Development and Validation of a Microsimulation Economic Model to Evaluate the Disease Burden Associated with Smoking and the Cost-Effectiveness of Tobacco Control Interventions in Latin America

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ABSTRACT

Objective: To describe the development and validation of a health economic model (HEM) to address the tobacco disease burden and the cost-effectiveness of smoking cessation interventions (SCI) in seven Latin American countries. Methods: The preparatory stage included the organization of the research network, analysis of availability of epidemiologic data, and a survey to health decision makers to explore country-specific information needs. The development stage involved the harmonization of a methodology to retrieve local relevant parameters and develop the model structure. Calibration and validation was performed using a selected country dataset (Argentina 2005). Predicted event rates were compared to the published rates used as model inputs. External validation was undertaken against epidemiologic studies that were not used to provide input data. Results: Sixty-eight decision makers were surveyed. A microsimulation HEM was built considering the availability and quality of epidemiologic data and relevant outcomes conceived to suit the identified information needs of decision makers. It considers all tobacco-related diseases (i.e., heart, cerebrovascular and chronic obstructive pulmonary disease, pneumonia/influenza, lung cancer, and nine other neoplasms) and can incorporate individual- and population-level interventions. The calibrated model showed all simulated event rates falling within ±10% of the sources (-9%–5%). External validation showed a high correlation between published data and model results. Conclusions: This evidence-based, internally and externally valid HEM for the assessment of the economic consequences of smoking and SCIs incorporates a broad spectrum of tobacco related diseases, SCI, and benefit measures. It could be a useful policymaking tool to estimate tobacco burden and cost-effectiveness of SCI. Keywords: cost-effectiveness, cost-utility, disease burden, economic model, Latin America, Monte Carlo microsimulation, smoking cessation interventions, tobacco, validation.

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Introduction

Smoking is the single most preventable cause of disease and death worldwide, and this burden is increasingly shifting from upper to lower and middle-income countries. In the year 2000 there were 4.83 million premature tobacco-related deaths [1], and this number is expected to grow to 10 million per year by 2030 [2,3]. Currently half of the current tobacco-attributable deaths occur in high-income countries [1,3]; however, by the year 2030 7 out of 10 of these deaths are expected to occur in developing countries. This represents one out of six of all the deaths around the world [3].

Although the Framework Convention Tobacco Control from World Health Organization has been signed by almost every country in the Latin American region [4], tobacco control policies are still scarce in these countries.

The lack of quality information related to the health and economic consequences of tobacco use in our region is an important barrier for the implementation of evidence-based tobacco control policies. This has led to a biased assessment by policy makers, resulting in a distorted prioritization of health policies where tobacco control interventions are considered less urgent than action on other diseases [5].

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Model-based health economic evaluations (HEEs) are widely accepted as decision-making tools [6] that can provide valuable information for the optimization of health resource allocation [7]. Although in many developed countries this “fourth hurdle” based on health economic evidence is required to shape health policies [8], there is still little experience in Latin America [9]. This project constitutes a collaboration among seven Latin American countries that aims to provide relevant evidence to inform tobacco control policies.

The LatinCLEN Tobacco Research Group, an international and interdisciplinary network, is composed of eight research units from the Latin American chapter of the International Clinical Epidemiology Network in Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru. The specific aims for this project were to select and develop the most suitable methodologic framework, as well as to elaborate a common health economic model to estimate the smoking-related disease burden and the cost-effectiveness of smoking cessation interventions (SCIs). In this article we present the details of the model’s development, structure, and validation using data inputs from one of the participating countries.

Material and Methods

The final model structure and its inputs were agreed after two stages; the preparatory stage and the development stage.

Preparatory stage

Organization of a research network to monitor the model building process and to ensure the generalizability to all participant countries. The LatinCLEN Tobacco Research Group was formed in 2004. The group designed two surveys that were completed in each country to 1) evaluate the availability, cost, and current coverage policies of SCIs; and 2) assess the availability and the quality of relevant information to be incorporated in each country-specific analysis (e.g., local epidemiology and cost of smoking-related diseases).

Performance of a rapid systematic review of existing health economic evaluations regarding tobacco cessation strategies. Forty-four individual studies and seven reviews published between 1984 and 2003 (search data up to November 2004) were critically assessed.

Design and administration of a survey to health decision makers to explore country-specific information needs when deciding on the implementation and coverage of SCIs. As future users of the HEE, relevant decision makers from the different health sectors in the seven participant countries defined the key aspects to be considered (e.g., relevant time horizon and relevant perspective) and the outcomes to be reported (e.g., the number of cases prevented, life years gained, or quality-adjusted life years [QALYs]) in the HEE.

Development stage

This stage involved the following tasks: 1) definition of the methodology for the information source selection and parameter incorporation; 2) development of the model structure; and 3) calibration and validation of the model.

The research group used Email and a Web-based platform to exchange documents, outlines, and ideas. The development of the model was completed in three phases: 1) based on information obtained in the preparatory stage, a first draft of the health economic model was sent to the participating countries for feedback, including the basic structure, disease states to be incorporated, and main assumptions; 2) three consultation rounds for refining the model description and structure; and 3) a face-to-face research meeting carried out in Buenos Aires, Argentina, during November 2006 where participants agreed on the final version of the HEE.

Excel (Professional Edition 2003, then updated to version 2007, Microsoft Corp., Redmond, WA) with Visual Basic Macros (version 6.3, Microsoft Corp., Redmond, WA) was selected as the model platform to easily share the information. A software package was installed to improve the original Excel’s random number generator function [10,11].

Results

Preparatory stage

The surveys and data retrieved in each country showed that implementation of tobacco control interventions was a relevant issue in the region. Sixty-eight decision makers (9–10 from each of the participating countries) completed the survey. The majority of decision makers belonged to the public (56%) or the social security (25%) health care sector and 80% considered that the lack of coverage for SCI adversely affected the prevalence of smoking in their institutions and countries. Ninety-three percent considered that this level of coverage should be increased and 83.3% believed that SCI should be included in the national lists or basket of mandatory coverage in their countries. When asked about what would be the most relevant information on the interventions needed when having to decide their incorporation into the health system, most of the decision makers identified the cost per QALY, cost per life-year saved, and budget impact information. The decision makers also mentioned a wide range of interventions that they considered should be evaluated for coverage, from population-wide interventions to pharmacological treatments, so the HEE had to be able to include all these aspects. On the other hand, the survey of epidemiologic data showed that the availability and quality of information in the region was very heterogeneous and poor, especially with regard to the incidence of events, thus making it necessary to design and harmonize a methodology to estimate locally relevant information in each country. All the results obtained during this first stage strongly influenced many of the decisions made later and shaped the type and structure of the model to be developed.

Development stage

Information source selection and parameter incorporation. We defined a decision rule that would establish a priority order among the possible data sources to populate the model: 1) use good quality local (country-specific) sources when available [12-14]; 2) use international sources when local data were unavailable or poor and when the parameter was considered transferable from other settings; or 3) derive or estimate the parameter from the best available local data when international sources were considered non-transferable.

Special attention was paid to the estimation of baseline disease event incidence in nonsmokers because these data are keys to the generalizability of the model. Given the low availability of information encountered in the region, we defined a common methodology, anchored on national health statistics, to derive these parameters from mortality data. This methodologic assumption linking mortality to incidence data is a widely used assumption in epidemiologic and health economic models, used by the World Health Organization in tools such as DisModII or the WHO-
CHOICE, and by GLOBOCAN [15-20]. Different approaches were taken for acute events or chronic conditions. For acute events, such as cardiac or cerebrovascular events, the first step was to obtain the age-, sex- and country-specific absolute risk of the event based on the specific mortality rate and the lethality of the event:

\[ R_{\text{pop},\text{event}} = \frac{R_{\text{death}}}{L} \]  

(1)

where \( L \) is the lethality of the event and \( R_{\text{death}} \) is the age- and sex-specific mortality of the condition. Once this absolute risk is known, the baseline risk in nonsmokers was calculated based on the age-, sex- and country-specific smoking prevalence as well as disease-specific smoking relative risk:

\[ R_{\text{nonsmk}} = R_{\text{pop},\text{event}} \left( \frac{R_{\text{smk}} \times f_{\text{smk}} + R_{\text{former smk}} \times f_{\text{formersmk}} + f_{\text{nosmk}}}{R_{\text{pop}} + R_{\text{smk}} + R_{\text{former smk}} + R_{\text{nosmk}}} \right) \]  

(2)

where \( R_{\text{nonsmk}} \) is the baseline event annual incidence in non-smokers, \( R_{\text{pop},\text{event}} \) is the age- and sex-specific population risk (obtained with formula 1), \( R_{\text{smk}}, R_{\text{former smk}} \) and \( f_{\text{smk}}, f_{\text{formersmk}} \) and \( f_{\text{nosmk}} \) are the relative risks of the event in smokers and former-smokers versus nonsmokers, and \( f_{\text{smk}}, f_{\text{formersmk}} \) and \( f_{\text{nosmk}} \) are the age- and sex-specific proportion of smokers, former-smokers, and nonsmokers. For cancer (as chronic conditions), the age and sex estimation of the probability of diagnosis was calculated using a more complex approach that considered both the annual mortality rate from national statistics as well as the estimated yearly survival rate since diagnosis. The age- and sex-specific risk of diagnosis for each cancer was calculated with the following formula:

\[ R_{\text{diagnosis},i} = \left( \sum_{n} R_{\text{mortality},i,n} \times P_{n} \right) \times \frac{1}{1 - S_{10}} \]  

(3)

where \( R_{\text{diagnosis},i} \) is the risk of diagnosis at age \( i \); \( R_{\text{mortality},i,n} \) is the population risk of death from the specific cancer at age \( i + n \); \( P_{n} \) is the conditional probability of dying in year \( n \) after the diagnosis, conditional on dying within 10 years; and \( S_{10} \) is the proportion of survivors after 10 years. We assumed that those subjects surviving 10 years after a lung cancer diagnosis, or five for other cancers, return to the general population risk of death. Then, the formula (2) was applied to derive the baseline risk in nonsmokers.

A special case was chronic obstructive pulmonary disease (COPD). Because national statistics are known to significantly underestimate COPD-related mortality, we estimated its incidence and prognosis based on international studies [21,22].

Model structure and operation. A first order Monte Carlo, or probabilistic microsimulation of individual subjects, was built. This model incorporates the natural history, costs, and quality of life of all the tobacco-related adult-specific diseases: coronary and non-coronary heart disease, cerebrovascular disease, COPD, pneumonia, influenza, lung cancer, and nine other neoplasms. This model allows the follow-up of the lives of thousands of individuals in hypothetical cohorts, calculating all outcomes for each patient in an annual basis, using the simulation of each individual’s history to ultimately obtain aggregated population results in terms of health and costs. Subjects can be assigned demographic and disease specific characteristics. The model updates the values of the various input parameters for each patient in a yearly basis and calculates event rates for outcomes on the basis of the variables and the underlying risk equations.

The model runs on Visual Basic and captures the key parameters from four main spreadsheets: 1) sex- and age-specific epidemiologic data; 2) unit cost; 3) quality of life; and 4) interventions effects. It consists of two main modules. The first one is used for the analysis of the disease burden associated with smoking, in which age and sex detailed information of selected epidemiologic and economic data is kept (e.g., the number of events suffered by the cohort throughout specific ages, the distribution of COPD stages or the prevalence of coronary heart disease). The second module is the one that performs the cost-effectiveness analysis, and it focuses on the comparison of the experience of two cohorts for whom different sets of interventions are defined. The cohorts are then followed during their lifetime, and the aggregated results are compared in terms of costs and benefits.

Disease incidence, progression, and mortality. For each time period, the model estimates the individual risks of occurrence of each event, disease progression and death, based on the subject’s demographic attributes, smoking status, and clinical conditions. Table 1A shows a list of possible events a subject can suffer in each time period and the calculation method used to derive it. Table 1B shows the different health states considered in the model. The risk of death is calculated for each time unit as the age- and sex-specific general mortality, excluding the 16 disease-specific risks of death considered in the model, plus the risk of death of the events and conditions that the individual experiences during that time unit (Table 1C).

For instance, in the case of myocardial infarction the model estimates its risk multiplying the age- and sex-specific risk in nonsmokers (baseline incidence) in each time period and for each subject, by the relative risk related to his smoking status. Then, a random number is generated; if this number is less tan or equal to the individual probability, the model assumes that the event is present. The risk of death, in this case, will be the general risk of death plus the myocardial infarction age- and sex-specific case fatality. When there is more than one simultaneous cause of death for a given subject in the same time period, a probabilistic approach is used to assign the final cause of death, weighted by the baseline risk of each competing cause.

For COPD, besides the risk of acquiring this condition, the risk of progression to more severe stages in those already affected is estimated according to the individual’s smoking status. For oncologic conditions, the specific risk of death is estimated according to the number of years since diagnosis. This type of individual-based model allows for having multiple events in a given year, as they are not mutually exclusive. This was the main reason to choose this model instead of a state transition cohort model (i.e., Markov cohort).

Smoking status and interventions. We considered three smoking status states: current smokers, former smokers, and never smokers. Smokers have a given probability of making a quit attempt in each time unit as well as a probability of succeeding in that attempt without any active intervention (background quitting rates). These probabilities are age- and sex-related, and in case of considering a population SCI, its effect could be modeled by directly influencing this background quitting rate (Table 1A). Similarly, former smokers have a given relapse probability related to the time elapsed since the successful quit attempt (background relapsing rates). The model was built to consider a wide range of intervention modalities: 1) interventions/policies with the objective of improving smoking cessation rates in smokers who have a quit attempt (e.g., nicotine replacement or behavioral interventions); 2) interventions/policies that increase the probability of smokers attempting to quit (e.g., media campaign) and; 3) mixed interventions/policies that influence both the probability of attempting to quit and the success rates (e.g., training primary care physicians in brief counseling interventions, including pharmacotherapy in benefit plans).

Resource use, cost, and quality of life. The model is programmed to calculate the use of resources and the QALYs in each time unit as a summary of the events the subject experienced in that particular time unit with the active health conditions coming from
and also as cost-effectiveness acceptability curves to show the cost-effectiveness rate dispersion, as 95% confidence intervals, can be shown in the cost-effectiveness plane as the incremental uncertainty, a graphical depiction of the results of several simulations averted, and cost per QALY. To reflect decision uncertainties are cost per quitter; cost per year of life gained, cost per the cost-effectiveness of the different smoking cessation strategies are cost per quitter; cost per year of life gained, cost per event averted, and cost per QALY. To reflect decision uncertainty, a graphical depiction of the results of several simulations (second-order uncertainty) each comparing a specific population of interest (first-order uncertainty) can be made. This can be shown in the cost-effectiveness plane as the incremental cost-effectiveness rate dispersion, as 95% confidence intervals, and also as cost-effectiveness acceptability curves to show the probability of each strategy being cost-effective according to locally relevant threshold values. To perform a probabilistic sensitivity analysis, the probability distribution of selected parameters values are recalculated and applied to the equations. In Figure 1 we present an example of the cost-effectiveness results of two hypothetical SCIs in 500 simulations of 5000 participants a year and the other for the subsequent years up to a customized specific time horizon. In the current version, this time horizon was set to a lifetime for the cardiovascular events and COPD, to 10 years in lung cancer, and to 5 years in all other neoplasms. Cancer survival was modeled as dependant of sex and the years since diagnosis, independent of age. COPD incidence was modeled as dependant of sex, age, and smoking status; its progression as dependant of sex, years in current stage, and smoking status. COPD deaths were modeled as dependant of sex and stage.

Model outputs. Results can be presented according to age, sex, previous cardiovascular history, and other specific epidemiologic data. Different benefit measures that can be used to report the cost-effectiveness of the different smoking cessation strategies are cost per quitter; cost per year of life gained, cost per event averted, and cost per QALY. To reflect decision uncertainty, a graphical depiction of the results of several simulations (second-order uncertainty) each comparing a specific population of interest (first-order uncertainty) can be made. This can be shown in the cost-effectiveness plane as the incremental cost-effectiveness rate dispersion, as 95% confidence intervals, and also as cost-effectiveness acceptability curves to show the probability of each strategy being cost-effective according to locally relevant threshold values. To perform a probabilistic sensitivity analysis, the probability distribution of selected parameters values are recalculated and applied to the equations. In Figure 1 we present an example of the cost-effectiveness results of two hypothetical SCIs in 500 simulations of 5000 50-year old men.

Different one-way or scenario sensitivity analyses can also be incorporated for the estimation of the effects of selected parameters. The detailed information provided by the model can also be used to perform budget impact analysis and to guide for locally relevant research priority setting [23,24].

### Calibration and validation

We applied the International Society for Pharmacoeconomics and Outcomes Research criteria for model development and reporting [25]. The model structure and the parameters’ calculation approach were validated and calibrated using a selected country dataset (Argentinean National Health Statistics year 2005) [26].

### Internal validation

Internal testing and debugging were performed to ensure that the mathematical calculations were accurate and consistent with the specifications of the model. The model was checked and tested during the modeling process to identify any errors relating to data incorporation and modeling syntax. Null and extreme input values were used and the test of
Calibration was performed to ensure that the model replication using equivalent input values was applied. Inconsistencies were detected and programming errors corrected.

Fig. 1 – (A) Cost effectiveness plane of cost- and effect-related differences between two smoking cessation interventions (SCI). SCI-a: cost $472, effectiveness: 15% smoking cessation at 1 year; SCI-b: cost $1.254, effectiveness: 23% smoking cessation at 1 year (Argentine pesos 2007). Preliminary results for 500 simulated cohorts of 5000 50-year old male smokers after one quit attempt. Discount rate for costs and effects: 5%. (B) Cost-effectiveness acceptability curve showing the probability that SCI-b is cost-effective as compared to SCI-a over a range of values for the maximum acceptable ceiling ratio.

Calibration. Calibration was performed to ensure that the model can reproduce the results of the sources used to run the model. General mortality and all age- and sex-specific death rates predicted by the model were compared with local health statistics, with a total of 16 parameters (excluding COPD mortality, universally agreed to be underestimated in national statistics) [21,22]. Sex- and age-specific model outputs were compared to the source rates and deviations from the expected values were analyzed. Mean simulated event rates within ± 10% of the mean reference event rates were considered acceptable, and in cases of higher deviations, the risk equation for that particular event was modified to provide a better fit to the published data. The search stopped as soon as all the outputs were within 10% of the target results. As explained earlier, the disease event incidence was estimated from the age- and sex-specific mortality and the lethality of the event for acute conditions and COPD, and the yearly survival rate since diagnosis for cancers. These last two parameters (lethality and survival rate) were estimated from local and international studies and were allowed to vary ± 15% to determine the best fitting parameter set. Table 2 describes the data sources, baseline risk parameters calculation process, and the allowed variation during the calibration process. Besides ensuring that the simulated results were within the prespecified range, the total number of events and the event incidence were graphed for each parameter according to age and sex. The resulting observed and expected curves were visually explored to confirm a good fit. Closeness of fit was additionally assessed by plotting predicted versus observed values outcomes, fitting a linear curve through the points with the intercept set at zero, and obtaining a squared linear correlation coefficient (R²). The final simulation set was composed of 20 cohorts (10 of men and 10 of women) of 25,000 continuing smokers, 25,000 smokers who quit smoking during follow-up and 25,000 lifelong nonsmokers followed through their lifetime. The sample size of the simulations was estimated on the basis of the standard error of the parameter with greater variability (lifelong risk of death from oral cavity cancer) to be able to obtain 95% confidence intervals within 10% in each cohort (smokers, former smokers, and nonsmokers). Incidence rates estimated from the simulated cohorts were transformed into absolute numbers of events in each age and sex strata following Argentina 2005 population distribution [26]. After calibration, the differences between published data and the model results ranged from -9% to +5%. The curves’ shapes of the age- and sex-specific simulated number of events adequately overlapped with those of the expected values, showing, in all cases, an excellent internal validity. Figure 2 shows results in four conditions: myocardial infarction, kidney cancer, nonischemic cardiovascular disease, and oral cavity cancer. As expected, correlation between predicted and observed results was better among high incidence events (such as myocardial infarction, stroke, or lung cancer) and weaker for less frequent (thus with greater variability) events such as leukemia or oral cavity cancer. When predicted values were plotted against observed data to assess goodness of fit, the majority of values were on or close to the y = x line, indicative of perfect fit. Evaluation of the correlation between predicted and observed data produced R² values that ranged from 0.758 to 0.999 (perfect fit = 1) indicating a very strong correlation. The regression lines obtained for the 16 parameters ranged from a gradient of 0.874 to 1.272, close to the

![Table 2](image)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Calculation process</th>
<th>Data inputs</th>
<th>Source</th>
<th>Allowed variation</th>
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<td>Formula 1 and Formula 2</td>
<td>– Age- and sex-specific mortality – Lethality – Smoking prevalence – Disease specific RR for smokers and former smokers</td>
<td>[26], [36]</td>
<td>None</td>
</tr>
<tr>
<td>Baseline cancer incidence in nonsmokers</td>
<td>Formula 3 and Formula 2</td>
<td>– Age- and sex-specific mortality – Survival rate – Smoking prevalence – Disease specific RR for smokers and former smokers</td>
<td>[26]</td>
<td>None</td>
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<tr>
<td>Baseline risk of COPD incidence</td>
<td>Formula 2</td>
<td>– Population COPD incidence (age and sex specific) – Smoking prevalence – Disease specific RR for smokers and former smokers</td>
<td>[21], [22]</td>
<td>± 15%</td>
</tr>
<tr>
<td>Risk of death from all other causes</td>
<td></td>
<td>Age- and sex-specific mortality</td>
<td>[26]</td>
<td>± 15%</td>
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COPD, chronic obstructive pulmonary disease.
perfect fit line (gradient = 1). These results are shown in Figure 3 for stroke, lung cancer, pancreatic cancer, and esophageal cancer.

External validation. Model results were validated against selected published epidemiologic and clinical studies not used to provide input data. Stroke and myocardial infarction age- and sex-specific event rates predicted by model were compared with those from international and local available data: the World Health Organization MONICA Project data on stroke and myocardial infarction incidence (World Health Organization monitoring of trends and determinants in cardiovascular disease) [27,28] and the only population-based myocardial infarction incidence study performed in Argentina [29,30] (see Fig. 4A and Fig. 4C). Age- and sex-specific COPD predicted prevalence was compared with the results from the Latin American Project for the Investigation of Obstructive Lung Disease, a population-based study carried out in five Latin American cities [31] (see Fig. 4B). Lung cancer incidence and lung cancer mortality predicted by the model were compared to those of the global cancer estimations reported by the International Agency for Research on Cancer [16,17] (see Figs. 4D and 4E). As a final endpoint that is influenced by the others, the toll on life expectancy of smokers and former smokers predicted by the model was analyzed together with the effect of quitting smoking at age 55 years. Results were compared to the population-based study of male British doctors [32] (see Fig. 4F). In all cases a high correlation between published data and model results was observed.

Discussion

Smoking is the single most preventable cause of disease and death all around the world [1]. In Latin America tobacco control policies are still poor and access to SCI is very limited [33-35]. In a context of more limited resources local evidence from cost-effectiveness studies is essential to implement more efficient health policies. Although international evidence regarding the burden of tobacco-related diseases is extensive, it is widely known that the results of health economic evaluations cannot be directly transferred from one setting to another. Recently, countries such as the United Kingdom have changed tobacco intervention policies using cost-effectiveness data, suggesting that the presence of regional, accurate information in Latin America could lead to an increased availability of effective interventions and a better definition of local research priorities.

Our study describes the development and validation of a HEE model to evaluate the disease burden associated with smoking and the cost-effectiveness of SCIs in Latin America. To ensure the local relevance of this model, decision makers and researchers from each participant country provided input from the beginning of the project. The main characteristics of the HEE were...
defined taking into consideration the availability and quality of the required epidemiologic data in the region. The relevant outcomes of the HEE model were conceived to suit the different policy makers’ information needs identified in the preparatory stage of the study. The HEE model showed internal validity with all simulated event rates falling within ± 10% of the source publications and it also showed an excellent external validity when model results were compared to selected published studies. This external validation considered different conditions analyzed from different perspectives: death incidence, disease prevalence, and survival experience of the simulated cohorts. This comprehensive validation process is reassuring regarding the adequate performance of the model. It showed to be a reliable tool that can be used to estimate the tobacco-related disease burden and the cost-effectiveness of different SCI in the participant countries. It is important to note that the validation that we are presenting here corresponds to a single country data set (Argentina), and that a similar validation process is required for each country in which the model is applied. This is the first multicountry collaborative project that, to our knowledge, developed and validated a microsimulation model capable to evaluate the cost-effectiveness of a wide range of SCIs in Latin America, from public health interventions to specific individual therapies. As opposed to most published tobacco economic models that are based on state transition structures, the main advantages of the microsimulation-based approach include the possibility of tracking each subject’s history (as opposed to the “memorylessness” of Markov models) and how it influences future events; the possibility of simultaneously experiencing different health states during follow-up (which would render a Markov model nearly unmanageable); and being intrinsically probabilistic, allowing to depict first order (person-level) uncertainty. Second order (parameter-level) uncertainty can be estimated in the probabilistic sensitivity analysis through the incorporation of defined distributions in selected parameters. In addition, it can be easily adapted to new information availability. Whereas other tobacco-related economic models are usually limited to cardiac disease and lung cancer, our model included most tobacco-related diseases and additionally encompassed cerebrovascular disease, COPD, pneumonia, and influenza as well as nine other neoplasms. It also allowed incorporation of background quitting and relapsing rates. Some considerations and possible limitations to our model include the following: 1) it is highly dependent upon local health statistics, which may, in some settings, misestimate the actual disease-specific toll; 2) it does not analyze the effect of second-hand smoking; and 3) it does not incorporate the effect of tobacco on mother and child health. This project was supported by grants from international agencies, allowing us to develop a generic tool not oriented to a particular SCI. In addition, because this model was designed taking into consideration the low availability and quality of information in the seven participant countries, it could be easily adapted to be used in other “information-poor” settings such as most low and middle income countries. Apart from being able to depict the incremental cost and effect of interventions for the economic evaluation, the model was conceived as a tool to provide burden of tobacco-related diseases and budget impact data. This is of utmost relevance to raise awareness of the health and economic consequences of smoking in the region. The need to more precisely estimate the burden of the smoking-associated diseases measured in terms of economics and clinical consequences (smoking related illnesses and quality-adjusted survival) still exists. Also, it is highly important to incorporate these tools in Latin America to inform decision makers about the cost-effectiveness of tobacco control policies.
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The funding agreement ensured the authors’ independence in designing the study, interpreting the data, writing, and publishing the report.


