The Netherlands SimSmoke:

The Effect of Tobacco Control Policies

On Smoking Prevalence and Tobacco Attributable Deaths in the Netherlands

Submitted by

David Levy
Pacific Institute for Research and Evaluation

Kenneth Blackman, MS

Pacific Institute for Research and Evaluation

Laura Currie, MSc

TobaccoFree Research Institute Ireland & Royal College of Surgeons in Ireland

Luke Clancy, MD

TobaccoFree Research Institute Ireland

Marc Willemsen, PhD

STIVORO and CAPHRI, Maastricht University, the Netherlands

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Summary

Proper surveillance and evaluation schemes can improve the effectiveness of future tobacco control policy in the Netherlands. This report describes the development of a simulation model projecting the effect of tobacco control policies in the Netherlands on smoking prevalence and associated future premature mortality. The model is developed using the *SimSmoke* simulation model of tobacco control policy, previously developed for the U.S. and other nations. The model uses population, smoking rates and tobacco control policy data for the Netherlands. The model assesses, individually, and in combination, the effect of seven types of policies: taxes, clean air, mass media, advertising bans, warning labels, cessation treatment, and youth access policies. The Netherlands *SimSmoke* also explores how the effect of policies depends on the population composition, the existence of other policies, and the length of time that policies are in effect. We consider the effect of actual past policies as well as the implementation of future policies. In addition, the model may help identify information gaps pertinent to both modeling and policymaking.

With a comprehensive set of policies, as recommended by MPOWER, the smoking prevalence can be decreased by as much as 21% in the first year, increasing to 35% reduction in the next twenty years and almost 40% by 30 years. The relative impact of a comprehensive tobacco policy on deaths in five years is small compared to the potential impact after 20 years. By 2040, 7,706 deaths can be averted in that year alone with the stronger set of policies. Without effective tobacco control policies, almost a million lives will be cut short due to tobacco-related diseases between 2011 and 2040. Of which, 145 thousand lives can be saved with a comprehensive tobacco control package.

INTRODUCTION

Globally, it is estimated that 5 million deaths each year are attributable to smoking, with trends driving a rise to 10 million deaths per year by the 2030s (1). In response, the World Health Organization (WHO) has set out the Framework Convention for Tobacco Control (FCTC). The MPOWER Report (2) has defined a set of five policies that are consistent with the FCTC.

Substantial evidence indicates that higher cigarette taxes, clean air laws, advertising bans, and well funded media campaigns can appreciably reduce adult smoking rates, especially when combined as a comprehensive strategy (3-6). Evidence is mounting for health warnings and cessation treatment coverage. These policies not only reduce smoking initiation, but also lead current smokers to quit. Quitting can halt or even reverse many of the health problems associated with smoking (7, 8). MPOWER suggests that each nation impose taxes on cigarettes that constitute at least 70% of the retail price, require large, bold and graphic health warnings, provide broad access to cessation treatments, conduct a well-funded mass media campaign, and implement and enforce comprehensive smoke-free indoor air laws and advertising/marketing restrictions.

The Netherlands ratified the FCTC in January 2005. Since 2000, the Netherlands has increased taxes on cigarettes twice, strengthened advertising restrictions and health warnings on cigarette packs, implemented mass media campaigns, and offered a quitline. This report uses a simulation model to examine the effect of Dutch policies implemented since 1996 and the effect of implementing stricter policies that would be fully consistent with the MPOWER/FCTC guidelines.

Most statistical studies of tobacco control policies have examined the effect of only one or, at most, two policies [e.g., Hu (9, 10), Farrelly (11)], because the ability to untangle the effects of tobacco control policies on smoking rates is often limited by lack of data or models that can statistically distinguish the effects. Simulation models combine information from different sources to provide a useful tool for examining how the effects of public policies unfold over time in complex social systems (12, 13). Simulation models examining the effect of tobacco control policies have been developed by Mendez and Warner (14, 15), Tengs et al. (16-18), Ahmad (19-21) and Levy et al. (13, 22-24). In the Netherlands, the Chronic Disease Model has been used to examine the impact of tobacco control policies on smoking rates and health risks, but this model has not modeled the full set of MPOWER interventions (25-29). The *SimSmoke* model of Levy et al. simultaneously considers a broader array of public policies than other models (30) and has been validated in several countries (31, 32) and states (33-35).

In order to examine past trends in smoking rates and to examine the potential effect of tobacco control policies on future smoking rates, a modified version of *SimSmoke* has been developed for The Netherlands. Using data from The Netherlands on population, birth rates, death rates, and smoking rates, the model predicts future smoking rates in total, as well as by age and gender. Using data on relative death risks, the model also estimates the number of deaths attributable to smoking. *Netherlands SimSmoke* also assesses the effect of the MPOWER interventions and policies to enforce limits on youth cigarette purchases on smoking rates and smoking-attributable deaths. *Netherlands SimSmoke* can be used to explore how the effect of policies depends on the age and gender group considered, on the manner in which policies are implemented, on the other policies in effect, and on the length of time considered. The model is also used to identify where further information is needed on tobacco control policies, smoking rates and smoking-attributable deaths, and their inter-relationships. Generally, *SimSmoke* demonstrates the role of different tobacco control policies within a complex, dynamic social system. This report describes the development of *Netherlands SimSmoke*. The model shows future trends in smoking and deaths due to smoking in the absence of policy change, thus justifying the need for policies. The Netherlands model also shows the effect of policies implemented since 1996, and the effect of a set of additional policies consistent with the FCTC, thus justifying the need for specific policies.

METHODS

Basic model

SimSmoke includes a population model, a smoking model, a smoking-attributable death model, and policy modules (13, 23, 24). The simulation model begins in a baseline year with the population divided into smokers, never smokers, and previous smokers by age and gender. The baseline year is usually chosen as a recent year before major policy changes occur and in which a large scale survey of smoking rates was conducted that provided the requisite data. The baseline year for the Netherlands model was chosen as 1996 because a large survey was conducted and major policy changes had not yet been implemented.

A discrete time, first-order Markov process is employed to project future population growth and smoking rates from the base year to future years. Population growth evolves through births and deaths, and smoking rates evolve through smoking initiation, cessation, and relapse rates. Smoking rates may shift due to changes in tobacco control policies. Smoking-attributable deaths in the *SimSmoke* model are estimated using smoking rates and the risks of smokers and ex-smokers relative to never smokers, similar to standard attribution measures (36, 37). The primary mathematical equations used in the model are provided in an Appendix and the data is summarized in Table 1.

Population model

Population by individual age group and gender is from the Netherlands Census for the year 1996 (http://statline.cbs.nl/StatWeb/). Netherlands population data from 1996 to 2006 were obtained for males and females in 2 forms: by single age. The 1996 single age data were chosen for the model and used in their original form (i.e. no smoothing was performed).

The population evolves over time due to deaths and births. Fertility rates by age group (< 20, 20-25, 25-30, 30-35, 35-40, 45 and older) were provided for 2007 & 2008 (CBS Statline (http://statline.cbs.nl/statweb/). The 2008 data were selected for use in the model, primarily for its application in future years. These data were distributed to single ages from 14- to 49-years-old. The unsmoothed data were then used in the model. We obtained mortality counts (Statistics Netherland, www.cbs.nl/infoservice) in total and by cause of death (lung cancer, heart diseases and COPD) by gender and age group (0, 1-5, 5-10… 90-95, 95 and older) for 1969, 1999 and 2008, but used the 1999 data. We also obtained total mortality counts for the above age-groups by gender for 1993, 1996, 2000 and 2009 using the 1996 data. The data from the three oldest age-groups were merged to form the 85-and-older group in order to be consistent with the model. Mortality rates were then computed by dividing by the population counts for each group. The grouped mortality rates were then assigned to single ages from 0 to 84, and the 85 and older age-group.

We also considered international net immigration but do not incorporate its effects into the model because the rate is low (www.theodora.com), and information is generally not available to distinguish smoking rates. Projections from the model for the year 2010 were close to 2010 estimates (www.theodora.com).

Smoking model

Within the smoking model, individuals are classified as never smokers from birth until they initiate smoking or die. They may evolve from current to former smoker through cessation or may return to smoker through relapse. The extent of relapse depends on the number of years since quitting.

Data on current and former smokers were from the Continuous Survey of Smoking Habits (CSSH) conducted by STIVORO (www.stivoro.nl/volwassenen/feitencijfers), conducted at least since 1992. This is a cross sectional population survey of respondents aged 15 years and older that is used to monitor smoking habits of the Dutch population, using weekly measurements. The CSSH is conducted by TNS NIPO (Amsterdam, the Netherlands) for the Dutch expert centre on tobacco control (STIVORO). Respondents were selected randomly from TNS NIPO base, a database with, at present, more than 140 000 potential respondents who participate in internet-based research on a regular basis. TNS NIPO base panel members are recruited actively using telephone and mail. The survey is a self-administered questionnaire at a national level using stratified sampling of about 20,000 individuals in both urban and rural areas. Those sampled are asked if they currently (daily, non-daily, never) or previously smoked. Those who have ever smoked and do not currently smoke are asked when they quit. Changes in the sampling methods occurred in 2001 and 2009. In 2001, the survey mode changed from face-to-face household survey to internet mode (CAWI: Computer Assisted Web Interviewing). In 2009, household sampling (allowing for proxy-respondents for some questions, including on smoking status) changed into person-based sampling.

We were provided with data on the distribution of current, former, and never smokers by gender and age group (15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and older) for single years from 1988 to 2009. For the same breakdowns, data on the number of every day smokers and on former-smokers by how long ago they had quit, as a percentage of former smokers, were also provided for the years 1992-2009. The time-quit categories presented are: 1) This month; 2) Between 1 and 3 months ago; 3) Between 4 and 6 months ago; 4) Between 7 and 12 months ago; 5) Between 1 and 2 years ago; 6) Between 3 and 4 years ago; 7) Between 5 and 9 years ago; 8) Between 1 and 2 years ago; 9) Ten years and longer; 10) Unknown.

The choice of base year was made based on data availability and stability of smoking rates, making it a period trends could be established before major changes in policy. We examined smoking prevalence data over the period 1988-2008, and found that smoking rates were quite stable from 1990 through 2000, about 38% for males and 30% for females. This period also had little tobacco control activity. We selected the 1996 data to use as the base year in the model, and used other years for comparison purposes.

The data were restructured using the following steps:

1. To convert the former smokers to a percentage of the population, the rates for former-smokers by years-quit were multiplied by the overall percent of former-smokers.

2. Because the categories of the data supplied did not match those in the model, the 4 lowest time-quit categories were then merged to form the “quit < 12 months” category. The “quit 10+ years” category was divided into “quit 10-15 years” and “quit > 15 years” by using the appropriate age/years-quit distribution for the Netherlands. The years-quit categories that did not match those in the model were changed. These are “quit 3 - 4 years”, “quit 5 – 9 years” and “quit 10 – 15 years,” while the model contains “3 – 5”, “6 – 10” and “11 – 15”. The formulas used are “quit 3 - 5 years” = (“quit 3 - 4 years” + 0.2*(“quit 5 - 9 years”)); “quit 6 - 10 years” = 0.8*(“quit 5 - 9 years”) + (“quit 10 - 15 years”)/6); and “quit 11 - 15 years” = 5*(“quit 10 - 15 years”)/6.

3. The age-group rates for current-smokers and former-smokers (by years-quit) were then distributed into single ages and smoothed by using a 10-year moving average (MA) process. The quit rates for persons aged younger than 25 were set to zero.

4. The proportion of never-smokers was then computed by subtracting the sum of current- and former-smokers from 1, and then entered into the model.

Due to empirical challenges in measuring initiation and cessation and in order to ensure stability and internal consistency of the model, initiation rates at each age are measured in SimSmoke as the difference between the baseline smoking rate at an age and the rate at the previous age. For example, in the year 1996, smoking rates reached a maximum of about 43.6% for males at age 29 and 42.2% for females at age 39. We allow initiation through age 30. In calibrating the model, we checked smoking rates for ages 18-28 to confirm our choice of maximum initiation age.

Cessation rates are from the same smoking survey and are measured after age 24. Data on cessation was only available for the year 2007. We used the 1996 current smokers and those who quit < 12 months to compute cessation rates. The cessation rate is calculated as (quit < 12 months ago) / (current-smokers + quit < 12 months ago). No smoothing was applied to the cessation rates. Because data were not available for The Netherlands, we use U.S. relapse rates. The cessation rates were about 2% of the population which translated to about 5% of the smoking population. Since about 50% of those who quit in the last year can be expected to relapse, we applied a 50% relapse rate, yielding cessation rate in the range of 2-3%, which are consistent with those found in studies of quitting behaviors in the Netherlands (38-42)

Data is available on the mean number of cigarettes smoked among daily smokers for males and females by age group (15-24, 25-44, 45-64, 65 and older), for each year from 2001 to 2009. The values range from 11.61 to 19.32. In the current version, we do not consider quantity smoked.

Smoking-Attributable Deaths

Smoking attributable deaths (SADs) are determined by excess smoking risks of male and female smokers and ex-smokers, calculated as the differences between estimated mortality risk of smokers (or ex-smokers) and of never smokers. Death rates were first calculated by age, gender and smoking categories (never, current, and the 6 ex-smoker groups) using the data on death rates, smoking rates, and relative risks (see Appendix). The number of smokers at each age was then multiplied by the death rate of smokers minus the death rate of never smokers to obtain the excess deaths due to being a smoker. The same procedure was applied to each ex-smoker group, and the results were summed over smoking groups for all ages to obtain the number of SADs.

Large scale studies of the relative risk of smoking were not available for the Netherlands. However, because The Netherlands has a similar smoking history to the United States (43) and is a high income nation, we use relative risk estimates from the U.S. Cancer Prevention Study II (44-46), which are close to 2.4. We note that Doll and Peto (47, 48) find similar, albeit, slightly higher relative risks, but their analysis is confined to British doctors. For ex-smokers, we allow relative risks to decline at the rate observed in U.S. studies (49), which is similar to the British studies.

Policy Effects

As described in the Appendix, policy effect sizes are in terms of relative percentage reductions. For example, a 10% reduction in prevalence means that prevalence is reduced 10% relative to its initial level (the percentage point decrease divided by the initial level of prevalence).

They are applied to the smoking prevalence in the year in which the policy is implemented and, unless otherwise specified, are applied to initiation and cessation rates in future years if the policy is sustained. Unless synergies are specified, the effect of a second policy simultaneously implemented is reduced by (1- the effect of the first policy). The policy parameters in the model used to generate the predicted effects are based on thorough reviews of the literature and updates, and the advice of an expert panel. As a high income nation, the effects for the Netherlands are determined primarily from studies for that nation and other high income nations. Policies and potential effect sizes are summarized in Table 2.

The effect of each policy depends on its initial level (e.g., the incremental effect of a complete work site law ban is less when a nation already has a partial worksite ban), and, unless otherwise specified, the effect size corresponds to the effect relative to no policy, a weak policy, or otherwise. Because changes in policy affect the future path of smoking prevalence in *SimSmoke*, we track policy levels from the date that the model begins, 1996, to the most recent date, 2010. The level of a policy is based on information in the MPOWER reports (2, 50) and data from other organizations whose objective is to collect recent figures on tobacco control in the Netherlands with corroboration from Dutch tobacco control staff.

Cigarette Taxes

Cigarette taxes are considered one of the most potent tobacco control policies. When taxes change, an equation translates changes in the tax rate (as a percent of price) into changes in price. Changes in price are then translated into changes in smoking prevalence through an equation dependent on price elasticities as described in Levy et al (51). The price elasticities are the standard measures obtained from demand studies and have been extensively studied (52). Chaloupka et al.(52) found that high income nations have total price elasticities between -0.3 and -0.5, averaging -0.4. One study conducted for Netherlands obtained a consistent elasticity estimate (53). Taking into account U.S. studies distinguishing the price responsiveness by age (54), the model uses prevalence elasticities of -0.3 for those through age 24, -0.2 for those ages 25 to 34, -0.1 for those age 35 and above. We also note that the Netherlands has smuggling from abroad, and that a relatively large share is to roll your own using fine cut tobacco (55). Data indicated that the price of fine cut tobacco moves closely with manufactured cigarettes CBS (Dutch Bureau for Statistics).

The model uses a cigarette price index of actual prices from 1996 to 2009, and keeps the 2010 price constant at the 2009 level based on the lack of price change in the first 3 months and the lack of tax increase during 2010. The index was obtained from CBS (Dutch Bureau for Statistics). Following standard economic practice, the price is adjusted for inflation using a consumer price index (http://stats.oecd.org/index.aspx?querytype=view&queryname=221:). According to this data, prices were relatively constant from 1996 through 2003, then increased in 2004, 2007, and 2009. After correcting for inflation, prices have gone up about 70% since 1996. The ad valorem and the specific excise tax are relevant. The specific taxes on cigarettes were 57% of the retail price by 2008 through 2010, based on MPOWER (2, 50) and on European Commission Reports on the Excise Duty Table (http://ec.europa.eu/taxation customs/index en.htm#). We examine the effect of raising the level of specific taxes to 70% of price, after allowing for the added impact of the 15.9% value added taxes (applied to the tax as well as producer price) and raising total taxes to 85.9%.

Smoke Free Laws

The smoke-free air module consists of bans on: 1) worksites, 2) restaurants, 3) pubs and bars, and 4) other public places. *SimSmoke* distinguishes the level of worksite bans by none, partial (work areas, but not common areas), in all workplaces except in ventilated areas, and complete. The level of bans in restaurants or pubs and bars can be distinguished as none, restricted to separate areas or smoke free in all indoor areas. A ban in other public places is designated if there are bans in transit, malls, recreational arenas and retail stores. For each of the bans, the effects depend on enforcement and publicity. Enforcement is also considered on a 1 to 10 scale based on the MPOWER report with strong enforcement if the score is between 8 and 10, medium enforcement if the score is between 4 and 7, and low enforcement if the score is between 0 and 3. The level of publicity is automatically established based on the level of tobacco control campaigns, and thus reflects a synergy related to a broader tobacco control campaign (e.g., through greater awareness of the dangers of second hand smoke).

With a high level of enforcement and publicity in an HIC (high income country), a restaurant ban has a 2% effect (i.e., a 2% relative reduction in prevalence in the first year, and a 2% increase in cessation rates and a 2% reduction in initiation in future years), a pub and bar ban has a 1% effect, a full worksite ban has a 6% effect (the ban in indoor offices only has a 4% effect and the ban in 2 of the 3 of health facilities, universities and government facilities has a 2% effect), and a ban in other public places has a 1% effect. Sensitivity analysis is conducted at 50% to 150% of these values. The effect sizes are based primarily on studies of restrictions by private worksites and clean air laws for HICs. The basis for these estimates is described in Levy et al. (4, 56, 57). For worksites, the effect size is consistent with Fichtenberg and Glantz (58) after converting their 3.8 percentage point prevalence reduction into relative terms and scaling for percent of the workers affected. Effects of similar or larger impact in relative terms have been observed in recent studies for Korea (59), Norway (60), Finland (61) and Spain (62). The effect of bans in restaurants, bars and other public places, and of enforcement has received little attention. The effects are scaled based on the value of the MPOWER smoke-free air law enforcement variable (2, 50) and publicity (e.g., the effects are halved in the absence of any enforcement and publicity).

One study (63) of the effect of smoke-free indoor air laws on smoking prevalence for the Netherlands was consistent with studies for the US and other nations. We also adjusted for work-related factors specific to the Netherlands. The effects of the worksite laws apply only to those who are currently working and work indoors. The percent of the workers employed in agriculture (2%) was similar to that in the U.S. (http://www.greekorthodoxchurch.org/wfb1998/netherlands/netherlands_economy.html), and the rate of labor participation was slightly higher in the Netherlands than the U.S. (http://www.photius.com/wfb1997/netherlands/netherlands_economy.html). Bans in work places, restaurants, and other public places are otherwise assigned the same effect sizes in the Netherlands as in the U.S.

The Dutch Tobacco Act contains measures for controlling the use of tobacco and protecting non-smokers against exposure to tobacco smoke. The 1988 Tobacco Act came into force on 1 January 1990 and had a limited scope. Smoking restrictions only applied to government buildings and certain categories of buildings in the 'semi-public sector' such as institutions for education and healthcare. The Tobacco Act was amended in 2004 to introduce smoke-free working places with ventilated smoking rooms permitted and a complete ban on smoking in public transport and in 2008 to introduce smoking restrictions in the hospitality, sport and art/culture sectors, again with allowances for smoking areas. We consider the Netherlands to have had a partial work ban, no restaurant ban, but a ban in public places in 1998. In 2004, a comprehensive smoke-free law came into effect, which applied to all worksites. A ban in bars and restaurants and other public places was implemented in 2008, but left loopholes for small establishments and is set equal to 50%. The government has set up penalty measures and increased enforcement resources since implementing the ban. No enforcement level data was provided for smoke-free air laws in MPOWER (2, 50), but a recent study by Verdonk-Kleinien (64) indicated that about 50% of workers are still exposed. The enforcement level was set to 5.

Advertising Bans

The advertising ban policy module in *SimSmoke* corresponds to the bans on advertising, promotion and sponsorship in the MPOWER report (2, 50): 1) no policy, 2) minimal policy, 3) moderate policy, and 4) complete policy. Based on data in the MPOWER report, advertising bans are considered to have strong enforcement with a score between 8 and 10 (out of 10), medium enforcement with a score between 4 and 7, and low enforcement with a score between 0 and 2.

The effect sizes for marketing bans are based on a review by Levy et al. (4), relying primarily on the more comprehensive studies by Saffer and Chaloupka (65) and Blecher (66). With a complete ban on direct and indirect marketing in a HIC, *SimSmoke* reduces prevalence by 5%, increases cessation by 3% and reduces initiation by 6%. With a moderate policy, prevalence is reduced by 3%, cessation is increased by 2% and initiation is reduced by 3%. With a minimal policy, prevalence is reduced by 1%, cessation is not affected and initiation is reduced by 1%. The effects of enforcement have not been studied. Like for smoke-free laws, the effects in *SimSmoke* are scaled back for incomplete enforcement (the effects are halved when MPOWER value of enforcement is zero).

Tobacco advertising, promotion and sponsorship on TV and radio have been banned in the Netherlands since 1990, and this was followed by cinemas in 1996. It has also been banned on billboards since 2002 and printed media since 2003. It has been restricted at the point of sale since 2002. Restrictions on marketing (sponsorships, use of logo, discounts are limited to sponsorship and certain types of discounts, according to the MPOWER report. Advertising is considered a partial ban from 1996 increasing to a 50% of a full advertising ban in 2003, but no marketing ban in 2008. There was no enforcement data from MPOWER (2, 50), which was arbitrarily set to 5.

Health Warnings

The health warnings policy module in *SimSmoke* corresponds to the Health Warnings in the MPOWER report. The MPOWER report provides 4 levels for health warnings: no policy, minimal policy (< 30% of the principal display area of the pack), moderate policy (a warning that covers at least 30% of the principal display area of the pack and includes 1 to 7 of the seven pack warning criteria outlined in the Technical Note of Appendix II), and complete policy (a warning that covers at least 50% of the principal display area of the pack and includes all seven pack warning criteria outlined in the Technical Note I, as well as a ban on deceitful terms). The effect of health warnings also depends on the level for tobacco control campaigns, as found in the tobacco control campaign/mass media module.

With strong health warnings, prevalence is reduced by 2%, cessation is increased by 5% and initiation is reduced by 1%. When the level is set to moderate, prevalence is reduced by 0.75%, cessation is increased by 2.5% and initiation is reduced by 0.5%. When the level is set to low, prevalence is reduced by 0.5%, cessation is increased by 1%, and initiation is reduced by 0.5%. When warning labels are strong or very strong, a synergy from publicity through tobacco control campaigns reduces prevalence by an additional 1% and increases cessation by an additional 2% if tobacco control funding is high and half of that amount if it is medium. Evidence on the effects of health warnings on cessation behaviors is provided in Levy et al. (4) and has been strengthened based on more recent articles (67-73). Nevertheless, knowledge on the effects of health warnings, particularly on prevalence and initiation, is indirect.

Prior to 2002, health warnings were minimal. Since 2002, the front of the pack is required to have one of two health warnings covering 30% of the surface. The back of the pack has one of 14 different health warnings (among which are a quitline telephone number). Health warnings are considered to increase from low through 2001 to moderate in 2002 and remaining at that level.

Tobacco Control Campaigns

The *SimSmoke* tobacco control campaign module has 3 levels of campaigns: high, medium, and low, and has been tailored to information in MPOWER (2, 50). The MPOWER report provides information on the national strategy, goals, number of employees, and overall budget for tobacco control. To qualify for a low level campaign, there must be a national agency and at least some level of funding and/or number of employees greater than zero. To qualify for a medium level campaign, the nation must meet the requirements for a low level campaign plus have either more than 10 employees devoted to tobacco control or per capita expenditures over $0.25 USD per capita. To qualify for a high level campaign, the nation must meet the requirements for a low level campaign plus have per capita expenditures over $1.00 USD per capita. In developing these measures, we consider supplementary information on the extent of campaigns and national and local organization using criteria from previous versions of *SimSmoke*.

The intent of this module is not only to capture the establishment of an organized tobacco control campaign, but specifically to incorporate the impact of mass educational programs. An important part of most campaigns is the level of communication through media and other sources, including local programs. Ideally, the module would consider characteristics of the media campaign specific to the country, such as the level of media and other campaign expenditures, the media included, the percent of the year that messages are promoted, whether the campaign has been tested, and the topics that are covered. However, this data is generally not available.

The campaigns with demonstrated effectiveness are those that have involved a strong media component and grassroots organization, such as those in California, Arizona, Australia, Massachusetts, and Thailand. With a well-funded tobacco control campaign in place in conjunction with other policies, the effect size is 6.5%. A moderately funded campaign yields an effect size of 3.25%, and a low funded campaign yields an effect size of 1%. Without other policies in place, the effects are reduced by half. The effect of mass media campaigns has been described in Levy et al. (4, 74, 75), with consistent results in a recent review (76) and some other recent studies (77-80). The module also incorporates the synergies from the effects of publicity from other tobacco control policies, independent of media expenditures. An indicator for other policies is computed with a value of 1 if two of the following four policies are in effect: the tax is greater than 50% of the retail price, there is a complete workplace ban, there is at least a complete advertising ban (3 or 4), or at least strong health warnings (3 or 4) and otherwise has a value of 0.5.

Tobacco control campaigns have been used in the Netherlands, but at a low level prior to the year 2000. In 2000, the well-funded Millennium campaign was put into effect. In 2004 and 2008, Stop-Smoking, a major mass-media campaign, was adopted. In between these highly publicized media campaigns, there were smaller low intensity campaigns directed at youth and their parents. According to MPOWER Reports (2, 50), expenditures on tobacco control were about $20 million US$ in 2007 and 2008, slightly more than US$1 per capita. Because campaigns have been erratic, tobacco control campaigns have been designated as medium intensity since 2000.

Cessation Treatment Policies/Programs

The cessation treatment policy module in *SimSmoke* corresponds to the section "Cessation Programs: Treatment of Tobacco Dependence" in Appendix II of the MPOWER report.(2, 50) In the revised cessation treatment policy module, we have four primary sub-policies included: pharmacotherapy (PT) availability, financial coverage of treatments, quit lines and brief interventions.

The PT availability sub-policy option corresponds to the information in the MPOWER Report regarding whether nicotine replacement treatment (NRT) and/or non-nicotine replacement therapy, such as Buproprion and Varenicline, are available and where they may be obtained. If PT is available and NRT is available without prescription, then prevalence is reduced by 1.0% in the first year of the policy and the pre-policy cessation rate is increased by 6% in all years after the first. The effect is reduced by 1/3 for each of the availability conditions not met, with the NRT indicator given twice the weight as Buproprion and with the weight reduced by 50% if NRT is only available in a pharmacy (with a prescription required). There is no effect on initiation.

For treatment coverage policies, we follow the MPOWER Report which distinguishes place of provision of cessation treatments by the following: primary care facilities, hospitals, offices of health professionals, community, and other. We designate either “yes in some (half effect)” or “yes in most (full effect)” and zero otherwise. We sum the scores to get the proportional effect with a maximum of 4. The synergistic effect of publicity on financial coverage is captured by whether there is a strong or medium level tobacco control campaign. With a high level campaign, prevalence is reduced by 2.25% in the first year of the policy and the cessation rate is increased by 12% in all future years. In the absence of a campaign, the effects are reduced by 25%. The effects are consistent with those in previous versions of *SimSmoke* (4, 81-83). Some recent evidence from Brazil (84) and Great Britain(85-92) provide results consistent with the above postulated effects.

In the MPOWER Report, quitlines are distinguished by whether or not the population has access to a toll free quitline. In previous versions of *SimSmoke*, quitlines were distinguished by type of quitline, with the quitline categorized as passive, active, or active with a follow-up. We now only consider an *active* quitline, which is consistent with the MPOWER Report. The effect of quitlines also depends on publicity, using the same equation as used for the financial access sub-policy. Prevalence is reduced by 0.5% in the first year of the policy, and the cessation rate is increased by 5% in all years after the first, as based on evidence provided in Levy et al. (4).

Brief interventions would involve at minimum a brief intervention by health care providers to advise and assist in cessation, and in more advanced forms would involve follow-up, training of the providers, charting, reminder systems, and integration with other services (quitlines, web-based cessation, and financial access). When fully implemented alone (a value of one), prevalence is reduced by 0.5% in the first year, and the cessation rate is increased by 10%, based on evidence provided in Levy et al. (4). When all sub-policies are implemented, smoking prevalence is reduced by 4.75% and the first year cessation rate is increased by 39.3%.

According to the MPOWER reports (2, 50), cessation treatment services were available in some health care (hospital and health provider offices) facilities, there is a national quitline, nicotine replacement is available at pharmacies and buproprion is available through prescription. We supplemented this information with information from Raw (93, 94), and information describing the lack of financial coverage in Netherlands (25, 39, 40). Based on that information, Netherlands has had NRT available in pharmacies and Buproprion by prescription since 2001, a quitline since 2000, and cessation treatment from some health care providers since 1996.

Youth Access

Youth access is not an MPOWER policy, but is included. Youth access in *SimSmoke* takes into account enforcement, publicity and self service and vending machine bans. A strongly enforced policy can reduce smoking prevalence by those under the age of 18 by as much as 25% (95, 96).

The Netherlands has had a ban on the purchase of tobacco by youth under 18 years of age since 2003. However, enforcement is set at a low level since 2003, with no vending machine and self-service bans.

The Model Outcomes

The model estimates the effects over time for two primary outcomes: smoking prevalence and smoking-attributable deaths. Smoking prevalence is provided for the population ages 15 and above, but the model also has the capability to provide breakdowns by age. Separate results are provided for males and females and for both combined. The model estimates these outcomes for the tracking period, which is from 1996 to 2010, and projects future outcomes for 2011 through 2040.

We use the tracking period to calibrate the model. Based on comparing the actual to the predicted smoking prevalence rates over the period 1996 to 2000, we adjusted the first year cessation rates downward, increasing the relapse rate of first year cessation from 50% to 65% for males and for females, and also modified the rates to 40% at ages above 65.

To validate the model, we compare the predicted smoking rates overall and by gender and age to annual smoking rates by age and gender from the yearly Continuous Survey of Smoking Habits surveys. Since changes in trend around policy changes are the focus, we examine percentage changes in the rates between survey years.

To examine the potential effect of future policies that may be implemented consistent with the FCTC, we first present the status quo case, where tobacco control policies are maintained at their 2010 level. We then consider the effect of varying levels of tobacco control policies in isolation and through a comprehensive tobacco control strategy. In comparing the effect of policies to the status quo, we focus on the relative change in smoking prevalence, i.e., the change in smoking prevalence from the status quo to the future policy scenario divided by the status quo smoking prevalence. For smoking attributable deaths, we calculate lives saved as the difference between the number of deaths under the new policy and the number of deaths under the status quo.

RESULTS

Predictions of Smoking Prevalence from 1996 to 2010

Smoking prevalence is reported as a percent of the population ages 15 and above (as reported in the CSSH) beginning in 1996 for the Netherlands. The model predicts smoking rates from the period 1996 to 2010 taking into account policy changes over that period. Between 1996 and 2010, the model predicts that male smoking rates decrease from 38.4% to 29.0% (a 9.4 percentage point drop, but a 24.5% decrease in relative terms) and that female smoking decrease from 29.6% to 24.5%, a 17.2% relative decline.

As shown in Figure 1 and Table 3, the model was validated against data for 1999, 2003 and 2008 from the same survey as the 1996 data. We note that the Netherlands survey data shows an increase in prevalence between 2008 and 2009, which may be an aberration in trend due to the changes in survey methodology or the worldwide economic recession.(97) In addition, the data show an absolute drop in male prevalence of 4% and in female prevalence of 2% in 2001 (with a 1% drop for each in 2002), which might be also explained by changes in survey methodology. Comparing data from 1996, male smoking prevalence fell by 5% by 1999 compared to a 3% drop predicted by the model, increasing to a 24% decline by 2008 according to surveys compared to 21% predicted by the model. After averaging over 1995-1997 for 1996 (due to apparent data irregularities), the predicted decrease in female prevalence is close for 1999 (1% predicted vs 1% from surveys), and for 2008 (19% predicted vs 25% actual). The model underpredicts the reduction in female prevalence on an aggregate basis (a 15% predicted drop compared to a 23% drop according to the surveys). Thus, the male and female models underpredict the reduction in smoking prevalence. However, some of the difference may reflect the drop in prevalence following the change in survey methodology in 2001.

By age group over the period 1996-2008, the male smoking prevalence from surveys for 1) those aged 18-24 decreases 16% compared to a predicted fall of 19%, 2) for those aged 25-44 falls 20% compared to a predicted fall of 21%, 3) for those aged 45-64 falls 22% compared to a predicted fall of 19%, and 4) for those aged 65 and above falls 56% compared to a predicted fall of 27%. Female smoking prevalence from 1996 to 2008 for 1) those aged 18-24 falls 28% compared to a predicted fall of 19%, 2) for those aged 25-44 falls 31% compared to a predicted fall of 22%, 3) for those aged 45-64 falls 3% compared to a predicted fall of 1%, and 4) for those aged 65 and above falls 22% compared to a predicted fall of 3%. The model does less well at the younger (<25 years) and older (> 64 years) ages, but is more accurate in the 25-64 year old age range, the less volatile ages.

Role of Policies Implemented in 2010 in Reducing Future Smoking Prevalence and Deaths

Estimates of smoking prevalence under the *status quo* and under varying policy scenarios are shown in Table 4a and 4b for males and females respectively. The total number of projected deaths attributable to smoking and lives saved is displayed for the different policies in Table 5a, 5b and 5c for males and females and both, respectively. The estimates for each year represent the number of premature deaths due to smoking in that year alone. In the last column, we summed the numbers over the years 2011-2040 to obtain the lives saved over that period.

The smoking prevalence and smoking-attributable death outcomes are first provided for the status quo case, where all future policies (in years 2011-2040) are maintained at their 2010 level. We then report these outcomes individually, adding each of the MPOWER policies maintained at the recommended levels. Finally, we report for all of the policies combined maintained at the recommended levels.

***Status quo* Scenario**

If tobacco control policies remain unchanged from their 2010 levels, as in the *status quo* scenario, male adult smoking is projected to decrease in absolute terms by 2.8 percentage points from 29.6% to 26.7% over the ten years between 2010 and 2020, by 5.0 percentage points to 24.6% over a 20-year projection period to 2030, and by 6.5 percentage points to 23.1% over a 30-year projection to 2040. *Relative* to the year 2010, the absolute decreases in male adult prevalence represent a decrease of 9.6% after 10 years, 16.8% after 20 years, and 22.0% after 30 years from its baseline level of 29.6%. In the *status quo* scenario, female adult smoking prevalence is at 24.9% in 2010. Female adult smoking prevalence is projected to decrease by 1.4% in absolute terms (5.7% in relative terms) in 10 years to 23.5%, by 2.8% (11.3% in relative terms) in 20 years to 22.1%, and by 4.0% (16.3% in relative terms) to 20.9% over the 30-year period 2010-2040.

Smoking-attributable deaths for the Netherlands depends on the number of current and former smokers (by years quit) and its relative mortality risks. The estimated number of smoking attributable deaths in 2010 is 21,990 for males and 9,898 for females. The projected number of male deaths attributable to smoking in the Netherlands is projected to rise through 2024 and fall below 2010 levels in 2033. Relative to 2010, male deaths are projected to increase by 806 over the 10-year period and by 524 over the 20-year period. However, relative to 2010, male deaths per year decreased by 2,514 over the 30-year period. Female smoking-attributable deaths are initially 9,898 projected to increase by 1,878 over a 10-year horizon, by 3,815 over a 20-year period, and by 3,639 over a 30-year period reaching 13,537 in 2040. Female attributable deaths reached their highest point in 2034.

The Effects of Individual MPOWER Policies

A. Excise Cigarette Taxes Increased to 70% of the Retail Price

Among the available policy measures, tax policy is especially effective in reducing youth smoking (3, 98). Increasing the tax on cigarettes stands out as one of the stronger MPOWER policies. MPOWER targets an increase in excise taxes to 70% of the retail price. Relative to the status quo scenario (the percentage change from the status quo), smoking rates are projected to decline by 8.3% for males and 8.2% for females by 2011. By the end of a 30-year projection period, the year 2040, the male smoking prevalence is projected to decline by about 14.5% and the female smoking prevalence is predicted to decline by 13.7%. Youth smoking prevalence declines at a greater rate as a result of tax increases than adult prevalence in the model, and is the primary reason that taxes continue to reduce adult smoking rates over time.

The projected number of deaths reflects the effectiveness of tax policy in reducing smoking. The effects of taxes on deaths are delayed not only because the effects of cessation on death rates are relatively slow to develop, but also because the greatest tax effects are on youth prevalence.

Changes in youth prevalence do not lead to saved lives for at least 20 years. The 70% tax slows the growth of deaths, with 2,149 lives saved (1,311 male and 838 female) in the year 2040. Summing over years from 2011 (the first year that deaths are averted) through 2040, 40,839 deaths are averted by 2040 with the effects still growing.

B. Well-enforced Comprehensive Smoke-free Laws

Comprehensive smoke-free air laws, with complete bans on smoking in worksites, bars, restaurant and other public places along with strong enforcement, are predicted to lead to a 4.3% (4.3%) reduction in the male (female) smoking prevalence relative to the *status quo* scenario in 2011. Since the Netherlands already has some laws in place, the effect changes to about 4.7% (4.7%) by the year 2020, to 5.1% (5.2%) by the year 2030, and to 5.5% (5.5%) by the year 2040.

Compared to the number of deaths under the *status quo*, comprehensive, well enforced laws are predicted to lead to 384 fewer male and 196 fewer female deaths in 2020 (580 in total), 819 fewer male and 507 fewer female deaths (1,326) in 2030, and 778 fewer male and 544 fewer female deaths (1,322) in 2040. The effects of clean air policies are relatively more immediate compared to tax policies because worksite laws are projected to have their greatest effects on those who are middle aged. The combined effects over the years 2011 through 2040 are 27,278 lives saved.

C. A Comprehensive, Well-enforced Marketing Ban

We consider a comprehensive marketing ban as being directed at all promotions as well as media advertising and as having strong enforcement. The model predicts a 3.5% immediate reduction in smoking prevalence after one year for both males and females, increasing to about a 4.5% reduction by 2040 for both males and females. At 20 years, there is a projected 1,024 fewer smoking-attributable deaths per year (634 male and 390 female) compared to the status quo policy scenario. At 30 years, there are 998 fewer predicted smoking-attributable deaths per year (590 male and 408 female) compared to the status-quo. A cumulative total of 21,104 lives are predicted to be saved between 2011 and 2040.

D. Bold and Graphic Health Warnings

We consider the effect of a warning that covers at least 50% of the principal display area of the pack and includes all seven pack warning criteria outlined in the MPOWER Report as well as a ban on deceitful terms. Introducing the large, graphic health warnings is projected to yield a 0.2% immediate reduction in both male and female smoking rates and about a 1.0% relative reduction in males (1.1% in females) by 2040. Health warnings are projected to avert 148 male and 111 female smoking-attributable deaths in the year 2040, with 4,051 deaths averted in total by 2040.

E. Well-funded Tobacco Control Campaigns

We consider a well-funded tobacco control campaign directed at all smokers (i.e., not targeted to a specific population, such as youth) relative to the current policy of a medium intensity campaign. For a well-funded and publicized campaign that is sustained over time, the model predicts a 3.5% immediate reduction in smoking prevalence for both males and females, changing to a 4.8% (4.8%) reduction by 2040 for males (females). There is a projected 1,132 fewer smoking-attributable deaths (699 male and 433 female) in 2030 and 1,172 fewer smoking-attributable deaths (688 male and 484 female) in 2040 compared to the status quo policy scenario, cumulating to a total of 23,293 lives saved from 2011 to 2040.

F. Comprehensive Cessation Treatment Plan

For direct smoking cessation treatment, we consider the MPOWER combination of ready availability of nicotine replacement therapy and buproprion, the provision of quitlines, and the provision of cessation treatment in primary care facilities, hospitals, the offices of health professionals, and community centers. The combined cessation policies are projected to reduce adult male smoking prevalence by a relative value of 5.2% by 2020 over the *status quo* scenario.

This effect grows to a 6.2% reduction relative to *status quo* by 2030, and to a 6.6% reduction relative to the status quo in 2040. For females the combined cessation policies are projected to reduce smoking prevalence by a relative value of 5.4% by 2020, 6.7% by 2030, and a reduction of 7.2% by 2040. The combined cessation policies are projected to avert 417 male and 222 female smoking-attributable deaths in the year 2020, 1,105 male and 722 female smoking-attributable deaths in the year 2030, and 1,309 male and 982 female smoking-attributable deaths in the year 2040, with a total of 37,566 deaths averted in total by 2040.

Compared to smoke-free air and media and even tax policies, cessation treatment policies have a smaller impact in the first year but have a relatively fast growing impact over time. They are projected to affect those at the ages most prone to quitting, generally above age 35. They might also play a particularly important role in affecting more addicted smokers, who smoke larger quantities and may be less amenable to quitting as a result of other policies.(4, 99)

G. Youth Access

With the enforcement of Youth Access laws, the model predicts a minimal immediate relative reduction in male (female) rates increasing to 8.2% (7.9%) by 2040. Youth access laws are projected to prevent 112 smoking attributable deaths in 2040, with a total of 603 lives saved over the period 2010-2040.

A Comprehensive Set of Policies

Research has shown that the most effective tobacco control campaigns use a comprehensive set of policy measures (100), targeting different populations and filling different needs to reduce smoking prevalence and subsequent deaths. The final scenario projects the effect for a combination of policies, representing increasing the tax to 70% of price; comprehensive worksite and restaurant smoking bans with enforcement; a high intensity tobacco control/media campaign; a total ban on cigarette advertisements/marketing with enforcement; strong health warnings; and a comprehensive smoking cessation treatment program.

In the immediate year, the smoking prevalence is projected to drop by about 20.8% for males and 20.7% for females under a comprehensive policy plan relative to the *status quo* scenario. The smoking prevalence in 2030 is projected to drop by 35.0% for both males and females relative to *status quo*, and by 2040 is projected to drop by 39.5% for males and 39.3% for females. As discussed above, some of these policies have a larger effect earlier in the projection period, while the effect of other policies is delayed. Some policies have a larger impact on adult smoking prevalence and others on youth prevalence. Furthermore, the effects of individual policies are magnified. In the model, the effects of health warning, clean air laws, and cessation treatment policies are magnified by the publicity of a well-funded tobacco control/media campaign. In turn, the effects of these other policies on the effect of a tobacco control campaign are intensified by the publicity that they generate.

Smoking rates are projected to reach targets of 20% by 2015 for males and by 2012 for females with comprehensive policies, and 2014 for the total population. In the absence of new policies, smoking rates are projected to still be about 23% for males and 21% for females in 2040.

As discussed above, some of these policies have a larger effect earlier in the projection period, while the effect of other policies is delayed. Some policies have a larger impact on adult smoking prevalence, e.g., cessation treatment policies, and others on youth prevalence, taxes and youth access enforcement. For example, by year 2020, the largest effects are from taxes, followed by cessation treatment policies, a complete smoke-free air law, marketing restrictions and a high intensity media campaign. By the year 2040, the effects of taxes and cessation treatment have grown relative to marketing restrictions and media campaigns, but youth access has grown more having the second largest effect. Furthermore, the effects of individual policies are magnified by other policies in the model; the effects of health warnings, smoke-free air laws and cessation treatment policies are magnified by the publicity of a well funded media campaign. These other policies also intensify the effect of a tobacco control campaign by the publicity that they generate.

Should a comprehensive set of policies be implemented in 2010, the number of smoking-attributable deaths averted seen under each individual policy scenario are captured here. The model projects 7,015 (4,325 male and 2,690 female) fewer annual smoking attributable deaths, relative to *status quo* policies, by 2030, and 7,706 (4,550 male and 3,156 female) fewer annual smoking attributable deaths by 2040. The projected cumulative effect of the comprehensive set provides strong encouragement for implementing a combination of policies as early as possible. If the number of lives saved is added up for all years between 2011 and 2040, then 89,736 male and 55,033 female deaths are averted by 2040, or a total or 144,769 deaths averted.

DISCUSSION

This report presents the results for the *SimSmoke* tobacco control simulation model as applied to the Netherlands. The model applies population, smoking prevalence, and policy data for that nation and modified parameter values to the established *SimSmoke* model. The model's credibility is supported by validation in countries with sufficient data to confirm predicted trends.

While the Netherlands has implemented some tobacco control policies in recent years, there is still ample scope to strengthen tobacco control policies consistent with the FCTC. Using the *SimSmoke* model, we have presented a short and long-term projection of the role of various tobacco control policies in reducing smoking prevalence and, subsequently, the number of deaths attributable to smoking. The smoking prevalence can be decreased by as much as 21% in the first year, increasing to 35% reduction in the next twenty years and almost 40% by 30 years.

Because of the natural progression of tobacco-related illnesses, early reductions in smoking prevalence have a relatively small impact on the number of smoking-attributable deaths in the short-term. The relative impact of a comprehensive tobacco policy in five years is small compared to the potential impact after 20 years. By 2040, 7,706 deaths can be averted in that year alone with the stronger set of policies. Without effective tobacco control policies, almost a million lives will be cut short due to tobacco-related diseases between 2011 and 2040. Of which, 145 thousand lives can be saved with a comprehensive tobacco control package.

Limitations

We recommend interpreting these projections in a conservative manner. The model's results depend on the reliability of the data, and the estimated parameters and assumptions used in the models.

The smoking prevalence results depend first on estimates of the rates of smoking in 1996, and initiation, cessation and relapse rates. Reliable data were not available for relapse rates except for the US, and are based on US rates (8, 46, 101, 102). We also did not consider differences by socio-economic status, which may be expected to play an increasing role, and of immigration.

The estimated relative mortality risks for smokers are based on studies from the US, but the rates may differ in the Netherlands. However, the relative risks for females may increase as those who have begun smoking at an earlier age reach age 50 and beyond.(47) Notably, the projections also do not include the additional deaths averted due to reductions in second hand smoke exposure. In countries with a higher rate of male than female smokers, female non-smokers may be exposed to smoke in the home.

The policy modules also depend on underlying assumptions, estimated parameters of the predicted effect on initiation and cessation, and assumptions about the interdependence of policies. Knowledge of the different effects of each policy varies (4). For example, many studies, with relatively consistent results, have been conducted on the effects of prices/tax. There are also many studies of clean air laws, with results somewhat less consistent than those of prices, but still falling into similar ranges. Studies on media/tobacco control campaigns and advertising bans provide a broad range of estimates. Studies on the overall effect of health warnings and cessation treatment policies on smoking prevalence are generally lacking.

We have assumed that taxes will be increased in roughly the same proportion for all brands. However, a lack of enforcement against smuggling and internet sales could lead to substitution to lower priced brands and our estimates may over-predict the actual effects of a tax increase.

Since non-nicotine replacement therapy in the Netherlands requires a prescription, physician involvement is necessary. Many physicians still do not ask their patients regularly if they smoke, and are even less likely to follow-up with advice to quit and suggestions on how best to quit. When fully implemented alone (a value of one), past work indicates that the prevalence is reduced by 0.5% in the first year (equivalent to an additional 5% of smokers making a quit attempt with a 10% average success rate net of relapse) and the pre-policy cessation rate is increased by 10% (equivalent to quit attempts increasing by 50% with the new treatment users having a 20% first year success rate) in all years after the first. These values are based on data from the United States, and thus estimates of the effect of physician involvement should be viewed as tentative. However, there may be even further gains with integrating services, use of the web and increasing treatment follow-up to reduce relapse. A recent study (99) suggests that the extensive cessation treatments suggested above can almost double quit rates.

Cessation treatment policies may also play a special role when combined with other policies. In a model where quit attempts are distinguished from treatment use, it has been shown that cessation treatment policies play a synergistic role (103, 104). Policies such as tax increases and smoke-free air laws act primarily to increase quit attempts, while cessation treatment policies help to make those quit attempts successful. Media campaigns targeting cessation and the provision of quitline numbers on cigarette warnings can also help insure that smokers make more efficient use of treatments.

In general, better understanding of the interactive effects of policies is also needed. We have made the conservative assumption that the effects of each policy are a constant proportion of the smoking rate independent of other policies. Evidence indicates that public policies may be synergistic through their cumulative impact on social norms and their reinforcing effects on smokers' motivation to quit.(35, 103) Studies need to be done not only to gauge the initial effect of policies, but also to understand how those policies unfold over time and depend on the other policies in effect.

In sum, the model relies on simplifying assumptions, in some cases due to the limited availability of data. Netherlands has more extensive data than most other EU nations. It will be important to continue to collect detailed information on smoking prevalence, so that accurate rates can be determined by age and gender. In particular, smoking rates at early ages, such as 15-17, 18-21, 21-24, and 25-29 are needed, as well as information on the prevalence of former smokers, distinguishing by years quit, so that cessation rates can be estimated and quitting can be tracked. In addition, it would be useful to monitor quit attempt behaviors, the use of pharmacotherapies and quitlines, the involvement of physicians in advising patients to quit, cigarette prices of the prominent brands and the amount of smuggled cigarettes, and compliance with marketing restrictions and smoke-free air laws. As this information is collected and monitored, the SimSmoke model can be adapted to more accurately reflect trends in smoking rates over time. Most important, improved data can be used to better monitor and evaluate policies, so that policies can be modified and adapted in reaction to successes and failures.

Conclusions

The *SimSmoke* results highlight the relative contribution of numerous policies to reducing the tobacco health burden. The model predicts that many lives can be saved by a large increase in taxes. When the tax increases by large percentages, stronger clean air and youth access laws are implemented, publicized and enforced, a strict advertising and marketing law is promulgated and enforced, strong warning labels are required, a high publicity media campaign is coordinated with the other policies, and a strong comprehensive cessation treatment program is implemented, the smoking rate is projected to fall by 40% in relative terms and 145 thousand deaths are averted by the year 2040. A large increase in taxes alone or in the provision of cessation treatments would substantially reduce the number of lives lost to smoking. Tax increases are also likely to increase government tax revenues (105), part of which can and should be earmarked to enforce and publicize other policies and subsidize cessation treatments.

SimSmoke: Mathematical Appendix

The *SimSmoke* model begins with the population in a baseline year divided into current, former, and never smokers. Assuming a discrete, first-order Markov process, population evolves over time through births and deaths, and the smoking population evolves through initiation, cessation, and relapse.

Demographics Model

SimSmoke is built first on a demographic model. The total population (*Pop)* is distinguished by time period **t** and age **a** (and is further distinguished in the model by gender)**.** Mortality rates (*MR)* are distinguished by age and gender. Newborns depend on first year deaths rates and fertility rates (*Fert)* of females by age with equal birth rates for males and females. Births through the first year (age 0) for each gender are:

$Pop_{t,0} = 0.5*(1\text{-}MortRate_{0})*\ \Sigma^{a}\ (Pop_{t,a,1} * Fert_{a})$, where t=1,…,20; a=14,…,49.

After the first year, the population evolves as:

$Pop_{t,a} = Pop_{t\text{-}1,a\text{-}1} * (1 – MortRate_{a})$.

Smoking Model

SimSmoke divides the population in the base year into (1) never smokers, (2) smokers, and (3) 16 categories of ex-smokers (n=1,…,16+) corresponding to years since last time smoking. After the base year, individuals are classified as never smokers from birth until they initiate smoking or die, as shown by:

$Neversmokers_{t,a} = Neversmokers_{t\text{-}1,a\text{-}1} * (1 – MortRate_{a,ns})*(1\text{-}Initiation\ rate_{a})$.

From never smokers, individuals can become smokers through initiation, leave smoking through cessation and return to smoking through relapse. The number of smokers (designated by s) is tracked as:

$Smokers_{t,a} = Smokers_{t-1,a-1} * (1 - MortRate_{t.a,s}) * (1\text{-}Cessation\ rate_a)$

$+ Neversmokers_{t-1,a-1} * (1 - MortRate_{a,ns}) * Initiation\ \ rate_a.$

$+ \Sigma^{16}_{n=1}\ Ex\text{-}smokers_{t-1,a-1,n} * (1 - MortRate_{t,a,n}) * (Relapse\ rate_{a,n}).$

First year ex-smokers are determined by the first year cessation rate applied to surviving smokers in the previous year. After the first year quit, individuals who have been ex-smokers for between n= 2,…, 15 are defined as:

$Ex\text{-}smokers_{t,a,n} = Ex\text{-}smokers_{t-1,a-1,n-1} * (1 - MortRate_{a,n}) * (1\text{-}Relapse\ rate_{a,n-1}).$

For those who have ceased smoking for more than fifteen years, we add to the above equation the ex-smokers from the previous year who have quit for more than fifteen years and have not died or relapsed in the previous year.

Smoking-attributable Death Models

Smoking-attributable deaths are estimated for each age and smoking group by multiplying the number of smokers in that group by the difference between the death rate of that smoking group and the death rate of never smokers. To estimate the age and smoking group specific death rate $DR_{a,s}$, we used the age and gender specific prevalence (*Prev*), relative risks ($RR_{a,s}$) and death rates (DR_a). The death rate of an age group can be expressed as:

$$DR_a = PrevNeversmokers_{a,ns} * DR_{a,ns} + PrevSmokers_{a,s} * DR_{a,s} + \Sigma^n (PrevEx\text{-}smokers_{a,n} * DR_{a,n}),$$

Dividing both sides by $DR_{a,ns}$, we obtain:

$$DR_a / DR_{a,ns} = PrevNeversmokers_{a,ns} + PrevSmokers_{a,s} * RR_{a,s} + \Sigma^n (PrevEx\text{-}smokers_{a,n} * RR_{a,n}),$$

because $RR_{a,s} = DR_{a,s}/DR_{a,ns}$ and similarly for ex-smokers, and $RR_{a,ns}=1$. Rearranging terms, the death rate for never smokers becomes:

$$DR_{a,ns} = DR_a / [PrevNeversmokers_{a,ns} + PrevSmokers_{a,s} * RR_{a,s} + \Sigma^n (PrevEx\text{-}smokers_{a,n} * RR_{a,n}].$$

For any smoking group s^* (of either smokers or ex-smokers), we multiply both sides by $DR_{a,s*}$ / $DR_{a,ns}$ to obtain the death rate:

$$DR_{a,s*} = DR_a * RR_{a.s*} / [PrevNeversmokers_{a,ns}+PrevSmokers_{a,s}*RR_{a,s}+\Sigma^n (PrevEx\text{-}smokers_{a,n}*RR_{a,n})].$$

Policy Modules

The effects of policies are calculated as percent reductions, PR, relative to the initial rates, i.e., [PR= (post-policy rate - initial rate)/initial rate, where PR< 0]. Policies generally have the greatest effect in the first years. The effects are modeled as a permanent additive effect on smoking prevalence in the first year that the policy is implemented, i.e., $Smokers_{t,a} * (1+PR_{i,t,a})$ for policy **i** at time period **t** and which may vary by age **a**.

After the first year, policies affect initiation and cessation rates. If the policy affects initiation, the effects of the policy are sustained through lower initiation rates. Throughout the years in which the policy **i** is in effect, the percentage reduction lowers the initiation rate by $(1+PR_{i,a})$. The effects of a policy **i** may also be augmented over the same time period through increases in the first year cessation rate by $(1-PR_{i,a})$. First-year quit rates remain elevated for each of the policies (except youth access policies), as justified by the higher propensity to quit among individuals who smoke less (106-108) as a result of policies and other factors (e.g., economic and informational) creating incentives to quit. It is assumed that the proportion of individuals who relapse increases in direct proportion with any added cessation, implying that the rates of relapse are unaffected by policy changes. Thus, policies have their greatest affect on cessation (directly through the prevalence rate) in the first year that the policy is in effect. Each of the policies also continues to affect initiation and first-year cessation rates during the period over which a policy is in effect.

When more than one policy is in effect, there may be synergies built into the model as described below. Otherwise, it is generally assumed that there are constant proportional reductions, i.e., $(1+PR_i)*(1+PR_j)$ for policies **i** and **j**. This formulation implies that the relative effect of a policy is independent of other policies in effect, but the absolute reduction is smaller when another policy is in effect (due to the reduction in smoking rate from the other policy).

Direct modifications are made in some of the policy effects for individual countries, especially as they relate to LMICs relative to HICs. Two main types of adjustments that pertain primarily to LMICs are made using scale factors. The first, **URBAN** (> 0, $\leq$ 1), is for the degree of urbanization and is generally meant to capture difficulties in reaching populations that are in more rural areas. This variable is measured as [(1-the percent of economy in rural trades [agriculture] in a country/percent of economy in rural trades) / (1- the percent of the economy in agriculture the U.S.)], based on information from the CIA FactBook (www.theodora.com). Because less than 1% of the economy in the U.S. is employed in agriculture, we omit the denominator (implying a value of one). The other scale factor, **AWARENESS** ($\geq$ 1) is for the potentially a greater impact of awareness about the dangers of smoking in countries where such information is at a lower base level than in the U.S. The level of **AWARENESS** depends on the policy, as designated below. The level of **AWARENESS** is applied to LMICs where information is less well-disseminated than in HICs. These scale factors are applied multiplicatively, so that the effect sizes become $(1+URBAN_i * AWARENESS_i * PR_{i,a})$ for the prevalence and initiation effects and $(1+URBAN_i * AWARENESS_i * PR_{i,a})$ for the cessation effect.

Taxation Policies

The tax policy module in *SimSmoke* follows the MPOWER Report and specifies the tax in percentage terms relative to the retail price. The model assumes that prices increase in absolute terms with the amount of the cigarette tax, based on (109) and evidence from other countries (110). We also assume that the factory price (after adjusting for inflation), the import and value added tax and the average percent markup by the manufacturers and foreign tobacco firms remains constant.

We obtain the factory price as retail price *(1-t), where t is all taxes on cigarettes. The total excise tax will be equal to t/ (1-t) times the final price (111) . Total taxes include excise taxes (specific and advalorem), plus the value added tax. We examine the effect of increasing the excise taxes to 70%. In conducting that analysis, we assume that the value added tax in percentage terms is held constant, which amplifies the effect of the excise tax increase.

The taxation effect works through elasticities, which we assume are constant. The formula for constant price elasticity, *E*, is defined in terms of the price, **P**, and quantity, **Q**, both distinguished by their new level, designated by subscript **n**, and their initial level, designated by subscript **t**. The formula is written as:

$$E = [(Q_{t+1} - Q_t)/(Q_{t+1} + Q_t)]/[(P_{t+1} - P_t)/(P_{t+1} + P_t)],\ E < 0.$$

To solve for Q_t, the equation is rewritten as:

$$[(Q_{t+1} - Q_t)/(Q_{t+1} + Q_t)] = E*[(P_{t+1} - P_t)/(P_{t+1} + P_t)]$$

Denoting $\Delta = E * [(P_{t+1} - P_t)/(P_{t+1} + P_t)]$, the equation can be solved for

$$Q_{t+1} - Q_t = \Delta(Q_{t+1} + Q_t), \text{ or}$$

$$Q_{t+1} = Q_t * (1 + \Delta)/(1 - \Delta).$$

Since we focus on participation rates, **Q** translates to the number of smokers for relatively small changes in population. In order to distinguish the effects for different periods, let $\mathbf{\Delta_t}$ denote the effects of a price change between periods **t** and periods **t-1**. Let $\delta_t = (1+\Delta_t)/(1-\Delta_t)$, then

$$Q_{t+1} = \delta_t * Q_t.$$

The elasticities vary by age based on U.S. data (as described in the text) and are scaled by country relative to the U.S., usually in terms of overall elasticity (participation and conditional quantity), depending on the type of elasticity available. For example, the average overall elasticity for the U.S. is 0.4 (Jha and Chaloupka 2000).

Actual prices adjusted for inflation are used for the tracking period. Future price changes occur through tax increases, which are specified as a portion of price. Future inflation adjusted prices are assumed constant in the absence of a tax change. Let $\mathbf{TR_t}$ be the tax rate as expressed as a percent of price in period **t**. Then the price, $\mathbf{P_t}$, can be re-written, $P_t * (1- TR_t) + P_t * TR_t / (1-TR_t)$, where the first term is the net of tax price, and the second term is the amount of the price that is taxed. We assume that the net of tax price remains constant and that prices increase by the amount of the tax, so that the new price is obtained by substituting the new tax TR_{t+1} for $\mathbf{TR_t}$ in the second term.

Smoke-Free Air Policies

Three types of smoke-free air policies (worksite, restaurant, and bars) are included in MPOWER *SimSmoke*, with the effect of worksite further distinguished by its stringency. Worksite bans are distinguished corresponding to data provided in the MPOWER Report as: 1) partial as designated by a ban in 2 of the 3 types of facilities: health, university, and government facilities, 2) ban in indoor offices only, and 3) ban in all indoor workplaces (including offices and other indoor workplaces, universities, and government). These policies are cumulative, i.e., inclusive of the previous policy, with the MPOWER target policy a complete ban. Consistent with the MPOWER Report, the model distinguishes only a total restaurant ban and a total ban in bars and restaurants. The MPOWER model includes a ban in pubs and bars. The model includes bans in other public places, based on the corresponding MPOWER variables, public transport, and supplementary information. An enforcement index is based on the MPOWER Report, whereby enforcement is scored between 1 and 10, with10 the highest level. In addition, publicity is directly dependent on the level of tobacco control campaigns.

The effects for HICs with a high level of publicity and enforcement are: worksites = 6%, restaurants = 2%, and bars = 1%. For LMICs, the effects are adjusted downward by using the

URBAN index to account for the percent of the population not affected due to lower rates of labor working in indoor workplaces and increased by 50% in a country in an LMIC without previously active tobacco control (then **AWARENESS** = 1.5, and otherwise = 1). In addition, while half of the effects occur automatically through passage of the law (e.g., due to a change in norms), the other half of the effects depend on enforcement ($0 \leq$ **ENF** ≤ 1, using the MPOWER index=1,…10 divided by 10 to be scaled to 1) and a publicity index based on tobacco control spending (= .5 if no tobacco control spending is low or non-existent, 0.75 if tobacco control spending is medium, and 1 if tobacco control spending is high). Letting *SFL'* equal the effect size of type **k** for a HIC with high enforcement and publicity, the effect SFL_i for country **i** is:

$$SFL_{i,k} = SFL_k' * URBAN_i * AWARENESS_i *0.5 (1+ENF_i*PUB_i).$$

Marketing Restrictions

Four levels of marketing restriction policies are distinguished: none, minimal, moderate, and comprehensive. The effects differ for prevalence, cessation, and initiation, and also depend on enforcement.

While a lower degree of urbanization may reduce the effectiveness of advertising by making it more difficult to reach those in rural areas, Blecher (2008) found that the effects of comprehensive bans are at least 4 times as great in LMICs as in HICs. In the model, this phenomenon is attributed to lack of awareness of the dangers of smoking and anti-smoking attitudes. The effect in the LMICs is doubled relative to HMICs. As for smoke-free laws, a total lack of enforcement reduces the impact by half ($0 \leq$ **ENF** ≤ 1, using the MPOWER index = 1…10 divided by 10 to be scaled to 1). For marketing restrictions at a level **k** for HICs with high enforcement designated as MR', the effect for country **i** will be:

$$MR_{i,k} = MRK_k' * AWARENESS_i *0.5 (1+ENF_i).$$

Health Warnings

The MPOWER *SimSmoke* distinguishes four levels of policy (none, mild, moderate, and strong) and the effects depend on the awareness factor. Because this policy is geared toward the dangers of smoking, the level of initial awareness is expected to play an important role. For LMICs, the effects are doubled due to the lower initial level of awareness (**AWARENESS** =2 in that case, **AWARENESS**= 1 otherwise). For effect size *HW*' at level **k** for health warning in a HIC, the effect for country **i** is:

$HW_{i,k} = HW_k' * AWARENESS_i$.

Tobacco Control Campaigns

Previously in the *SimSmoke* tobacco control/media campaign model, 3 levels of a campaign are specified: high, medium, and low. The degree of urbanization affects the ability to reach rural populations through the media and even local campaigns, and is taken into consideration in examining the effect of tobacco control spending. However, the level of awareness is expected to be low in LMICs that have not had prior policies, and for those countries is accorded a value of 1.5. For tobacco control spending at level **k** at effect size *TC'* in a HIC, the effect for country **i** is:

$TC_{i,k} = TC_k' * URBAN_i * AWARENESS_i$

Description of the New Cessation Treatment Policy Module

The new PT availability sub-policy option corresponds to the information in the MPOWER Report regarding whether nicotine replacement treatment (NRT) and/or Buproprion are available and where they may be obtained. The availability indicators are first developed separately for each PT by setting them equal to:

PT1 = 2 if NRT is yes, 0 if no

PT2 = 1 if Buproprion is yes, 0 if no

When pharmacotherapy is available, the MPOWER Report distinguishes whether each PT is available in a general store or pharmacy and if a prescription (Rx) is required. We do not distinguish effect sizes (they are each assigned a value 1) by these sources except when NRT is only available by prescription. Since access is thus more limited, the NRT variable is multiplied by 0.5, indicating that the effect is reduced by 50%. To get an overall effect, the indicators for NRT and Buproprion (PT1 and PT2) are summed and divided by 3 to obtain an overall indicator with a value between 0 and 1 that is used to scale the percentage effect of the new treatment availability sub-policy. If the value of the sub-policy is 1 (the policy is effect in full), then prevalence is reduced by 1.0% in the first year of the policy (which is roughly equivalent to the effect of 15% of smokers using either or both of the PTs with a 10% average success rate net of relapse in the first year) and the pre-policy cessation rate is increased by 6% in all years after the first (equivalent to quit attempts increased by 30% due to new PT users with those users having a 20% first year success rate). Therefore, there is no effect on initiation.

Unlike in previous *SimSmoke* models, treatment coverage does not distinguish pharmacotherapy and behavioral therapy, but rather focuses on where the treatment is provided. We followed the MPOWER Report that distinguishes place of provision of cessation treatments by the following: primary care facilities, hospitals, offices of health professionals, community and other. For each location, we designate a value of score for each of the above locations: 0 = None, 1 = Yes in some, and 2 = Yes in most. We then sum the scores. The highest possible score is 10, but a full effect is designated if at least 4 of the 5 places have indicated yes, whereby a score of 8 is for the full effect. To scale to 1, we multiply by 0.125 (1/8). That indicator is used to scale the effect of the financial coverage of treatment sub-policy.

Previously the financial access sub-policy in *SimSmoke* included the level of publicity, which is no longer an option in this module. The level of publicity is now automatically set based on the level of tobacco control campaigns. The effect of publicity on financial coverage of treatment is (1- 0.25 *(1- publicity)); where publicity = 1 if a high level tobacco control campaign, 0.5 if medium level, and 0.25 if low level)) so that the effects of treatment availability are scaled as much as a 25% reduction by this variable if publicity is less than high (equivalent to an additional 15% of smokers using treatment with a 15% success rate net of relapse) in the first year of the policy and the cessation rate is increased by 12% (equivalent to quit attempts increased by 40% with the new treatment users having a 30% first year success rate) in all years after the first.

In the MPOWER Report, quitlines are distinguished only by whether the population has access to a toll free quitline. In previous versions of *SimSmoke*, quitlines were distinguished by TYPE of quitline. We now enable the user to input supplementary information regarding whether the quitline is passive, active without follow-up or active with follow-up, with corresponding values of 1, 2 and 3 respectively. A default value for TYPE 2 (an active quitline without follow-up) is designated if no information is provided. In previous versions of *SimSmoke*, we also distinguished whether there was no cost NRT provided to callers, which is now excluded. The effect of quitlines also depends on publicity, which uses the same equation as for the financial access sub-policy.

If an active quitline with follow-up is implemented and the program is well publicized through a tobacco control campaign, then prevalence is reduced by 0.75% (equivalent to 5% of smokers using the quitline with a 15% success rate net of relapse) in the first year of the policy and the cessation rate is increased by 7.5% (quit attempts increased by 25% with users having a 30% first year success rate) in all years after the first. When the quitline is not active with follow-up, the effectiveness is reduced by (1- 0.5*TYPE/3). The MPOWER Report best case is only active quitlines.

In chapter 2 of the MPOWER Report, health care provider involvement is emphasized as a key element for successful cessation treatment services, but no information is provided in the MPOWER Reports on its level. This policy would involve at minimum a brief intervention by health care providers to advise and assist in cessation, and in more advanced forms would involve follow-up, training of the providers, charting, reminder systems, and integration with other services (quitlines, web-based cessation, and financial access). We include the health care provider involvement option as supplementary information provided by the user with a default value of zero, and the ability to scale the variable by between zero and one. The value should reflect the level of involvement, with 1 designating a required (or adequately subsidized) intervention with follow-up by all health care providers and with cessation treatment training, reminder systems and integration. When fully implemented alone (a value of one), prevalence is reduced by 0.5% in the first year (equivalent to an additional 5% of smokers making a quit attempt with a 10% average success rate net of relapse) and the pre-policy cessation rate is increased by 10% (equivalent to quit attempts increasing by 50% with the new treatment users having a 20% first year success rate) in all years after the first.

When more than one of the sub-policies is implemented, the effects are additive with the following exceptions. As in previous versions of SimSmoke, the effect of quitlines with NRT is reduced by 25% if there is also a policy of complete financial coverage of treatment, because NRT is then made available at no cost through other sources. In addition, a synergistic effect occurs between sub-policies 1-3 (which all provide for more treatment use) and brief interventions, as health care providers encourage treatment uses that have become more readily available. Brief intervention then increases the effect of sub-policies 1, 2 and 3 on prevalence by 10% and on the cessation rate by 30%. When all sub-policies are implemented, smoking prevalence is reduced by 4.75% and the first year cessation rate is increased by 39.3%. We allow for less effect if the country is rural because of less access to health care in rural areas, but we allow for a 50% greater effect in countries where awareness of health dangers is low. Thus, with effect size *CTP*' for cessation treatment policies in an HIC, the effect in country **i** is

$$CTP_{i,k} = CTP_k' * URBAN_i * AWARENESS_i$$

Table 1. Data Used in *The Netherlands SimSmoke*

Input	Source	Specifications
I. Population		
A. Population	CBS Statline (http://statline.cbs.nl/statweb/	Breakdowns by age and gender groups
B. Fertility rates	CBS Statline (http://statline.cbs.nl/statweb/	Breakdowns by age and gender groups
C. Mortality rates	CBS Statline (http://statline.cbs.nl/statweb/	Breakdowns by age and gender groups
II. Smoking and attributable deaths		
A. Baseline smoking rates	1996 Monitoring Trends in Smoking Behavior in the Dutch Population.	Breakdown of current, former and never smokers by age and gender groups.
B. Initiation rates	Change in smoking rates between contiguous age groups through age 30	Breakdowns by age and gender groups.
C. First year cessation rates	1996 Monitoring Trends in Smoking Behavior in the Dutch Population.	Breakdowns by age and gender groups.
D. Relapse rates	USDHHS (1989) and other studies	Breakdowns by age
E. Relative risks of current and ex-smokers	Cancer Prevention Study II (NCI 1997)	Breakdowns by age and gender.
III. Policies		
A. Prices and Taxes	Dutch Bureau for Statistics, Eurostat, WHO website	Prices (cigarette and CPI) and taxes
B. Clean air laws	Tobacco control staff in The Netherlands, and labor force participation rates	Types of laws (worksite, restaurant, and other places) and their stringency
C. Media & other educational campaigns	Tobacco control staff	Classification based on expenditures per capita and audience
D. Advertising Bans	WHO website and tobacco control staff in The Netherlands	Extent of bans
E. Warning Labels	WHO website and tobacco control staff	Strictness of labels
F. Cessation Treatment Policies	WHO website, tobacco control staff	Financial reimbursement, quitlines, and brief interventions
G. Youth access	Tobacco control staff	Enforcement checks, penalties, community campaigns, self-service and vending machine bans

Table 2. Policies, Description and Effect Sizes of the *SimSmoke* Model

Policy	Description	Potential Percentage Effect*
Tax Policy	Cigarette price index, taxes measure in absolute terms	Through price elasticity: -0.3 ages 15-17 -0.2 age 18-24 -0.15 ages 25-34 -0.1 ages 35 and above
Clean Air Policies		
Worksite total Ban	Ban in all areas	6% with variations by age and gender
Worksite ban except ventilated areas	Smoking restricted to ventilated areas in all indoor workplaces	2% with variations by age and gender
Worksite ban limited to common area	Smoking limited to non ventilated common area	2% with variations by age and gender
Restaurant total ban	Ban in all indoor restaurants in all areas	1% effect
Restaurant ban except separate areas	Ban in all restaurants except in designated areas	0.5% effect
Other places total ban	Ban in 3 of 4 (malls, retail stores, public transportation and elevators)	1% effect
Enforcement and publicity	Government agency is designated to enforce and publicize the laws	Effects reduced by as much as 50% if 0 enforcement
Mass Media Campaigns		
Highly publicized campaign	Campaign publicized heavily on TV (at least two months of the year) and at least some other media	3.25% effect (doubled when accompanied by local programs)
Moderately publicized campaign	Campaign publicized sporadically on TV and in at least some other media, and a local program	1.8% effect (doubled when accompanied by local programs)
Low publicity campaign	Campaign publicized only sporadically in newspaper, billboard or some other media.	0.5% effect (doubled when accompanied by local programs)
Advertising Bans		
Comprehensive marketing ban	Ban is applied television, radio, print, billboard, in-store displays, sponsorships and free samples	5% reduction in prevalence, 6% reduction in initiation, 3% increase in cessation rates
Total Advertising Ban	Ban is applied all media television, radio, print, billboard	3% reduction in prevalence, 4% reduction in initiation, 2% increase in cessation rates
Weak advertising ban	Ban is applied some of television, radio, print, billboard	1% reduction in prevalence and initiation only
Enforcement and publicity	Government agency is designated to enforce the laws	Effects reduced by as much as 50% if 0 enforcement
Warning Labels		
Strong	Labels are large, bold and graphic	2% reduction in prevalence 2% reduction in initiation 4% increase in cessation rate
Weak	Laws cover less than 1/3 of package, not bold or graphic	1% reduction in prevalence & initiation rates, 2% increase in cessation rates
Publicity	Health information is well publicized	1% additional effect on prevalence and initiation rates

Cessation Treatment Policy	Complete availability and reimbursement of pharmaco- and behavioral treatments, quitlines, and brief interventions	4.75% reduction in prevalence, 39% increase in cessation rate
Youth Access Restrictions		
Strongly enforced & publicized	Compliance checks are conducted regularly, penalties are heavy, and with publicity is strong, vending machine and self-service bans	30% reduction for age < 16 in prevalence and initiation only, 20% reduction for ages 16-17 in prevalence and initiation only
Well enforced	Compliance checks are conducted sporadically, penalties are potent, and little publicity	15% reduction for age < 16 in prevalence and initiation only, 10% reduction for ages 16-17 in prevalence and initiation only
Low enforcement	Compliance checks are not conducted, penalties are weak, and no publicity	3% reduction for age < 16 in prevalence and initiation only, 2% reduction for ages 16-17 in prevalence and initiation only

***** Unless otherwise specified, the same percentage effect is applied as a percentage reduction in the prevalence and initiation rate and a percentage increase in the cessation rate, and is applied to all ages and both genders. The effect sizes are shown relative to the absence of any policy. They are based on literature reviews, advice of an expert panel and model validation

Figure 1. Netherlands: SimSmoke vs CSSH Survey, 1996-2010

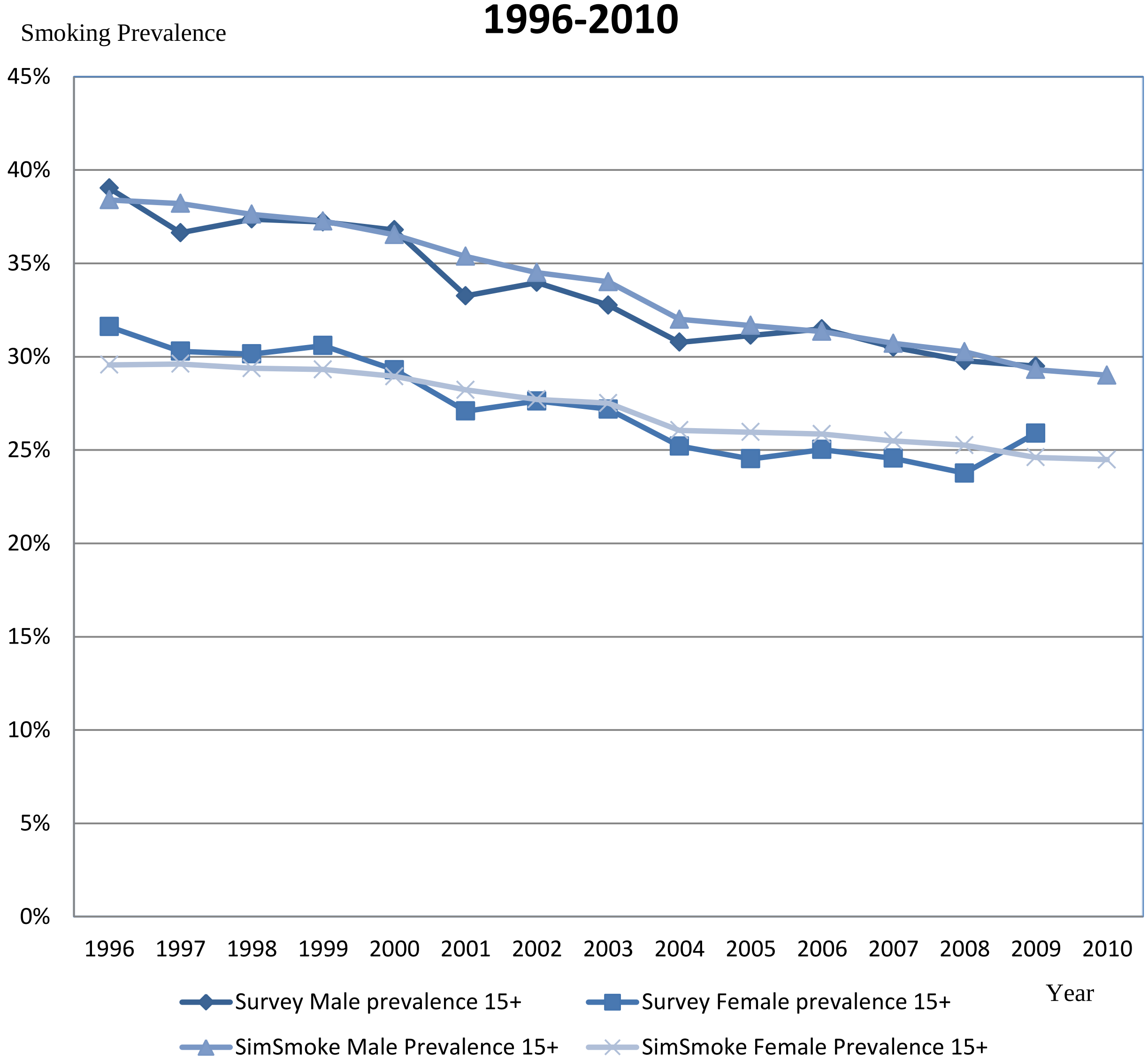

Table 3. Netherland Smoking Prevalence: CSSH Survey Rates vs. SimSmoke Rates, by age and gender, 1996-2008

Survey Results									
Year	***1996***	***1999***	***% change from 1996***	***2000***	***2003***	***% change from 1996***	***2004***	***2008***	***% change from 1996***
Male									
15-24	*32.9%*	*29.9%*	*-9%*	*32.3%*	*30.6%*	*-7%*	*28.1%*	*27.8%*	*-16%*
25-44	*43.1%*	*41.1%*	*-5%*	*42.3%*	*38.8%*	*-10%*	*35.5%*	*34.3%*	*-20%*
45-64	*39.4%*	*38.9%*	*-1%*	*36.6%*	*32.4%*	*-18%*	*32.0%*	*30.9%*	*-22%*
65+	*30.4%*	*29.1%*	*-4%*	*24.5%*	*13.3%*	*-56%*	*14.9%*	*13.4%*	*-56%*
Ages 15 and above	*39.0%*	*37.2%*	*-5%*	*36.8%*	*32.8%*	*-16%*	*30.8%*	*29.8%*	*-24%*
Female									
15-24	*29.4%*	*31.8%*	*8%*	*29.0%*	*28.4%*	*-4%*	*24.1%*	*21.1%*	*-28%*
25-44	*38.7%*	*33.6%*	*-13%*	*34.2%*	*32.1%*	*-17%*	*29.2%*	*26.6%*	*-31%*
45-64	*29.2%*	*32.6%*	*12%*	*29.0%*	*27.5%*	*-6%*	*27.8%*	*28.4%*	*-3%*
65+	*14.0%*	*13.4%*	*-4%*	*14.7%*	*13.2%*	*-6%*	*12.4%*	*10.9%*	*-22%*
Ages 15 and above	*30.9%*	*30.6%*	*-1%*	*29.3%*	*27.2%*	*-12%*	*25.2%*	*23.8%*	*-23%*
SIMSMOKE									
Male									
15-24	*31.6%*	*30.4%*	*-4%*	*30.1%*	*28.5%*	*-10%*	*26.0%*	*25.6%*	*-19%*
25-44	*42.5%*	*41.5%*	*-2%*	*40.7%*	*37.9%*	*-11%*	*35.7%*	*33.7%*	*-21%*
45-64	*39.7%*	*38.9%*	*-2%*	*38.2%*	*35.7%*	*-10%*	*34.0%*	*32.2%*	*-19%*
65+	*31.2%*	*28.8%*	*-8%*	*27.9%*	*25.4%*	*-19%*	*24.1%*	*22.8%*	*-27%*
Ages 15 and above	*38.4%*	*37.3%*	*-3%*	*36.5%*	*34.0%*	*-11%*	*32.0%*	*30.3%*	*-21%*
Female									
15-24	*27.7%*	*26.6%*	*-4%*	*26.3%*	*24.9%*	*-10%*	*22.8%*	*22.4%*	*-19%*
25-44	*37.8%*	*37.0%*	*-2%*	*36.2%*	*33.4%*	*-12%*	*31.4%*	*29.4%*	*-22%*
45-64	*29.6%*	*30.8%*	*4%*	*30.8%*	*30.6%*	*3%*	*29.5%*	*29.3%*	*-1%*
65+	*14.5%*	*14.2%*	*-2%*	*14.1%*	*13.9%*	*-4%*	*13.5%*	*14.0%*	*-3%*
Ages 15 and above	*29.6%*	*29.3%*	*-1%*	*28.9%*	*27.5%*	*-7%*	*26.1%*	*25.3%*	*-15%*

Table 4a. SimSmoke Projections: Male Smoking Prevalence for ages 18 and above, Netherlands, 2010-2040

POLICY/YEARS	***2010***	***2011***	***2020***	***2030***	***2040***
Status Quo Policies	*29.6%*	*29.3%*	*26.7%*	*24.6%*	*23.1%*
Independent Policy Effects					
Tax at 70% of Retail Price	*29.6%*	*26.9%*	*24.0%*	*21.5%*	*19.8%*
Complete Smoke Free Air Law	*29.6%*	*28.0%*	*25.5%*	*23.4%*	*21.8%*
Comprehensive Marketing Ban	*29.6%*	*28.3%*	*25.7%*	*23.6%*	*22.1%*
High Intensity Tobacco Control Campaign	*29.6%*	*28.3%*	*25.7%*	*23.5%*	*22.0%*
Strong Health Warnings	*29.6%*	*29.2%*	*26.6%*	*24.4%*	*22.9%*
Strong Youth Access Enforcement	*29.6%*	*29.3%*	*26.0%*	*23.2%*	*21.2%*
Cessation Treatment Policies	*29.6%*	*28.5%*	*25.4%*	*23.1%*	*21.6%*
Combined Policy Effects					
All of the above	*29.6%*	*23.2%*	*19.0%*	*16.0%*	*14.0%*
% Change in Smoking Prevalence from Status Quo					
Independent Policy Effects					
Tax at 70% of Retail Price		*-8.3%*	*-10.3%*	*-12.5%*	*-14.5%*
Complete Smoke Free Air Law		*-4.3%*	*-4.7%*	*-5.1%*	*-5.5%*
Comprehensive Marketing Ban		*-3.5%*	*-3.8%*	*-4.2%*	*-4.5%*
High Intensity Tobacco Control Campaign		*-3.5%*	*-4.0%*	*-4.4%*	*-4.8%*
Strong Health Warnings		*-0.2%*	*-0.6%*	*-0.9%*	*-1.0%*
Strong Youth Access Enforcement		*0.0%*	*-2.7%*	*-5.6%*	*-8.2%*
Cessation Treatment Policies		*-2.6%*	*-5.2%*	*-6.2%*	*-6.6%*
Combined Policy Effects					
All of the above		*-20.8%*	*-28.8%*	*-35.0%*	*-39.5%*

Table 4b. SimSmoke Projections: Female Smoking Prevalence for ages 18 and above, Netherlands, 2010-2040

POLICY/YEARS	***2010***	***2011***	***2020***	***2030***	***2040***
Status Quo Policies	*24.9%*	*24.8%*	*23.5%*	*22.1%*	*20.9%*
Independent Policy Effects					
Tax at 70% of Retail Price	*24.9%*	*22.8%*	*21.1%*	*19.5%*	*18.0%*
Complete Smoke Free Air Law	*24.9%*	*23.7%*	*22.4%*	*21.0%*	*19.7%*
Comprehensive Marketing Ban	*24.9%*	*23.9%*	*22.6%*	*21.2%*	*19.9%*
High Intensity Tobacco Control Campaign	*24.9%*	*23.9%*	*22.5%*	*21.1%*	*19.9%*
Strong Health Warnings	*24.9%*	*24.7%*	*23.3%*	*21.9%*	*20.6%*
Strong Youth Access Enforcement	*24.9%*	*24.8%*	*22.9%*	*20.9%*	*19.2%*
Cessation Treatment Policies	*24.9%*	*24.1%*	*22.2%*	*20.6%*	*19.4%*
Combined Policy Effects					
All of the above	*24.9%*	*19.6%*	*16.7%*	*14.4%*	*12.7%*
% Change in Smoking Prevalence from Status Quo					
Independent Policy Effects					
Tax at 70% of Retail Price		*-8.2%*	*-10.1%*	*-12.0%*	*-13.7%*
Complete Smoke Free Air Law		*-4.3%*	*-4.7%*	*-5.2%*	*-5.5%*
Comprehensive Marketing Ban		*-3.5%*	*-3.8%*	*-4.2%*	*-4.5%*
High Intensity Tobacco Control Campaign		*-3.5%*	*-4.1%*	*-4.5%*	*-4.8%*
Strong Health Warnings		*-0.2%*	*-0.7%*	*-0.9%*	*-1.1%*
Strong Youth Access Enforcement		*0.0%*	*-2.7%*	*-5.5%*	*-7.9%*
Cessation Treatment Policies		*-2.6%*	*-5.4%*	*-6.7%*	*-7.2%*
Combined Policy Effects					
All of the above		*-20.7%*	*-28.9%*	*-35.0%*	*-39.3%*

Table 5a. Male Smoking-Attributable Deaths, SimSmoke Netherlands, 2010-2040

POLICY/YEARS	***2010***	***2020***	***2030***	***2040***	***Cumul.***
Status Quo Policies	*21,990*	*22,796*	*22,514*	*19,476*	*664,848*
Independent Policy Effects					
Tax at 70% of Retail Price	*21,990*	*22,245*	*21,288*	*18,165*	*639,090*
Complete Smoke Free Air Law	*21,990*	*22,412*	*21,695*	*18,697*	*647,878*
Comprehensive Marketing Ban	*21,990*	*22,493*	*21,880*	*18,885*	*651,677*
High Intensity Tobacco Control Campaign	*21,990*	*22,481*	*21,815*	*18,787*	*650,385*
Strong Health Warnings	*21,990*	*22,754*	*22,396*	*19,328*	*662,411*
Strong Youth Access Enforcement	*21,990*	*22,796*	*22,506*	*19,394*	*664,406*
Cessation Treatment Policies	*21,990*	*22,379*	*21,409*	*18,166*	*642,174*
Combined Policy Effects					
All of the above	*21,990*	*20,909*	*18,189*	*14,926*	*575,112*
Absolute Change in Attributable Deaths from Status Quo					***2011-2040***
Independent Policy Effects					
Tax at 70% of Retail Price		*551*	*1,226*	*1,311*	***25,758***
Complete Smoke Free Air Law		*384*	*819*	*778*	***16,971***
Comprehensive Marketing Ban		*304*	*634*	*590*	***13,171***
High Intensity Tobacco Control Campaign		*316*	*699*	*688*	***14,463***
Strong Health Warnings		*43*	*118*	*148*	***2,437***
Strong Youth Access Enforcement		*0*	*8*	*82*	***442***
Cessation Treatment Policies		*417*	*1,105*	*1,309*	***22,674***
Combined Policy Effects					
All of the above		***1,887***	***4,325***	***4,550***	***89,736***

Table 5b. Female Smoking-Attributable Deaths, SimSmoke Netherlands, 2010-2040

POLICY/YEARS	***2010***	***2020***	***2030***	***2040***	***Cumul.***
Status Quo Policies	*9,898*	*11,776*	*13,713*	*13,537*	***377,987***
Independent Policy Effects					
Tax at 70% of Retail Price	*9,898*	*11,497*	*12,978*	*12,699*	***362,906***
Complete Smoke Free Air Law	*9,898*	*11,579*	*13,206*	*12,994*	***367,680***
Comprehensive Marketing Ban	*9,898*	*11,621*	*13,322*	*13,129*	***370,054***
High Intensity Tobacco Control Campaign	*9,898*	*11,615*	*13,280*	*13,054*	***369,158***
Strong Health Warnings	*9,898*	*11,753*	*13,635*	*13,426*	***376,373***
Strong Youth Access Enforcement	*9,898*	*11,776*	*13,710*	*13,507*	***377,826***
Cessation Treatment Policies	*9,898*	*11,554*	*12,990*	*12,555*	***363,095***
Combined Policy Effects					
All of the above	*9,898*	*10,806*	*11,023*	*10,381*	***322,955***
Absolute Change in Attributable Deaths from Status Quo:					***2011-2040***
Independent Policy Effects					
Tax at 70% of Retail Price		*279*	*735*	*838*	***15,081***
Complete Smoke Free Air Law		*196*	*507*	*544*	***10,308***
Comprehensive Marketing Ban		*154*	*390*	*408*	***7,933***
High Intensity Tobacco Control Campaign		*161*	*433*	*484*	***8,830***
Strong Health Warnings		*23*	*78*	*111*	***1,615***
Strong Youth Access Enforcement		*0*	*3*	*30*	***161***
Cessation Treatment Policies		*222*	*722*	*982*	***14,892***
Combined Policy Effects					
All of the above		*969*	*2,690*	*3,156*	***55,033***

Table 5c. Total Smoking-Attributable Deaths, SimSmoke Netherlands, 2010-2040

POLICY/YEARS	2010	2020	2030	2040	Cumul.
Status Quo Policies	31,888	34,572	36,227	33,013	**1,042,836**
Independent Policy Effects					
Tax at 70% of Retail Price	31,888	33,742	34,266	30,864	**1,001,997**
Complete Smoke Free Air Law	31,888	33,992	34,901	31,691	**1,015,557**
Comprehensive Marketing Ban	31,888	34,114	35,202	32,015	**1,021,731**
High Intensity Tobacco Control Campaign	31,888	34,095	35,095	31,841	**1,019,543**
Strong Health Warnings	31,888	34,506	36,031	32,755	**1,038,784**
Strong Youth Access Enforcement	31,888	34,572	36,217	32,901	**1,042,233**
Cessation Treatment Policies	31,888	33,933	34,399	30,722	**1,005,269**
Combined Policy Effects					
All above, with 70% tax	31,888	31,715	29,212	25,307	**898,067**
Absolute Change in Attributable Deaths from Status Quo:					
Independent Policy Effects					
Tax at 70% of Retail Price		830	1,960	2,149	**40,839**
Complete Smoke Free Air Law		580	1,325	1,322	**27,278**
Comprehensive Marketing Ban		458	1,025	998	**21,104**
High Intensity Tobacco Control Campaign		477	1,132	1,172	**23,293**
Strong Health Warnings		66	196	259	**4,051**
Strong Youth Access Enforcement		0	10	112	**603**
Cessation Treatment Policies		639	1,828	2,291	**37,566**
Combined Policy Effects					
All above, with 70% tax		2,857	7,015	7,706	**144,769**

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