2020a).
[d]Own estimates based on hospital discharge records (Dirección General de Información en Salud, 2020a).
[e]See Pichon-Riviere *et al.* (2013).
[f]See Espinola *et al.* (2023).
[g]Own estimates based on data from the National Occupation and Employment Survey 2020 (Instituto Nacional de Estadística y Geografía, 2021).
[h]World Development Indicators (World Bank, 2021).
[i]See Haacker et al. (2020).
[j]See Jiménez-Ruíz *et al.* (2008) and Sáenz-de-Miera *et al.* (2022).
[k]Own estimates based on current regulations (IEPS and VAT Laws) and the average price per pack of 20 cigarettes (see details in Saenz-de-Miera *et al.* (2022)).
[l]See Secretaría de Hacienda y Crédito Público (2021).
[m]See Saenz-de-Miera *et al.* (2020).
[n]Own estimates based on Maldonado *et al.* (2020).
[o]CONSAR.
[p]See Banco de México (2020). MX = Mexican pesos, US$ = US dollars, US$1 = MX$22.8.

Price elasticity

The price elasticity of the demand for cigarettes was taken from previous studies for Mexico (Jiménez-Ruiz *et al.*, 2008; Saenz-de-Miera *et al.*, 2022), which are generally consistent with estimates for low- and middle-income countries (Marquez and Moreno-Dodson, 2017). A 10% increase in cigarette prices is expected to reduce demand by 4.5% on average. Since this parameter is key to the model, sensitivity analyses also employed two alternative estimates of price elasticity, −0.37 and −0.54. The cross-price elasticity between licit and illicit cigarettes was calculated using information from a recent study for Colombia that analysed consumption patterns before and after a tobacco tax increase (Maldonado *et al.*, 2020). Specifically, it was defined as the ratio between the percentage change in the participation of individuals who smoke illicit cigarettes in the total cigarette market (4.8%) and the percentage change in cigarette prices (28.2%). The baseline values (pre-tax) of the participation of smokers who use illicit cigarettes and the price per cigarette pack were 3.35% and COP$189.2, respectively, while the differences (post-tax) were 0.16 pp and COP$53.4, respectively.

Tobacco excise tax

The tobacco tax burden was calculated based on the average price per cigarette pack and the tax structure derived from current regulations (Saenz-de-Miera *et al.*, 2022). The tobacco tax revenue at baseline was taken from the Ministry of Finance and was used to calibrate the model (Secretaria de Hacienda y Crédito Público, 2021).

Table 2. Annual tobacco-attributable mortality and disease incidence by cause: Mexico 2020

Cause	Total deaths	Tobacco-attributable deaths		Total events	Tobacco-attributable events	
		n	%		*n*	%
AMI	102 060.7	15 826.2	15.5	387 179.4	84 739.8	21.9
Ischaemic heart disease	8267.3	1203.5	14.6	251 127.1	51 751.1	20.6
Non-ischaemic heart disease	22 866.7	2439.4	10.7			
Stroke	35 245.5	4060.4	11.5	261 235.5	34 810.2	13.3
Lung cancer	6922.1	5164.8	74.6	8277.4	6122.6	74.0
Pneumonia	26 455.8	4 076.6	15.4	265 376.0	43 966.3	16.6
COPD	23 872.8	17 424.8	73.0	302 954.4	196 576.1	64.9
Mouth and pharynx cancer	1383.1	758.1	54.8	3021.0	1655.1	54.8
Oesophagus cancer	1169.5	757.4	64.8	1296.0	832.0	64.2
Stomach cancer	6022.0	1057.8	17.6	7872.8	1382.3	17.6
Pancreatic cancer	4656.4	854.0	18.3	5408.0	996.7	18.4
Kidney cancer	2760.7	694.5	25.2	4531.6	1102.2	24.3
Laryngeal cancer	783.8	619.2	79.0	1552.4	1207.7	77.8
Leukaemia	2758.4	388.9	14.1	4123.7	608.8	14.8
Bladder cancer	1092.4	415.2	38.0	2112.3	785.8	37.2
Cervical cancer	4087.0	217.7	5.3	7074.5	404.0	5.7
Passive smoking and other causes	7274.6	7274.6	100.0			
Total	257 678.8	63 233.1	24.5	1 513 141.9	426 940.8	28.2

Illicit cigarette trade

The estimate of the illicit cigarette market in Mexico comes from a recent study that used two methodologies to validate the results, namely the collection of discarded cigarette packs and face-to-face surveys of smokers (Saenz de Miera Juarez *et al.*, 2021).

Results

Tobacco-attributable burden of disease

Table 2 shows the estimates of the burden of disease. Each year, >63 000 deaths are attributable to tobacco in Mexico (63 233), that is, 24.5% of the total deaths from the causes considered or 9.7% of the total deaths in the country. Deaths from COPD and AMI are the most numerous (17 425 and 15 826, respectively). The relevance of tobacco as a risk factor for COPD and cancers of oesophagus, mouth and larynx stands out since it is responsible for more than half of the deaths from these pathologies. Additionally, tobacco causes about 427 000 disease events annually (426 941), including 84 740 heart attacks and 15 097 cancer cases. Appendix Table A5 shows the results stratified by sex, which basically reflect the behaviour of the tobacco epidemic in Mexico, more focused on men.

Tobacco-attributable costs

The healthcare costs of tobacco-attributable diseases amount to 116.15 billion pesos per year or 9.3% of total health expenditure (Table 3). These costs are largely concentrated in the most frequent conditions, cardiovascular diseases (MX$38.6 billion) and COPD (MX$43.3 billion). The direct cost of other relatively less frequent but costly conditions such as lung cancer represents 5% of total attributable costs (MX$6.3 billion). On the other hand, the costs of the informal care of those who get sick from tobacco amount to about MX$20 billion, while productivity losses add up to MX$58.5 billion. In sum, total tobacco-attributable costs reach MX$194.6 billion or 0.8% of GDP, of which 60% corresponds to direct costs and the remaining 40% to indirect costs. Results stratified by sex are in Appendix Table A6.

Effects of tobacco taxation

Table 4 shows the benefits of increasing cigarette prices through taxation. Naturally, the scenario that considers the highest increase (75%) would result in much higher benefits. For example, premature deaths averted in the next 10 years would reach 73 747, compared to nearly 49 314 and 24 704 under the scenarios that consider price increases of 50% and 25%, respectively. The economic benefits would also be substantial. With a 50% cigarette price increase, direct costs averted in the following 10 years would reach MX$87.5 billion, while indirect costs averted would amount to MX$74.3 billion (MX$16.5 billion for averted informal care costs and MX$57.8 billion for averted productivity losses). In addition, tobacco tax revenue could reach up to MX$154.3 billion in this 10-year period. Sensitivity analysis implemented using different price elasticities (−0.37 and −0.54) provides lower and upper bounds for all the outcomes (in parenthesis in Table 4). Considering the most modest consumer response to price changes, premature deaths averted with a 50% price increase would be just >40 000 compared to almost 60 000 with the highest consumer response.

Finally, Figure 1 depicts the results of the sensitivity analysis that considers a potential increase in illicit cigarette consumption as a result of the price increase. While both health and economic benefits would be reduced if some smokers switch to illicit cigarettes instead of quitting, they would still be substantial. Specifically, a 50% cigarette price increase would prevent 43 224 premature deaths in the following decade and MX$136.2 billion in direct and indirect costs. Considering tobacco tax revenue, ∼92% of the economic benefits would be maintained (MX$290.5 million).

Table 3. Annual tobacco-attributable direct and indirect costs by cause, MX$ (US$) in millions: Mexico 2020

			Labour productivity losses			
Cause	Direct costs	Informal care costs	Premature mortality	Disability	Total	Total
Cardiovascular diseases	38 641.0 (1694.8)	5359.3 (235.1)	8336.2 (365.6)	7545.1 (330.9)	15 881.3 (696.5)	59 881.6 (2626.4)
COPD	43 285.6 (1898.5)	7832.1 (343.5)	4078.7 (178.9)	12 856.2 (563.9)	16 934.9 (742.8)	68 052.6 (2984.8)
Stroke	6925.3 (303.7)	2932.7 (128.6)	2328.6 (102.1)	4288.0 (188.1)	6616.6 (290.2)	16 474.4 (722.6)
Lung cancer	6279.8 (275.4)	533.6 (23.4)	1360.9 (59.7)	2148.5 (94.2)	3509.4 (153.9)	10 322.8 (452.8)
Other cancers	6230.9 (273.3)	858.7 (37.7)	2777.9 (121.8)	4600.0 (201.8)	7377.9 (323.6)	14 467.5 (634.5)
Pneumonia	1193.5 (52.3)	129.6 (5.7)	1284.4 (56.3)	10.2 (0.4)	1294.6 (56.8)	2617.7 (114.8)
Passive smoking and other causes	13 594.5 (596.3)	2334.5 (102.4)	2685.9 (117.8)	4194.6 (184.0)	6880.4 (301.8)	22 809.4 (1000.4)
Total	116 150.6 (5094.3)	19 980.4 (876.3)	22 852.5 (1002.3)	35 642.6 (1563.3)	58 495.0 (2565.6)	194 626.1 (8536.2)

MX = Mexican pesos, US$ = US dollars, US$1 = MX$22.8.

Table 4. Estimated 10-year health and economic benefits under three cigarette price increase scenarios

	Price increase		
	25%	50%	75%
Health benefits			
Premature deaths averted	24 704.0 (20 312.2–29 644.8)	49 314.4 (40 547.4–59 177.3)	73 746.7 (60 636.2–88 496.1)
Cardiovascular disease events averted	60 912.0 (50 083.2–73 094.4)	121 919.2 (100 244.7–146 303.0)	182 838.7 (150 334.0–219 406.4)
Stroke events averted	27 698.5 (22 774.3–33 238.2)	55 490.9 (45 625.9–66 589.1)	83 281.1 (68 475.5–99 937.3)
Cancer events averted	6131.8 (5041.7–7358.1)	12 018.5 (9881.9–14 422.2)	17 979.4 (14 783.1–21 575.3)
COPD events averted	52 720.2 (43 347.7–63 264.2)	105 443.3 (86 697.8–126 532.0)	158 121.5 (130 011.0–189 745.7)
Economic benefits (MX$, in millions)			
Healthcare costs averted	43 823.7 (36 032.8–52 588.5)	87 475.1 (71 923.9–104 970.1)	131 253.0 (107 919.1–157 503.6)
Informal care costs averted	8235.4 (6771.3–9882.5)	16 514.1 (13 578.3–19 816.9)	24 795.7 (20 387.6–29 754.9)
Labour productivity loss averted	29 051.2 (23 888.8–34 857.7)	57 809.2 (47 541.0–69 356.2)	86 482.1 (71 127.8–103 745.2)
Tax revenue increase	95 507.9 (81 208.9–110 209.0)	154 344.7 (137 626.3–167 611.5)	176 510.4 (169 252.2–172 207.7)
Total economic benefit	176 618.2 (147 901.9–207 537.6)	316 143.1 (270 669.6–361 754.7)	419 041.2 (368 686.8–463 211.4)

Lower and upper bounds provided in parenthesis correspond to the outcomes of sensitivity analyses conducted using alternative price elasticity estimates, −0.37 and −0.54, respectively (instead of −0.45 for the main analysis). MX = Mexican pesos, US$ = US dollars, US$1 = MX$22.8.

Discussion

The burden of disease and the main social costs associated with tobacco use in Mexico are considerable. Each year, tobacco use causes 63 000 premature deaths and 427 000 disease events, and current tobacco tax revenue barely covers 23.3% of the total costs attributable to tobacco, which are estimated at MX$194.6 billion—MX$116.2 direct costs and MX$78.5 indirect costs. In line with previous studies for the country (Fleischer *et al.*, 2017; Saenz-de-Miera *et al.*, 2022) and a comprehensive literature review for the region (Miracolo *et al.*, 2021), however, we show that increasing cigarette prices by 50% would bring substantial benefits. Specifically, premature deaths averted in the decade following the tax increase would exceed 49 000, while direct and indirect costs averted would amount to MX$87.5 billion and MX$74.3 billion, respectively. Moreover, we show that tobacco taxation is highly effective even in the presence of illicit trade. In the most pessimistic scenario in which illicit tobacco trade increases due to higher excise taxes, the health and economic benefits far outweigh any potential losses.

A common concern that arises when discussing tobacco tax increases is related to welfare effects and its distribution among socioeconomic groups, as the tax negatively impacts household budgets, especially those of the poorest households who allocate higher shares to purchases of tobacco products (as in Mexico) (Chaloupka *et al.*, 2012). However,

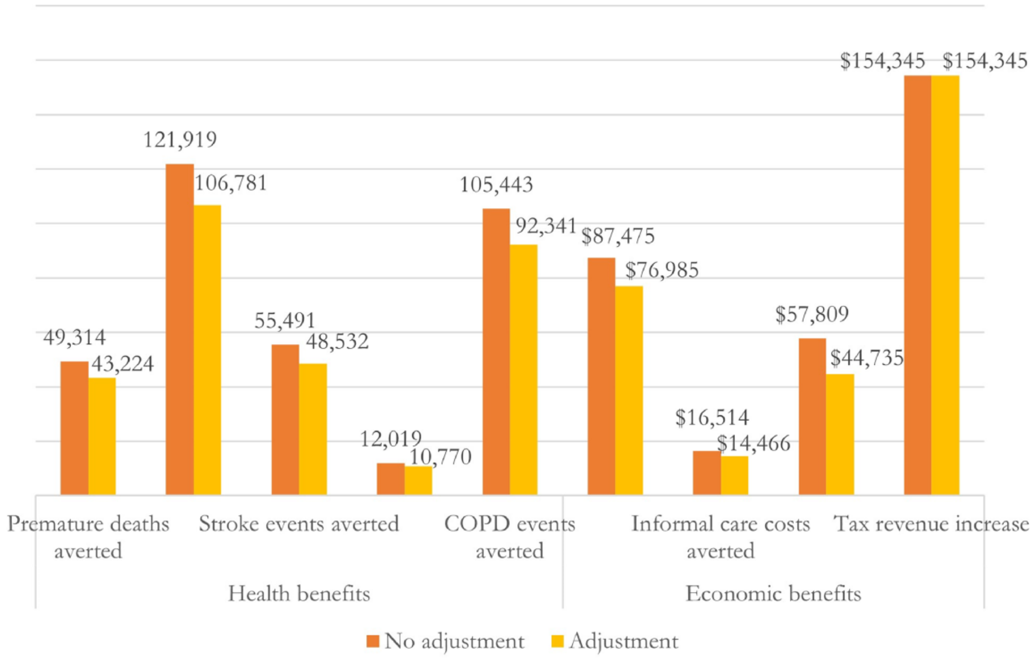

Figure 1. Estimated 10-year health and economic benefits of a 50% cigarette price with and without adjustment for illicit trade

studies using a similar approach to ours suggest that welfare losses produced by the initial price shock are offset by the long-term benefits derived from reduced medical expenditures and increased productivity, which are usually higher for the most disadvantaged due to their greater price-responsiveness (Global Tobacco Economics Consortium, 2018; Fuchs *et al.*, 2019). In particular, a recent study in 13 middle-income countries showed that a 50% tobacco price increase would largely favour those in the bottom income group as they would obtain 31% of the life years gained and 29% of the averted costs while paying only 10% of the additional tax revenue (Global Tobacco Economics Consortium, 2018). Likewise, a study for eight low- and middle-income countries also concluded that tobacco tax increases are pro-poor and welfare-improving (Fuchs *et al.*, 2019). The main contribution of this study is to delve into the measurement of the long-term gains of tobacco taxation, although future studies should present estimates disaggregated by socioeconomic groups to more clearly address distributional impacts. It is also important to consider that the allocation of the additional tax revenue can also be welfare-improving if it is invested in expanding access to smoking cessation services and tobacco-related medical expenses for those who continue smoking after the tax increase, especially the less well off.

Although recent progress was made in Mexico to recover the value of the specific tobacco tax, the last tax increase took place >12 years ago. As a result, the country lags behind in the most cost-effective measure to combat the tobacco epidemic, with a combined tax burden of 69.2% (excise + VAT) that is still well below international best practice (World Health Organization, 2021). At the same time, overall smoking prevalence has remained at ∼17% for over a decade (Zavala-Arciniega *et al.*, 2020; Shamah-Levy *et al.*, 2022), which poses a major challenge to advance in the reduction of NCDs as envisioned in the 2030 Agenda (United Nations General Assembly, 2015). Our results suggest that increasing the excise tax could play a key role in reducing smoking prevalence and its health and economic consequences. Furthermore, combined with the reforms approved last year that established 100% tobacco-free environments throughout the country and the complete ban on advertising, the effects of the tax policy on successful quitting could be enhanced (Fleischer *et al.*, 2017; Secrataria de Salud, 2022).

Globally, the evidence on the indirect costs associated with tobacco use is still limited, but some studies for high- and middle-income countries such as the USA (Shrestha *et al.*, 2022), China (Ju-Fang *et al.*, 2020), Sri Lanka (Amarasinghe *et al.*, 2018), Thailand (Bundhamcharoen *et al.*, 2016) and Vietnam (Hoang Anh *et al.*, 2016) had shown that labour productivity losses constitute a significant share of the total costs attributable to smoking. In Latin America, a study for Brazil indicated that these indirect costs represent 30% of the total economic burden of tobacco use (Pinto *et al.*, 2019). Our findings are in line with this evidence and suggest that a previous study focused on the social security provider for formal sector employees underestimated the magnitude of labour productivity losses attributable to tobacco in Mexico (Guerrero-López *et al.*, 2012). On the other hand, the costs of informal care for those who become ill from tobacco have been practically ignored in economic evaluations. According to the results of this study, however, more than a quarter of the indirect costs attributable to tobacco correspond to unpaid care costs (MX$20 billion). Moreover, these costs represent a burden that falls heavily on women, contributing to gender inequalities. These new figures represent an important strength of our modelling exercise. Although national surveys on time use do not usually detail the time spent on care tasks by gender, a comprehensive literature review found that between 70% and 80% of informal caregivers were women, aged 50–60 years (Espinola *et al.*, 2023). In Mexico, it has been estimated that women spend an average of 4 h more than men in unpaid care tasks in general (OXFAM Mexico, 2019). This unequal distribution significantly affects women's employment decisions and has important consequences on well-being. Accordingly, considering the value of informal caregiving is essential to understand the actual social costs of tobacco and show the need to design policies related to informal caregiving with a gender perspective (Organización Panamericana de la Salud, 2008).

This study has some limitations. First, although we used the best information available for the country, some indicators such as lethality rates are only an approximation. The same can be said in a few cases where we used international parameters in the absence of country-specific data. Information on informal care in Mexico was particularly scarce and deserves further investigation. Second, we covered the main sources of indirect costs attributable to tobacco, but others will have to be addressed in subsequent studies. For example, it has been estimated that 680 388 tons of waste from cigarette butts are generated annually, which imposes significant cleaning costs (Kaza *et al*., 2018). Likewise, we considered the main diseases caused by tobacco use but excluded others such as diabetes and hepatocarcinoma. Third, the model provides aggregate estimates. Future extensions of the model should explore subnational differences, especially important in countries like Mexico where the tobacco epidemic varies by region (Shamah-Levy *et al*., 2020; 2022; Saenz-de-Miera *et al*., 2022), as well as patterns across socioeconomic groups to better understand the distributional effects of tobacco taxation. Fifth, the model evaluates the impact of price increases rather than tax increases, i.e. it assumes that average prices will increase by 25%, 50% or 75% and do not consider the tax change that would be required to achieve those price increases. However, it is worth mentioning that a recent analysis found that, on average, the 2020 tax adjustment implemented in Mexico was fully passed onto consumers (Saenz-de-Miera *et al*., 2024). If we observed a 100% pass-through, the 50% price increase could be obtained by raising the tax by 1.15 pesos as mentioned earlier. Finally, the model did not consider electronic cigarette use since they are prohibited, and the national prevalence is not >2% (Secretaria de Salud, 2022; Barrera-Núñez *et al*., 2023).

Conclusions

Tobacco use imposes high social costs and disease burden on the Mexican population, but fiscal policy could be a highly effective intervention to reduce this burden and save lives. A 50% cigarette price increase could prevent ∼49 000 deaths and yield economic benefits of up to MX$156.5 billion in the next 10 years, without considering the additional tax revenue that could be employed to improve the sustainability of the health system. Such progress in tobacco taxation would be especially important in the context of other recent interventions implemented in the country, including a total ban on tobacco advertising, to optimize synergy and resume momentum to control the tobacco epidemic.

Data availability

The data underlying this article are available in the article and in its online supplementary material.

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Author contributions

B.S.-d.-M. and L.M.R.-S. implemented the project in Mexico, prepared the databases, model indicators and data collection in Mexico and wrote the first draft of the manuscript. A.P., A.C. and N.E. validated the economic data and analysed healthcare and indirect health costs. A.B. validated the epidemiological data on tobacco use and disease burden (morbidity and mortality). F.R.C. and A.A. reviewed, interpreted and wrote the results. F.A. and A.P.-R. conceived the original project, the work design for the countries of Latin America, and performed the critical review of the article. All authors reviewed and approved the final version before submitting it to the journal.

Reflexivity statement

The authors are four women and six men and consider three young researchers working with others with extensive experience and seniority in tobacco control. The researchers (two women) from Mexico have broad experience in economics, epidemiology and evaluation of tobacco control public policies at the local level. Researchers from Argentina have developed the simulation model for over a decade with vast experience in epidemiology, economics and public health policy in ∼15 countries in the Americas region and other low- and middle-income countries globally.

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Conflict of interest: None declared.

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Appendix

Table A1. Coding of diseases considered according to the 10th revision of the International Classification of Diseases (ICD-10)

ICD-10 codes	Description
C00–C148	Mouth and pharyngeal cancer
C150–C159	Oesophagus cancer
C160–C169	Stomach cancer
C22	Liver cancer
C250–C259	Pancreatic cancer
C32	Laryngeal cancer
C34	Lung cancer
C50	Breast cancer
C53	Cervical cancer
C64	Kidney cancer
C65	Renal pelvic cancer
C67	Bladder cancer
C920	Acute myeloblastic leukaemia
E10–E14	Diabetes
I21–I22	AMI
I20; I24; I25	Unstable angina
I00x; I010–I012; I018–I020; I029; I050–I052; I058; I062; I068–I072; I078–I083; I088–I092; I098–I099; I110; I119; I260; I269–I272; I278–I281; I288; I289; I300; I301; I308–I313; I318–I319; i320*; I321*; I328*; I330; I339–I342; I348–I352; I358–I362; I368–I372; I378; I379; I38X; I390*–I394*; I398*; I400; I401; I408; I409; I410*–I412*; I418*; I420–I429; I430*–I432*; I438*; I440–I447; I450–I456; I458–I461; I469–I472; I479; I48X; I490–I495; I498–I501; I509–I519; I059.I060-1. I700–I702; I708; I709	Non-ischaemic cardiovascular diseases
I600–I629; I630–I639; I64x; I678; I679; I690–I694; I698	Stroke
I700–I708	Atherosclerosis
I71	Aneurysm and dissection
I72	Other aneurysms
I73	Other peripheral vascular diseases
I74	Arterial embolism and thrombosis
I77	Other affections of arteries and arterioles
I78	Capillary diseases
J10–J18	Pneumonia and influenza
J40–J43	Bronchitis and emphysema
J44	Airway obstruction

Table A2. Medical care costs of main tobacco-attributable diseases

	January 2020 (MX$)
AMI	100 477.74
Coronary event no AMI, first year	66 115.80
Coronary event no AMI, post-event care	25 708.51
Stroke, first year	85 361.61
Stroke, year 2+	13 517.91
Pneumonia/influenza	27 145.94
Mild COPD	6 205.45
Moderate COPD	18 563.00
Severe COPD	191 403.05
Lung cancer, first year	285 825.86
Lung cancer, year 2+	369 576.91
Mouth cancer, first year	205 793.96
Mouth cancer, year 2+	140 438.96
Oesophageal cancer, first year	240 092.95
Oesophageal cancer, year 2+	162 614.39
Stomach cancer, first year	234 377.37
Stomach cancer, year 2+	177 396.65
Pancreatic cancer, first year	194 361.42
Pancreatic cancer, year 2+	133 048.51
Kidney cancer, first year	205 793.96
Kidney cancer, year 2+	144 134.87
Laryngeal cancer, first year	234 377.37
Laryngeal cancer, year 2+	170 006.20
Leukaemia, first year	308 690.94
Leukaemia, year 2+	354 794.67
Bladder cancer, first year	194 361.42
Bladder cancer, year 2+	177 396.65
Cervical cancer, first year	99 142.51
Cervical cancer, year 2+	27 543.23

Source: Pichon-Riviere *et al.* (2013). MX$ = Mexican pesos.

Table A3. Mincer equations (dependent variable = ln (wage))

	Men		Women	
	Coefficient	*t*	Coefficient	*t*
Age	0.0335***	6.69	0.0161**	2.55
Age^2	−0.0004***	−6.81	−0.0002***	−2.62
Education				
None	0.1420***	5.73	0.0895***	2.85
Primary incomplete	0.2476***	10.81	0.1689***	5.99
Primary complete	0.3393***	15.32	0.2441***	8.85
Secondary incomplete	0.4701***	20.38	0.4296***	14.90
Secondary complete	0.6361***	21.97	0.5362***	15.99
Superior incomplete	0.9839***	42.43	0.9529***	33.70
Superior complete	Reference		Reference	
Constant	2.3988***	20.01	2.7416***	18.31
Region fixed effects	Yes		Yes	
Observa-tions	40 724		29 695	

***p<0.01, **p<0.05. Source: Own estimates based on data from the National Occupation and Employment Survey 2020 (INEGI)

Table A4. Informal care time required for conditions associated with tobacco use

	Mean hours per year	95% CI
AMI	374	321–427
Coronary event no AMI, first year	351	299–405
Coronary event no AMI, post-event care	183	128–237
Stroke, first year	555	500–606
Stroke, year 2+	379	325–431
Pneumonia/influenza	131	77–183
Mild COPD	0	0–55
Moderate COPD	250	197–303
Severe COPD	2086	2033–2139
Lung cancer	1290	1237–1343
Mouth cancer	877	825–931
Oesophageal cancer	1436	1383–1489
Stomach cancer	1825	1770–1876
Pancreatic cancer	1825	1770–1876
Kidney cancer	706	653–759
Laryngeal cancer	804	752–858
Leukaemia	512	460–566
Bladder cancer	1202	1150–1256
Cervical cancer	813	759–865

Source: Espinola *et al.* (2023). 95% CI = 95% confidence interval.

Table A5. Annual tobacco-attributable mortality and disease incidence by cause and gender: Mexico 2020

Cause	Total deaths	Tobacco-attributable deaths		Total events	Tobacco-attributable events	
		n	%		*n*	%
Women						
AMI	45 450.4	3196.2	7.0	113 66.7	9219.9	8.1
Ischaemic heart disease	3 738.0	252.3	6.7	83 780.7	7075.0	8.4
Non-ischaemic heart disease	12 349.4	489.5	4.0			
Stroke	17 973.6	1094.1	6.1	126 146.6	9056.8	7.2
Lung cancer	2730.4	1470.9	53.9	3413.2	1838.1	53.9
Pneumonia	12 186.0	857.7	7.0	126 379.7	11 430.5	9.0
COPD	8625.6	5026.0	58.3	113 880.7	56 456.1	49.6
Mouth and pharynx cancer	590.8	172.8	29.3	1329.9	390.5	29.4
Oesophagus cancer	252.2	98.2	38.9	302.9	116.7	38.5
Stomach cancer	2866.0	171.6	6.0	3769.2	225.8	6.0
Pancreatic cancer	2468.4	317.9	12.9	2899.1	376.1	13.0
Kidney cancer	1071.8	25.7	2.4	1907.7	50.8	2.7
Laryngeal cancer	105.6	61.4	58.1	256.9	135.7	52.8
Leukaemia	1329.5	50.6	3.8	1963.9	83.1	4.2
Bladder cancer	319.6	49.0	15.3	682.6	106.1	15.5
Cervical cancer	4087.0	217.7	5.3	7074.3	403.8	5.7
Passive smoking and other causes	1626.2	1626.2	100.0			
Total	117 770.7	15 177.9	12.9	587 354.1	96 964.9	16.5
Men						
AMI	56 610.3	12 630.0	22.3	273 612.7	75 519.9	21.9
Ischaemic heart disease	4529.3	951.3	21.0	167 346.5	44 676.0	20.6
Non-ischaemic heart disease	10 517.3	1949.9	18.5			
Stroke	17 271.9	2966.3	17.2	135 088.9	25 753.4	13.3
Lung cancer	4191.7	3693.9	88.1	4864.2	4284.5	74.0
Pneumonia	14 269.8	3218.9	22.6	138 996.3	32 535.8	16.6
COPD	15 247.2	12 398.8	81.3	189 073.6	140 120.0	64.9
Mouth and pharynx cancer	792.3	585.2	73.9	1691.1	1264.7	54.8
Oesophagus cancer	917.3	659.2	71.9	993.1	715.3	64.2
Stomach cancer	3156.0	886.1	28.1	4103.5	1156.5	17.6
Pancreatic cancer	2188.0	536.1	24.5	2508.8	620.6	18.4
Kidney cancer	1688.9	668.8	39.6	2623.9	1051.4	24.3
Laryngeal cancer	678.2	557.9	82.3	1295.5	1072.1	77.8
Leukaemia	1428.9	338.3	23.7	2159.8	525.8	14.8
Bladder cancer	772.8	366.2	47.4	1429.7	679.8	37.2
Cervical cancer						
Passive smoking and other causes	5767.3	5767.3	100.0			
Total	140 27.0	48 174.1	34.4	1 513 141.9	426 940.8	28.2

MX = Mexican pesos, US$ = US dollars, US$1 = MX$22.8.

Table A6. Annual tobacco-attributable direct and indirect costs by cause and gender (MX$ in millions): Mexico 2020

			Labour productivity losses		
Cause	**Direct costs**	**Informal care costs**	**Premature mortality**	**Disability**	**Total**
Women					
Cardiovascular diseases	4213.9	577.8	881.4	395.0	6068.1
COPD	1938.1	849.1	974.8	2962.6	6724.6
Stroke	12 466.9	2260.7	543.3	1025.3	16 296.2
Lung cancer	310.3	33.7	434.0	352.3	1130.3
Other cancers	2040.1	172.4	517.3	411.1	3140.9
Pneumonia	1101.0	189.3	198.5	2.3	1491.1
Passive smoking and other causes	2648.4	490.0	425.9	617.8	4182.1
Total	24718.7	4573.0	3975.2	5766.4	39 033.3
Men					
Cardiovascular diseases	34 427.1	4781.4	7454.8	7150.1	53 813.4
COPD	4987.2	2083.5	3103.9	9893.6	20 068.2
Stroke	30 818.7	5571.4	1785.2	3262.7	41 438.0
Lung cancer	883.2	95.9	926.9	1796.2	3702.2
Other cancers	4239.7	361.3	2260.6	4188.9	11 050.5
Pneumonia	5129.9	669.4	1085.9	7.9	6893.1
Passive smoking and other causes	10 946.1	1844.6	2259.9	3576.7	18 627.3
Total	91 431.9	15 407.5	18 877.2	29 876.1	155 592.7