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Update and extension of the Brazil SimSmoke model to estimate the health impact of cigarette smoking by pregnant women in Brazil

Atualização e extensão do modelo SimSmoke para estimar o impacto do tabagismo na saúde das gestantes brasileiras

Actualización y extensión del modelo SimSmoke para estimar el impacto del tabaquismo en la salud de las gestantes brasileñas

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Abstract

A previous application of the Brazil SimSmoke tobacco control policy simulation model was used to show the effect of policies implemented between 1989 and 2010 on smoking-attributable deaths (SADs). In this study, we updated and further validated the Brazil SimSmoke model to incorporate policies implemented since 2011 (e.g., a new tax structure with the purpose of increasing revenues/real prices). In addition, we extended the model to estimate smoking-attributable maternal and child health outcomes (MCHOs), such as placenta praevia, placental abruption, preterm birth, low birth weight, and sudden infant death syndrome, to show the role of tobacco control in achieving the Millennium Development Goals. Using data on population, births, smoking, policies, and prevalence of MCHOs, the model is used to assess the effect on both premature deaths and MCHOs of tobacco control policies implemented in Brazil in the last 25 years relative to a counterfactual of policies kept at 1989 levels. Smoking prevalence in Brazil has fallen by an additional 17% for males (16%-19%) and 19% for females (14%-24%) between 2011 and 2015. As a result of the policies implemented since 1989, 7.5 million (6.4-8.5) deaths among adults aged 18 years or older are projected to be averted by 2050. Current policies are also estimated to reduce a cumulative total of 0.9 million (0.4-2.4) adverse MCHOs by 2050. Our findings show the benefits of tobacco control in reducing both SADs and smoking-attributable MCHOs at population level. These benefits may be used to better inform policy makers in low and middle income countries about allocating resources towards tobacco control policies in this important area.

Smoking; Pregnant Women; Maternal and Child Health

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Introduction

Brazil has experienced a large decline in smoking prevalence in the last 25 years [1,2,3,4]. A previously developed SimSmoke simulation model by Levy et al. [1] estimated nearly a 50% decline in Brazil's smoking prevalence among adults aged 18 years or older, due to the implementation of interventions recommended by the World Health Organization Framework Convention on Tobacco Control (WHO-FCTC) between 1989 and 2010 [5]. Since 2011, several states, covering 50% of the population, implemented 100% smoke-free air restrictions, followed by a federal law in 2014 [6,7]. Moreover, in 2012, a new tax structure went into effect to further increase cigarette tax revenues, which led to an increase of 23% in inflation-adjusted prices between 2012 and 2014 [8,9].

Tobacco control is not only vital for reducing smoking prevalence and, as consequence, smoking-attributable deaths among adults, but it also contributes towards the attainment of the Millennium Development Goals proposed by the United Nations' Secretary-General in 2000, in particular goal #4 (reducing child mortality) [10,11]. Indeed, studies have found a causal relationship between prenatal smoking and adverse maternal and child health outcomes (MCHOs), such as placenta praevia, placental abruption, preterm birth, low birth weight, and sudden infant death syndrome [12,13,14]. Although prenatal smoking is a particular concern in low and middle income nations [15], the impact of prenatal smoking and the potential role of tobacco control policies in improving child health have received little attention [14,16].

With strong tobacco control policies and a comprehensive surveillance network for MCHOs based on three health information systems – Information System on Live Births (SINASC), Mortality Information System (SIM), and Hospital Information System (SIH) [17,18] –, Brazil is well-suited to evaluate the effect of implementing tobacco control policies on smoking-attributable adverse MCHOs. We updated the Brazil SimSmoke to incorporate the role of new policies and extended it to assess the overall impact of tobacco policies on the reduction of cigarette smoking by pregnant women and, as a consequence, on MCHOs. To our knowledge, our study represents the first one that considers the effect of tobacco control policies on MCHOs for low and middle income countries, including Brazil. A large scale survey in 2013 also made it possible to further validate the model [4,19].

Methods

Basic model and update in 2015

Brazil SimSmoke estimated the effect of Brazil's tobacco control policies on smoking prevalence and smoking-attributable deaths (SADs) among adults aged 18 years or older between 1989 and 2010 [1]. A discrete-time, first-order Markov process was employed to project population growth by births and deaths, and smoking prevalence by smoking initiation, cessation, and relapse rates. Changes in tobacco control policies shifted smoking prevalence through initiation and cessation. SADs were calculated using relative risks, smoking prevalence, and death rates. Projected smoking prevalence rates were validated using data from the Brazilian module of the 2003 *World Health Survey* (WHS) [2] and from the 2008 *Brazilian Global Adult Tobacco Survey* (GATS) [20].

Since 2011, stricter smoke-free air laws were implemented and cigarettes taxes were increased [6,7,8,9]. We incorporated those policies and validated the model using results from the 2013 Brazilian GATS, a large-scale population-wide survey [19].

Extension of the model: incorporating smoking-attributable birth outcomes

Brazil SimSmoke was extended to estimate smoking-attributable MCHOs , including cases of low birth weight (LBW), preterm births (PTB), sudden infant death syndrome (SIDS), placenta praevia, and placental abruption. The number of smoking-attributable MCHOs is estimated as a product of the total number of cases for each outcome and the smoking-attributable fraction (SAF) for that outcome. The SAF is defined as:

$$SAF_o = p^*[RR_o - 1] / [1 + p^*(RR_o - 1)],$$

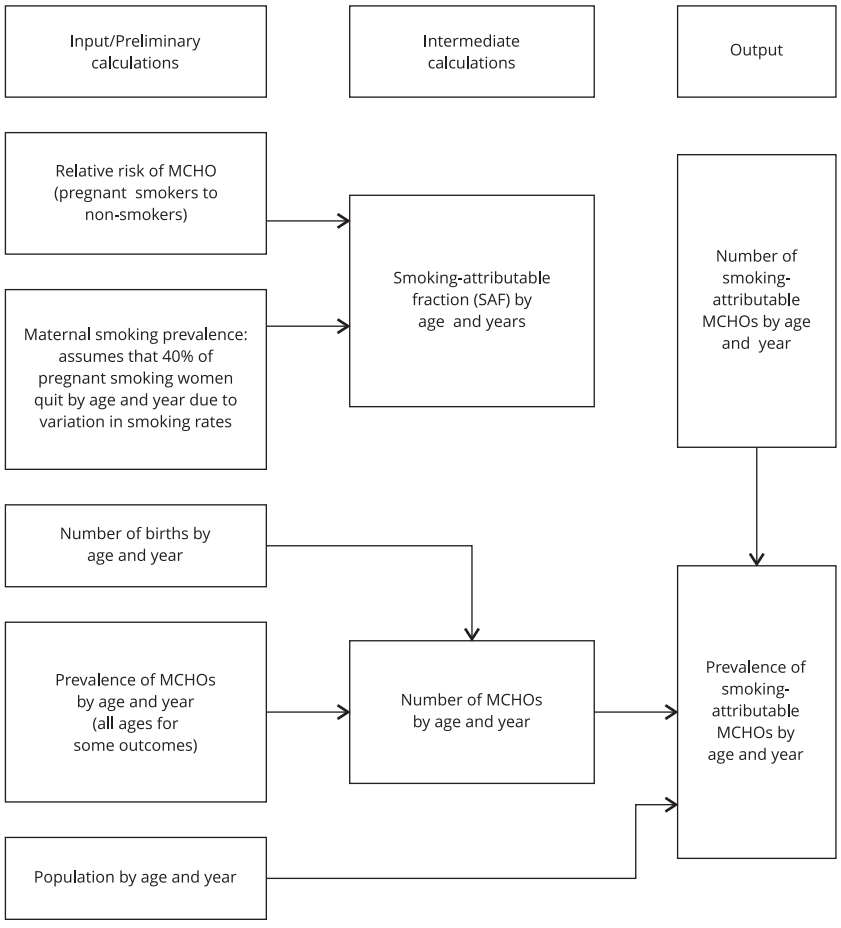
where p = active prenatal smoking prevalence and RR_o = relative risk of MCHO for active prenatal smokers compared to prenatal nonsmokers [21]. Figure 1 shows the inputs, intermediate calculations, and outputs. Due to uncertainty in each of the three parameters, we conducted sensitivity analyses with credible upper and lower bounds.

To obtain the number of MCHOs, births by age and gender of the women of child-bearing potential were multiplied by the corresponding prevalence of MCHOs. Data on MCHOs from 2000 to 2013 were obtained from the SINASC, the SIM, and the SIH [17,18,22], aggregated by ages 18-19, 20-29, 30-39, and 40-49. Because placenta praevia and placental abruption were included as one category since 2009, rates were combined in prior years. To avoid overlap, we excluded PTB from LBW cases. Since reliable data for adverse MCHOs were not available before 2000, we estimated trends in years prior to 2000 from the published literature on an outcome-by-outcome basis [23], yielding an increasing trend for PTB and a decreasing trend for SIDS between 1989 and 2000, but no trend for LBW and placenta praevia/placental abruption.

Our literature review [23] found that PTB tend to be underdiagnosed and underreported. However, their measurement improved in 2011, when gestational age began to be collected in exact weeks and not grouped into categories [24]. With rates 50% higher in 2011, but flat in prior years, we adjusted pre-

Figure 1

Relationship of the components for each maternal and child health outcome (MCHO).



2011 PTB estimates upward by 50%, which served as our lower bound. Since 2011 estimates were underestimated by at least 15% [24], we adjusted all years by an additional 15% as our midrange estimate and by 30% as our upper bound. We also adjusted SIDS estimates upward by 100% for midrange and by 200% for the upper bound [23]. Rates after 2013 for all MCHOs were assumed to remain at their 2013 levels (cf. Supplemental Table 1; http://www2.inca.gov.br/wps/wcm/connect/observatorio_controle_tabaco/site/home/biblioteca).

Our review [23] also indicated that the relative risks in Brazil were consistent with estimates for the United States, although at the low end in some cases. Consequently, the relative risks and the lower/upper bounds of smoking-attributable MCHOs for Brazil are based on US risks, which are based on reviews and recent studies with large samples for each outcome (cf. Supplemental Table 2; http://www2.inca.gov.br/wps/wcm/connect/observatorio_controle_tabaco/site/home/biblioteca) [14,23,25].

To estimate prenatal smoking prevalence, we assumed that the prevalence of smoking among pregnant women mirrors that of women of the same age in the general population, and that a fixed percentage of pregnant women who smoke quit during their pregnancy. Based on data from two earlier studies [26,27], and previous analyses [23], we estimate that 40% of women quit smoking during pregnancy. We also considered a lower bound where 30% quit at all ages, since the higher rate may reflect policies targeted at pregnant smokers implemented only after 2000 [3]. Based on evidence from the 2013 Brazilian GATS [19], we also estimated an upper bound where 50% of women smokers quit during pregnancy. These data were also used to distinguish prenatal smoking rates by age. Based on a study for Spain [28], we assumed a 15% underreport of prenatal smoking, within the range of other countries [29].

The effect of policies

Policies are assumed to have the same effect sizes on prenatal smoking as on the female population, based on previous studies. For example, demand studies [30,31,32,33,34] have obtained prenatal prevalence price elasticities between -0.13 and -0.7, which are consistent with the elasticities used in SimSmoke, and a recent study [34] found higher elasticities for those of low socioeconomic status. Studies have found that other tobacco control policies, including cessation treatment [35,36], smoke-free air laws [26], and media campaigns [37], are effective at reducing prenatal smoking.

To estimate the effect of the tobacco control policies implemented since 1989, all 2015 policies were set to their 1989 levels for all years. This counterfactual represents predicted smoking rates if there were no changes in tobacco control policies in Brazil, i.e., the long-term trend in the absence of policy change. For smoking prevalence, we considered the effect of all policies regarding the counterfactual rate in the same year. For SADs and each adverse MCHO, we calculated the net gain by subtracting the number of outcomes with policies implemented from the number of outcomes under the counterfactual in the same year.

Since tax policies have been found to be particularly effective in reducing initiation among young people and increasing cessation among underprivileged ones [38], we assessed the independent effect of price increases. This point is particularly important for Brazil, because, between 1986 and 2015, the country had multiple tobacco excise tax policies, going from a single rate ad valorem system in the 1990s to a mixed system composed of two specific rates and one small ad valorem component since 2012 [39]. It is worth noting that, between 2008 and 2014, consumer prices increased 146%, and much of this price expansion was possible due to an increase in the specific rate over the accumulated inflation rate in 2009 and the new tax structure implemented in 2012 [9,39].

Results

Validation and update of SimSmoke from 2011 to 2015

As shown in Table 1, SimSmoke predicted the overall relative decrease in smoking prevalence rates between 1989 and 2013 within 1% and 4% accuracy for males and females, respectively, but it was less accurate for the subperiod 2008-2013. The model made worse predictions for females by age

Table 1

Validation of the Brazil SimSmoke: predictions versus survey estimates, by gender and age group, 2008-2013.

Gender (Age)	Smoking prevalence at status quo (%)					Smoking prevalence from surveys (%) *				
	1989	2008	2013	Relative change 2008-2013	Relative change 1989-2013	1989	2008	2013	Relative change 2008-2013	Relative change 1989-2013
Male										
18+	43.3	22.4	19.4	-15.3	-55.4	43.3	22.9	18.9	-17.5	-56.4
18-24	34.3	19.6	16.8	-14.3	-51.0	34.3	18.9	15.5	-18.0	-54.8
25-44	48.3	23.6	20.7	-12.3	-57.1	48.3	22.5	18.4	-18.2	-61.9
45-64	45.3	23.8	19.4	-18.5	-57.2	45.3	28.1	23.2	-17.4	-48.8
65+	34.2	17.7	15.0	-15.3	-56.1	34.2	17.3	13.9	-19.7	-59.4
Female										
18+	27.1	13.8	11.6	-15.9	-57.2	27.1	13.9	11.0	-20.9	-59.4
18-24	23.9	13.6	11.6	-14.7	-51.5	23.9	8.2	5.8	-29.3	-75.7
25-44	31.7	15.0	13.0	-13.3	-59.0	31.7	14.5	9.4	-34.7	-70.3
45-64	23.9	13.7	10.8	-21.2	-54.8	23.9	18.0	17.2	-4.4	-28.0
65+	18.3	9.4	8.5	-9.6	-53.6	18.3	9.3	7.1	-23.7	-61.2

* *Brazilian Global Adult Tobacco Survey* (GATS) 2008 and 2013.

group in the 2008-2013 subperiod, underpredicting the decline for the age groups 18-44 and 65+ and overpredicting the decline for women aged 45-64 years old.

In Table 2, Brazil SimSmoke uses the counterfactual of no policies implemented since 1989 to show the effect of policies implemented between 1989 and 2015, including stronger smoke-free air laws and higher cigarette taxes implemented in the last five years. In this counterfactual scenario, smoking prevalence is projected to have fallen from 43.3% to 31.3% among males and from 27.1% to 19.2% among females between 1989 and 2050. Compared to policies set to their 1989 levels, the policies implemented between 1989 and 2015 indicate a net 62% (56.9%-67.1%) and 66.7% (51.0%-78.7%) relative reduction in the smoking prevalence in Brazil by 2050 among males and females, respectively. If only the tax policy was implemented in Brazil since 1989, the net relative reduction in the smoking prevalence by 2050 would have been of 40.3% (32.0%-47.6%) for males and 40.6% (32.3%-47.9%) for females.

With current policies in place, cumulative smoking-attributable deaths are estimated at 594,017 (535,194-650,881) among men and 239,048 (160,549-321,842) among women by 2015 (Table 3). This number increases to 5.0 million (4.6-5.4) among men and 2.5 million (1.8-3.1) among women by 2050. Compared to the counterfactual of no policies, Brazil SimSmoke estimates a cumulative total of 7.5 million (6.4-8.5) fewer deaths (male and female) by 2050, as a result of the policies implemented between 1989 and 2050. Tax policy alone would have accounted for about 4.2 million (3.3-5.0) fewer deaths between 1989 and 2050 (male and female).

The relative differences from the implementation of the chosen policies are shown in Supplemental Table 3 (cf. http://www2.inca.gov.br/wps/wcm/connect/observatorio_controle_tabaco/site/home/biblioteca). By 2050, all policies will have reduced smoking-attributable deaths by 35.1% (32.1%-37.9%) in males and by 36.7% (26.7%-45.7%) in females. Also, tax policy alone will have reduced smoking-attributable deaths by 20.1% (15.8%-24.2%) in males and by 19.1% (15.0%-22.9%) in females.

Impact of tobacco policies on prenatal smoking prevalence and selected MCHOs

As shown in Table 4, the cumulative number of averted placenta praevia/placental abruption cases is estimated at 11,281 (3,538-22,336) by 2015 (net effect of policies implemented since 1989) and 28,564

Table 2

Smoking prevalence from ages 18 to 85, Brazil.

	1989	2010	2015	Lower bound	Upper bound	2050	Lower bound	Upper bound
Male								
Policy scenario								
Actual (status quo)	43.3%	21.7%	17.9%	19.3%	16.3%	11.9%	13.5%	10.3%
No policies	43.3%	37.9%	36.9%	36.9%	36.9%	31.3%	31.3%	31.3%
Price only	43.3%	28.5%	25.2%	27.7%	23.0%	18.7%	21.3%	16.4%
Relative difference from implementing chosen policies								
Actual policies	-	-42.7%	-51.5%	-47.7%	-55.8%	-62.0%	-56.9%	-67.1%
Price only	-	-24.8%	-31.7%	-24.9%	-37.7%	-40.3%	-32.0%	-47.6%
Female								
Policy scenario								
Actual (status quo)	27.1%	13.0%	10.5%	13.8%	7.6%	6.4%	9.4%	4.1%
No policies	27.1%	23.9%	23.3%	23.3%	23.3%	19.2%	19.2%	19.2%
Price only	27.1%	17.9%	15.8%	17.4%	14.3%	11.4%	13.0%	10.0%
Relative difference from implementing chosen policies								
Actual policies	-	-45.6%	-54.9%	-40.8%	-67.4%	-66.7%	-51.0%	-78.7%
Price only	-	-25.1%	-32.2%	-25.3%	-38.6%	-40.6%	-32.3%	-47.9%

Table 3

Smoking-attributable deaths from ages 18 to 85, Brazil.

	1989-2015	1989-2015 lower bound	1989-2015 upper bound	1989-2050	1989-2050 lower bound	1989-2050 upper bound
Male						
Policy scenario (deaths)						
Actual (status quo)	4,134,169	4,192,992	4,077,305	9,306,335	9,738,742	8,903,108
No policies	4,728,186	4,728,186	4,728,186	14,337,723	14,337,723	14,337,723
Price only	4,416,718	4,489,432	4,347,086	11,449,055	12,078,603	10,871,130
Lives saved under chosen scenario compared to no policies						
Actual policies	594,017	535,194	650,881	5,031,388	4,598,982	5,434,615
Price only	311,468	238,754	381,100	2,888,668	2,259,121	3,466,593
Female						
Policy scenario (deaths)						
Actual (status quo)	1,704,902	1,783,402	1,622,108	4,242,783	4,914,411	3,635,963
No policies	1,943,951	1,943,951	1,943,951	6,701,886	6,701,886	6,701,886
Price only	1,828,676	1,855,699	1,802,731	5,419,303	5,697,792	5,163,988
Lives saved under chosen scenario compared to no policies						
Actual policies	239,048	160,549	321,842	2,459,103	1,787,474	3,065,922
Price only	115,275	88,252	141,220	1,282,582	1,004,094	1,537,898

Table 4

Smoking-attributable maternal and child health outcomes for mothers aged 18 to 49, Brazil.

	1989-2015	1989-2015 lower bound	1989-2015 upper bound	1989-2050	1989-2050 lower bound	1989-2050 upper bound
Placenta praevia/Placental abruption						
Policy scenario						
Actual (status quo)	25,070	11,387	38,310	40,572	19,367	59,301
No policies	36,351	14,925	60,646	69,226	28,404	115,583
Price only	28,622	12,285	46,236	49,795	21,756	79,246
Averted cases: chosen policies - no policies						
Actual policies	11,281	3,538	22,336	28,654	9,037	56,282
Price only	7,729	2,641	14,410	19,431	6,648	36,337
PTB						
Policy scenario						
Actual (status quo)	358,821	210,710	1,084,778	578,322	360,615	1,668,798
No policies	531,501	276,682	1,753,195	1,024,732	533,316	3,383,959
Price only	410,304	226,784	1,309,492	716,202	405,462	2,251,038
Averted cases: chosen policies - no policies						
Actual policies	172,680	65,972	668,417	446,410	172,702	1,715,161
Price only	121,197	49,898	443,703	308,530	127,854	1,132,921
LBW births						
Policy scenario						
Actual (status quo)	410,065	379,288	454,091	631,837	617,513	663,786
No policies	571,508	477,611	698,469	1,037,626	866,881	1,268,667
Price only	458,688	403,134	535,752	760,959	683,359	870,636
Averted cases: chosen policies - no policies						
Actual policies	161,442	98,323	244,379	405,788	249,368	604,880
Price only	112,820	74,478	162,717	276,666	183,522	398,030
SIDS						
Policy scenario						
Actual (status quo)	2,333	447	4,863	3,087	613	6,216
No policies	3,040	547	6,722	4,605	828	10,194
Price only	2,530	469	5,454	3,553	666	7,571
Averted cases: chosen policies - no policies						
Actual policies	706	100	1,859	1,518	215	3,979
Price only	510	79	1,268	1,052	162	2,623

LBW: low birth weight; PTB: preterm births; SIDS: sudden infant death syndrome.

(9,037-56,282) by 2050. A cumulative total of 172,683 (65,972-668,417) fewer PTB and 161,442 (98,323-244,379) fewer LBW babies were born by 2015, increasing to an estimated 446,410 (172,702-1,715,161) and 405,788 (249,368-604,880) fewer cases by 2050. For SIDS, a cumulative total of 706 (100-1,859) fewer deaths are estimated by 2015, increasing to 1,518 (215-3,979) fewer deaths by 2050. By 2050, tax policy alone will have reduced 19,431 (6,648-36,337) placenta praevia/placental abruption cases; 308,530 (127,854-1,132,921) PTB; 276,666 (183,522-398,030) LBW; and 1,052 (162-2,623) SIDS.

The relative differences from the implementation of the chosen policies are shown in Supplemental Table 4 (cf. http://www2.inca.gov.br/wps/wcm/connect/observatorio_controle_tabaco/site/home/biblioteca). By 2050, all policies will have reduced smoking-attributable placenta praevia/placental abruption cases by 41.4% (31.8%-48.7%), PTB by 43.6% (32.4%-50.7%), LBW by 39.1% (28.8%-47.7%), and SIDS by 33.0% (26.0%-39.0%). By 2050, tax policy alone will have reduced

smoking-attributable placenta praevia/placental abruption cases by 28.1% (23.4%-31.4%); PTB by 30.1% (24.0%-33.5%); LBW by 26.7% (21.2%-31.4%); and SIDS by 22.8% (19.6%-25.7%).

Discussion

In previous study [1], we showed that tobacco control policies were responsible for a 46% decrease in smoking prevalence between 1989 and 2010. Smoking prevalence in Brazil has fallen by almost 20% between 2011 and 2015. SimSmoke projected that 7.5 million deaths will be averted by 2050, including 500,000 cumulative deaths from policies implemented between 2011 and 2015 [1]. This translates to a 46% reduction in smoking-attributable deaths between 2016 and 2050.

Brazil SimSmoke was also extended to consider the effect of prenatal smoking on smoking-attributable MCHOs. The model projected that 0.9 million (0.4-2.4) MCHOs will be averted by 2050. Brazil was chosen for this analysis because it had high rates of smoking at population level, but has witnessed marked reductions in smoking rates [1,2,3,4]. Our results indicate that, between 2016 and 2050, the already implemented policies will reduce the total number (net absolute reduction) of placental abruption/placenta praevia by 7.4%; PTB by 3.1%; LBW births by 8.3%; and SIDS by 9.2% (data not shown in a table).

Brazil has achieved the Millennium Development Goal of reducing under-five child mortality by two thirds between 1990 and 2015 [40]. Our results indicate that tobacco control policies may have played a major role. The case for tobacco control becomes more compelling upon extending the analyses to consider the effects of second-hand smoke and/or other MCHOs, such as ectopic pregnancy and cleft palate [12]. In addition, the costs of tobacco consumption pose a heavy burden on governments and society [10]. In 2011, smoking-attributable direct medical expenditures for cardiovascular, cancer, chronic obstructive pulmonary and perinatal diseases cost USD 15 billion in Brazil [41]. Continuing to increase cigarette prices will increase tax revenues and reduce smoking prevalence, particularly among underprivileged people, thus saving funds for other health care challenges [38].

Limitations

The previously validated model [1] was updated in 2015 and made good predictions for the overall adult female and male smoking prevalence. The updated model made fewer good predictions for females by age group for the subperiod 2008-2013, which may reflect limitations in the model or in the data used to validate SimSmoke. Specifically, the model underpredicted the smoking rate reduction for those aged 18-44 yearsold, i.e., an age group closely linked to child-bearing potential. Consistent with the literature [1], SimSmoke assigns a small effect size to the impact of warning labels on young people, who are often thought to ignore warnings. However, mass media campaigns and the new set of stronger health warnings related to both miscarriage and passive smoking exposure, implemented since 2009 [6,7,8,9,42], may have produced greater effects than predicted. Price and tax policy may also have had greater effects on younger females than predicted by the model, due to their lower income than males [8,9,38,39,40,41,42,43], thus suggesting that our estimates probably underestimated the decrease in smoking prevalence from implementing chosen policies among women of child-bearing potential and, as a consequence, probably underestimated the cumulative number of averted MCHOs.

The results of the model are based on the assumptions inherent to it, the policy effect sizes, and the data quality [1,44]. Additional limitations are related to the estimates of the smoking-attributable MCHOs: (i) while the estimates of the relative risks of smoking for LBW babies, PTB, and SIDS for Brazil are generally consistent with estimates for the US [14,23], we found no Brazilian studies that considered placental abruption or placenta praevia; (ii) while smoking behaviors of Brazilian mothers appear to be similar to those of high income countries, Brazilian pregnant women may smoke fewer cigarettes and be less nicotine dependent [4,14], which may lower relative risks and the SAF measure used, thus suggesting that we may have overestimated the effect of policies on the cumulative number of averted MCHOs; (iii) in examining prenatal smoking over time, differences in smoking behaviors by socioeconomic status were not considered, which have become increasingly important in Brazil [1,2,3,4]; for instance, smoking prevalence is usually higher among less educated women (versus high

educated), and they quit less during pregnancy [4,45]. As a consequence, although we also considered a lower quitting rate during pregnancy to increase the SAF measure used and to estimate the upper bounds for averted MCHOs, we still may have underestimated the number of averted MCHOs; (iv) although we could not consider the frequency of maternal smoking in successive pregnancies and its association with repetition of the selected MCHOs, smoking persistence may be an important risk factor to further increase the respective relative risks and, as a result, the cumulative number of averted outcomes [46]; (v) although estimates of prenatal smoking prevalence were corrected for underreporting [28], underreporting may also reduce the strength of the SAF measure used [29] and, therefore, underestimate the total number of averted MCHOs; (vi) wide variations in MCHOs exist by regions of Brazil, and they were not considered [23,24,47]; (vii) Brazil SimSmoke does not directly incorporate changes in policies that target pregnant smokers; (viii) we did not consider the fact that pregnancy interruptions – by either induction or caesarean section – have become much more frequent in Brazil in the last years [17,48,49]. Although the relative risks of adverse MCHOs from Brazilian studies were within the range of the lower bounds of relative risks used to estimate smoking-attributable MCHOs for Brazil [23], Brazilian pregnant women who do not smoke may be increasingly at higher risk for MCHOs than those from high income countries, which may further lower respective relative risks, thus suggesting that we may have overestimated the effect of policies on MCHOs.

Conclusion

The WHO-FCTC is a clear translation of the goals expressed in the Millennium Declaration regarding maternal and child health [5,10,11]. Our findings show the benefits of tobacco control in reducing both SADs and smoking-attributable MCHOs at population level. Thus, our analysis may better inform policy makers in low and middle income countries (LMICs) about allocating resources toward tobacco control policies in this important area. The analyses of this study are applied to Brazil, but similar results may be expected in other LMICs with strong tobacco control policies.

Contributors

A. S. Szklo participated in the data analysis and as lead author in the elaboration/preparation of the article. Z. Yuan participated in the data processing, data analysis, and elaboration/preparation of the article as co-author, and approved the final manuscript as submitted. D. Levy participated in the data analysis and elaboration/preparation of the article as co-author, and approved the final manuscript as submitted.

Conflicts of interest

The authors declare no conflicts of interest.

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Resumo

Foi utilizada uma versão anterior do modelo SimSmoke, de simulação de políticas de controle do tabagismo, para mostrar o efeito das políticas implementadas entre 1989 e 2010 sobre a mortalidade atribuível ao tabagismo (MAT). O estudo atualiza e estende a validação do modelo SimSmoke para incorporar as políticas implementadas a partir de 2011 (p.ex.: uma nova estrutura tributária com o objetivo de aumentar os impostos e preços reais do produtos de tabaco). Estendemos o modelo também para estimar os danos à saúde materna e infantil atribuíveis ao tabagismo, como placenta prévia, descolamento prematuro da placenta, prematuridade, baixo peso ao nascer e síndrome da morte súbita infantil, para demonstrar o papel do controle do tabagismo no cumprimento dos Objetivos do Milênio. O modelo usa dados demográficos, de nascimentos, de tabagismo, de políticas e de prevalência de desfechos maternos e infantis para avaliar o efeito das políticas de controle do tabagismo dos últimos 25 anos sobre mortes prematuras e danos à saúde materna e infantil, comparado a um cenário contrafatual de manutenção das políticas nos níveis de 1989. Entre 2011 e 2015, a prevalência do tabagismo no Brasil caiu em mais 17% entre homens (16%-19%) e 19% em mulheres (14%-24%). Como resultado das políticas lançadas desde 1989, estima-se que até 2050 serão evitadas 7,5 milhões (6,4-8,5 milhões) de mortes entre adultos com 18 anos ou mais. Estima-se também que as políticas atuais reduzirão um total acumulado de 0,9 milhão (0,4-2,4 milhões) de desfechos adversos de saúde materna e infantil até 2050. Nossos achados demonstram os benefícios do controle do tabagismo na redução da MAT e de danos à saúde materna e infantil atribuíveis ao tabagismo em nível populacional. Esses benefícios podem ser utilizados para informar os gestores nos países de renda baixa e média sobre a alocação de recursos para as políticas de controle do tabagismo.

Hábito de Fumar; Gestantes; Saúde Materno-infantil

Resumen

Se utilizó una versión anterior del modelo SimSmoke, de simulación de políticas de control del tabaquismo, para mostrar el efecto de las políticas implementadas entre 1989 y 2010 sobre la mortalidad atribuible al tabaquismo (MAT). El estudio actualiza y extiende la validación del modelo SimSmoke para incorporar las políticas implementadas a partir de 2011 (p. ej., una nueva estructura tributaria con el objetivo de aumentar los impuestos y precios reales de productos de tabaco). Extendemos el modelo también para estimar los daños a la salud materna e infantil atribuibles al tabaquismo, como placenta previa, desprendimiento prematuro de la placenta, prematuridad, bajo peso al nacer y síndrome de muerte súbita infantil, para demonstrar el papel del control del tabaquismo en el cumplimiento de los Objetivos del Milenio. El modelo usa datos demográficos, de nacimientos, de tabaquismo, de políticas y de prevalencia de desenlaces maternos e infantiles para evaluar el efecto de las políticas de control del tabaquismo de los últimos 25 años sobre muertes prematuras y daños a la salud materna e infantil, comparado con un escenario contrafáctico de mantenimiento de las políticas a los niveles de 1989. Entre 2011 y 2015, la prevalencia del tabaquismo en Brasil disminuyó en más de un 17% entre hombres (16%-19%) y 19% en mujeres (14%-24%). Como resultado de las políticas lanzadas desde 1989, se estima que hasta 2050 se evitarán 7,5 millones (6,4-8,5 millones) de muertes entre adultos con 18 años o más. Se estima también que las políticas actuales reducirán un total acumulado de 0,9 millones (0,4-2,4 millones) de desenlaces adversos de salud materna e infantil hasta 2050. Nuestros hallazgos demuestran los beneficios del control del tabaquismo en la reducción de MAT y de los daños a la salud materna e infantil, atribuibles al tabaquismo en nivel poblacional. Esos beneficios pueden ser utilizados para informar a los gestores en los países de renta baja y media sobre la asignación de recursos para las políticas de control del tabaquismo.

Hábito de Fumar; Mujeres Embarazadas; Salud Materno-infantil

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