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Pacific Institute for Research and Evaluation

Important note: This document will remain archived as a technical appendix for publications. New versions will be added periodically as model refinements and updates are completed. The most current version is available at http://cisnet.cancer.gov/profiles. Note that unlike most PDF documents, the CISNET model profiles are not suitable for printing as they are not typically written or read in sequential fashion.

We recommend you let your interests guide you through this document, using the navigation tree as a general guide to the content available.

The intent of this document is to provide the interested reader with insight into ongoing research. Model parameters, structure, and results contained herein should be considered representative but preliminary in nature.

We encourage interested readers to contact the contributors for further information.

Go directly to the: Reader's Guide.

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Readers Guide

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Core Profile Documentation

These topics will provide an overview of the model without the burden of detail. Each can be read in about 5-10 minutes. Each contains links to more detailed information if required.

Model Purpose

This document describes the primary purpose of the model.

Model Overview This document describes the primary aims and general purposes of this modeling effort.

Assumption Overview

An overview of the basic assumptions inherent in this model.

Parameter Overview

Describes the basic parameter set used to inform the model, more detailed information is available for each specific parameter.

Component Overview

A description of the basic computational building blocks (components) of the model.

- Population Component
- Incidence Component
- Natural History Component
- Screening Component
- Treatment Component
- Survival Mortality Component

Output Overview

Definitons and methodologies for the basic model outputs.

Results Overview

A guide to the results obtained from the model.

Key References

A list of references used in the development of the model.

Further Reading

These topics will provide a intermediate level view of the model. Consider these documents if you are interested gaining in a working knowledge of the model, its inputs and outputs.

Advanced Reading

These topics denote more detailed documentation about specific and important aspects of the model structure

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Model Purpose

Summary

This document discusses the reason for and the purpose of the Sim Smoke model.

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Purpose

Over 85% of lung cancers are attributable to smoking. In addition, smoking plays a major role in heart disease, stroke and chronic obstructive pulmonary disease (COPD). Public concern about smoking levels in the United States and the associated health risks have stimulated consideration of a number of public policies.

Many of the recent strategies have focused on youth, such as increased retail compliance with minimum purchase age laws, school-based education programs, and restrictions on advertising and promotions. However, since youth policies are directed primarily at new smokers, they may need to be supplemented with strategies aimed at cessation by older smokers. Policies, such as tax increases, affect all age groups, but their effects may vary by age as well as gender and racial/ethnic distribution. Further, different cohorts of smokers have different smoking rates, which in turn influence the effect of policies. Cessation has been shown to reduce health risks.

The complexity of the smoking problem along with the number of interacting factors and potential prevention strategies leave policy makers with difficult choices. Science-based tools for evaluating the potential effects of policy alternatives would facilitate the process. One such tool is computer modeling or simulation. Simulation models are useful in predicting and describing complex social phenomena. They are particularly helpful in understanding policies directed at tobacco use because the effects of each policy unfold over time, depend on other policies in place, and depend on cohort, age, and other sociodemographic factors. Currently the model considers the following policies: taxes, clean air laws, media campaigns, cessation treatment access, advertising restrictions, and youth access enforcement.

The model also considers the relationship between smoking rates and deaths attributable to smoking and how public policies might reduce those risks. The model considers total deaths, and also lung cancer deaths. In particular, the model considers how lung cancer deaths are related to age, gender, current smoking and years since quit.

Specifically, as discussed in the Model Overview, Sim Smoke may be used to:

- Assess the magnitude of current and future smoking rates and current and future health needs, specifically tobacco-attributable deaths, under current policies as well as changing policies between 1993 and 2003;
- Assess the effects of a new intervention on future smoking rates and deaths (total and lung cancer);
- Compare the effect of different interventions; and
- Distinguish the effect of policies on specific age groups, including youth and older populations, and by gender and racial/ethnic group.

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- Show how the effects of a policy depend on the way that it is implemented.

As an example, the model can be used by policy makers as a tool to estimate the long-term impact of a tax increase on smoking rates or deaths, and to compare these effects to those of youth access policies alone or in combination with tax policies.

More recent versions of the Sim Smoke model have been developed with a view towards being a central part of a nation's or state's surveillance and evaluation system for tobacco control, smoking and lung cancer. The model is primarily designed as a tool for 1) Prediction and planning, but may also be used for the 2) Justification of policies by policy planners and advocates, and for 3) Teaching and heuristic purposes. The model attempts to provide an understanding of the relationship between changes in tobacco control policies, smoking and lung cancer rates as part of a changing social system.

The model focuses on the relationship between public policies and smoking, and does not consider other non-smoking factors, except insofar, as they operate through past initiation and cessation rates. The model focuses on the relationship between smoking and lung cancer, and does not consider the effect of non-smoking factors as they affect lung cancer (e.g., radon, asbestos, air pollution or other tobacco products), although these areas are being considered for future development. The model focuses on smoking prevalence, but is also currently being developed to understand the role of smoking intensity and duration.

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Assumption Overview

Summary

This document discusses assumptions underlying the model as well as some of their implications.

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Background

The Sim Smoke model begins with baseline levels of each demographic group and smoking category. This document discusses the assumptions underlying:

1. How the population model tracks population over time assuming a discrete, first order Markov process with respect to birth rates and death rates.
2. How the smoking model tracks smokers, ex-smokers and never smokers over time assuming a discrete first order Markov process with respect to initiation, cessation, and relapse rates.
3. How smoking attributable deaths are determined by smoking rates and relative risks.
4. How tobacco control policies affect the smoking parameters, and the interactive effect between policies.

Sim Smoke is first a model of population growth, which then divides the population into smokers, never smokers and ex-smokers. Over time, the population evolves through births and deaths, and the smoking population evolves through initiation, cessation and relapse. Deaths attributable to smoking are based on the prevalence of smokers and ex-smokers, as well as their relative risks. Tobacco control policies influence the number of smokers through initiation and cessation rates. Smoking attributable deaths are determined by relative risks applied to smokers and ex-smokers.

Sim Smoke is organized according to a mathematical structure of formulas that describe the relationship between tobacco policies, tobacco-related behaviors and mortality. The formulas in the model are based on logical relationships and a synthesis of the best available published research findings and survey data. Where insufficient information is available, reasonable estimates have been developed with an expert panel and theories from economics, sociology, public health and marketing. The panel of advisors—primarily economists, epidemiologists, psychologists, and sociologists who are all internationally recognized for contributions to their fields—played a particularly important role in the development of each policy module.

Besides being subject to rigorous review, sensitivity tests of the policy modules were

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conducted to assure that values of the policy variable for the allowable ranges yielded acceptable predictions, and that the results were consistent with studies in the literature and with opinions of our expert panel. Our reviews of the literature have been consistently published in high level journals.

Assumptions were made both for the purposes of simplifying the model, and because of the lack of data or estimates to guide certain parameters or relationships. Assumptions were also required regarding: the extent of demographic variations considered, the "other" factors that stay constant (and are thus excluded from the model), the time pattern of effect of policies on smoking variables, the demographic pattern of effect of policies, the time patterns of effect of changes in smoking rates on deaths (total and by lung cancer), and the interactive effect between policies.

Assumptions were tested indirectly by examining outcomes of the model (smoking prevalence rates and lung cancer deaths) over a tracking period of 1993-2003. The model will also be tested by considering how cessation and initiation rates have changed over time. We also consider how the population model tracks with the actual population and future predictions of population over time. For all outcomes, we validate against their initial levels and trends. We consider rates for the total US population and rates by age, gender and racial/ethnic group.

Assumption Listing

Basic structure: The model is developed as a population level model for the total population at each age. We develop separate models by gender, and by racial/ethnic group. Other socio-demographic distinctions are not considered. Assumptions are tested through internal consistency of the model, calibration to existing studies and validation of the model.

1) Population model. As described in Component Overview, the population by age begins in a baseline year and changes over time assuming a discrete, first order Markov process through:

a) Constant fertility rates over time distinguished by age.

- We currently allow for low, medium and high fertility rates.
- The population model could be modified to allow fertility rates to change over time, with differing amounts by age group. Fertility rates could grow or decline at a constant rate or different rates over time.

b) Constant overall mortality risk over time distinguished by age.

- We currently use a relatively recent year to measure the constant mortality rate.
- The population model could be modified to allow mortality risk to change over time, perhaps, specific to age group. Mortality rates could grow or decline at a linear or non-linear rate over time.

c) No immigration inflow or outflow is not considered both for simplicity and because the effects do not appear of sufficent importance.

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- The model could be modified to incorporate net immigration distinguished by age, similar to the modeling of fertility. This issue is greatest for the Hispanic and Asian populations, and will take on increasing importantce in future years.

2) Smoking model. As described in Component Overview, the population is divided into never smokers, smokers and ex-smokers (1 year, 2 years,…, 15+ years) in the baseline year. Unless otherwise noted, distinctions are made by age, gender and racial/ethnic group. For simplicity, changes over time assuming a discrete, first order Markov process through:

a) Constant initiation by age.

- Initiation occurs through a particular age, as determined by the data, and then no additional initiation takes place.
- Initiation is measured as net of cessation for each age population group.
- Initiation changes over time due to changes in policy through the policy modules.
- The model could be modified to allow initiation rates to change over time, due to other factors such as economic growth (increased income) or increased/targeted marketing by tobacco manufacturers. Initiation rates could grow or decline following a linear or more complex relationship over time.

b) Constant first year cessation by age.

- Cessation occurs after a particular age (24 for the US), due to the instability of cessation during the period of initiation.
- First year cessation is modeled over the tracking period through changes in treatment use and changes in tobacco control policy. In future years, changes occur subject to changes in policies through the policy modules.
- The model could be modified to allow cessation rates to change over time, e.g., due to economic growth (greater availability or affordability of cessation treatments, and greater concern about health) or increased/targeted marketing by tobacco manufacturers. Cessation rates could grow or decline at a constant rate or different rates over time.

c) Constant relapse rates corresponding to ex-smoking categories (years since quit) vary by age and gender, but not racial ethnic group

- Relapse rates are constant over time and unaffected by policy.
- The model could be modified to allow relapse rates to change over time due to changes in policy or some other factor, but would strain the computability and programming of the model.

3) Smoking-Attributable Deaths. As described in Component Overview, smoking-attributable deaths are calculated overall and for lung cancer based on the prevalence of current and ex-smokers, and the relative mortality risks, assuming:

a) Relative risks for smokers vary by age and gender.

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- We do not consider cohort-specific changes. The model could be modified to allow for the role of changes in quantity smoked, average age of initiation or smoking duration and their effect on population relative risks. These changes are being implemented in a base year model. Assumptions will be necessary to model how these factors would change with changes in policy. The role of these factors might be incorporated by allowing relative risks to vary in some systematic manner reflective of these factors.
- Relative risks might also vary by racial ethnic group.

b) Relative risks for ex-smokers are modeled as constant proportional adjustments in the smoker relative risks, and are distinguished by years since quit and gender.

- The model could be modified to allow for other factors affecting relative risks for ex-smokers (as described above for smokers), but additional complications regarding decline of risks would need ot be considered.
- We have recently modified the model to allow for adjustments by age, but we are still working out inconsistencies.

c) Relative risks for smokers and ex-smokers are constant over time, which would most readily be modified by considering how these risks vary by duration and intensity of smoking. The difficulty lies in distinguishing long variations from recent (short-term) changes. Recent changes would need to consider compensation effects (deeper inhalation to maintain nicotine levels) and how recent changes in smoking intensity are weighted against preveious levels.

d) Mortality rates are constant over time
As described above, the model could be modified to allow mortality rates (especially background rates) by cause to vary over time.

e) Deaths are calculated for overall smoking attributable deaths and for lung cancer. We are also incorporating other mortality risks (e.g., heart, COPD, stroke). Currently, total mortality risks are based on relative risks for total mortality. We will consider how the total death risks relate to the sum of the component death risks.

4) Policy modules. As described in the Component Overview, separate policy modules are adopted for each of the policies. See descriptions, assumptions and parameters for each by clicking on Tax Module, Clean Air Law Module, Mass Media Module, Advertising Ban Module, Youth Access Policy Module, and Cessation Treatment Module.

We assume:

a) Log linear effects of policies (i.e., constant proportional effects). As described in the Component Overview, while the effects of a policy on initiation and cessation (through

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first year and prevalence) vary over time, the effect sizes are generally assumed to be constant in proportional terms regardless of the initial level of the smoking rates and, in some cases, of the size of the policy (as indicated for the individual policies, i.e., constant elasticity for the effect of price).

b) The time pattern of tobacco control policies effects depends on how they alter initiation and cessation rates over time. Each of the policies has immediate effects such as a reduction in prevalence or initiation rates apportioned over the first three years that the policy is in effect. Policies continue to affect cessation and initiation rates as long as the policy is sustained. The user varies the period over which policies are sustained.

c) The effect of policies depends on the initial level of policies (i.e., the current level if cigarette taxes), the extent of change in policies (the change in the tax), and how the policies are implemented (per unit or as a percent of sales).

d) Interactive Effects of Policies. As described in Component Overview, the effects are generally independent (subject to exceptions noted below) and their effects are modeled as multiplicatively related in terms of their effect in reducing prevalence and initiation rates or increasing cessation rates.

- Specifically, when more than one policy is in effect, the percentage reductions are multiplicatively applied, e.g., (1+PCi,t,a)*(1+PCj,t,a) for policies i and j, which implies that the absolute effect from policy i (PCi,t,a
- Other forms and relations may be employed. The multiplicative relationship yields acceptable asymptotic properties, and appears to be justified by model results and empirical studies.
- We allow for some specific interactions between policies. The model incorporates increased effects of media, clean air and youth access policies when they are implemented with other policies that generate publicity and help to promote anti-smoking norms.

e) A potentially important simplifying assumption is that policies are modeled as having a unidirectional effect on smoking rates. As such, the model does not explicitly model potential feedbacks through industry practices, social norms and attitudes, and peer and family behaviors.

- As policies are implemented, the tobacco industry might acquiesce to policies or strategically respond through pricing or marketing practices. Empirical studies of tobacco control policies have generally not considered how the effects of a policy might depend on current industry practices and industry reactions to the policy.
- While allowing for some of the synergies that might be caused by changing social norms, Sim Smoke does not explicitly model attitudes or norms. These may enhance the effect of policies, and may further fuel programmatic change, which in turn can lead to further changes in societal norms that reduce smoking rates. Modeling these features would add considerably to the complexity of the model, and we did not find sufficient empirical studies to support such model components.

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- While Sim Smoke considered the effect of peer and parental smoking in influencing the effect of youth-oriented policies, it does not explicitly model direct social interactions or feedback. Reductions in peer and adult smoking may spill over and reduce subsequent initiation. In a model, such as Sim Smoke, it might be possible to further consider intergenerational effects.

5) The modeling of the population, smoking and policy module components incorporate limted feedbacks. As described in the Components Overview, the smoking model is built on the population model, and policy model affects parameters (initialtion and cessation) in the smoking model. The smoking model as affected by the policies determines prevalence rates for the smoking-attrubutable death model. We note the following additional interactions and potential interactions.

a) Deaths due to smoking alter the population over time through change in death risks as indviduals change smoking pattens, ii.e, as an individual quits smoking their risk of death declines.

b) While not currently in the model, smoking rates might affect policies, e.g., fewer smokers may mean lower resistance ot policies.

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PARAMETER OVERVIEW

SUMMARY

The purpose of this document is to provide the reader an overview of the parameters that inform the model. In reading this document, the readers should obtain a good view of the scope and divisions of prior information the model works with.

BACKGROUND

This section describes the data used in Sim Smoke. All data is population level data. Baseline data is collected for the year 1993 for the population and smoking rates, and is collected for the years 1993-2003 for the policy components to track the effect of the policies over that period. Description of the Components is found in Component Overview and assumptions in Assumption Overview.

The Population Component requires data on the baseline population and data on fertility and mortality rates to model changes over time. The projections of the model are compared to actual population (from the Census) over the tracking period and projections for future years.

The Smoking Component requires data on baseline smoking rates from a large scale, nationally representative data set. We rely primarily on the Current Population Survey-Tobacco Use Supplement for 1992/3 for the baseline rates, and later data from later years (1995/6, 1998/9 and 2001/2) and the National Health Interview Survey for validation.

The Smoking Attributable Death Component requires data on relative risks, prevalence rates and death rates. Data on relative risks is largely based on the Cancer Prevention Study-II, but we also consult the CPS-I and various studies that control for lifestyle factors. Attributable deaths are only validated for lung cancer, because a large percentage of lung cancer deaths are caused by smoking.

Policies are developed in separate modules. For the tracking period, data on the level of policies is required. These data are obtained from various sources specific to the policy, and averaged over states for the US. For each policy the effects depend on the policy in place on the last year of the tracking period. Each module also has a set of parameters that determine their effect sizes, which depend on how the policies are implemented.

The model is validated by comparing the population size, smoking rates, and lung cancer deaths projected by the model to their estimated levels in 1993-2003 from other data sources. Since the model begins with baseline data for each of these outcome variables, we use the same data to validate the model, except in the case of smoking rates, where we also use the National Health Interview Survey (NHIS).

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Parameter Listing Overview

Each Section below describes the primary parameters. It is headed by the name of the variable, followed by the current source (and description where appropriate), and the current specifications.

1. Population model

   A. Population

- 1993 Current Population Survey (CPS)
- Breakdowns by age, gender, and racial/ethnic groups
- Fertility rates

- U.S. Census Vital Rate Inputs Tables, 1993-3003
- Breakdowns by age and racial/ethnic group through age 40
- Mortality rates

- Multiple Cause-of-Death File (NCHS), 1993-2003
- Breakdowns by age, gender, and racial/ethnic groups, for total deaths and by lung cancer, COPD, heart disease and stroke

1. Smoking model

   A. Baseline smoking prevalence rates for current and ex-smokers for the year 1993

- Tobacco Use Supplement (TUS) of the CPS (1992-93) for age 15+, and 1993 Teenage Attitudes and Practices Survey for age
- Based on 100+ cigarettes lifetime and distinction between current and previous smokers. Breakdowns by age, gender, and racial/ethnic groups, for ex-smokers by years since quitting (
- Initiation rates for years after 1993

- Change in smoking prevalence rates from TUS and TAPS between contiguous age groups
- Breakdowns by age, gender, and racial/ethnic groups.
- First year cessation rates for years after 1993

- Calculated from cessation module with adjusters for demographic group based on the CPS-TUS
- Breakdowns by age, gender, and racial/ethnic groups.
- Relapse rates for years after 1993

- Calculated from COMMIT data and other studies
- Breakdowns by age and gender

1. Smoking Attributable Deaths

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A. Relative death risks of smokers and ex-smokers for all years
B. Cancer Prevention Study II (see NCI 1997 and USDHHS 2001) and confirmed by other sources
C. Breakdowns by age and gender.
D. Prevalence rates of never-smokers, smokers and ex-smokers as described above in the smoking section
E. Death Rates as described above in the Population section.

1. Policy Modules As described in Component Overview, separate policy modules are adopted for each of the policies. Data for tracking period, years 1993-2003, for each policy module are summarized here. See descriptions, assumptions and parameters for each by clicking on Tax Module, Clean Air Law Module, Mass Media Module, Advertising Ban Module, Youth Access Policy Module, and Cessation Treatment Module.

A. Prices and Taxes

- Tobacco Institute, www.bls.gov/cpi/home.htm
- Cigarette Prices, Taxes and CPI
- Clean air laws

- www2.cdc.gov/nccdphp/osh/state/report_index.asp and slati.lungusa.org/search-form.asp, CPS-TUS data on extent of worksite bans
- Different types of laws and their stringency
- Media & other educational campaigns

- CDC and various state websites, and assorted articles.
- Expenditures per capita and by audience (adult vs. youth)
- Youth access

- CDC website, SAMHSA website
- Enforcement checks, penalties, community campaigns, self-service and vending machine bans
- Cessation Treatment policies

- Various sources
- Treatment effectiveness, treatment use, insurance coverage, and insurance effectiveness
- Advertising Restrictions and Advertising warning

- CDC website
- Extent of bans and warnings

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Component Overview

Summary

This document summarizes the basic components of the Sim Smoke model, which include a population model (with births and deaths), a smoking model (with cessation and initiation), a death rate model (which distinguishes smoking related and other deaths)and policy modules (which affect initiation and cessation).

Overview

Components of the core model are a demographics model, a smoking model, and a death rates model (described below). Sim Smoke is first a demographic model, in which the population evolves through births and deaths.

Sim Smoke is next loaded with the smoking categories of never smokers, current smokers, and ex-smokers (1, 2, 3, ...15, 16 years and above years since quit). The model begins with baseline levels of each demographic group and smoking category and tracks their numbers over time assuming a discrete first order Markov process with respect to initiation, cessation, and relapse rates.

The death rate model distinguishs deaths attributable to smoking. Death rates for each of the smoking categories are determined by age and gender, using the risks of smokers relative to never smokers, the risks of ex-smokers relative to smokers, and death rates by age. Death rates by age and gender for each of the eight smoking groups (never smokers, smokers and 6 ex-smoker groups) are calculated as the death rates by age and gender times the relative risk divided by a standardization factor. Smoking-attributable deaths are calculated by age as the excess death rate due to smoking (difference between the death rate of smokers or ex-smokers and never smokers) multiplied by the number of people in the smoking category.

Separate policy modules have been developed for each of the public policies. Sim Smoke models the effects of price interventions (taxes), clean indoor air laws, mass media policies, advertising restrictions, strategies to reduce youth access to cigarettes, and brief interventions to promote cessation and insurance coverage of cessation treatments. Policies affect smoking rates through initiation and cessation, which in turn determine smoking-attributable deaths.

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Component Listing

The Sim Smoke model begins with the population in a baseline year first divided into the number of smokers, never smokers, and former smokers. Assuming a discrete first order Markov process, population evolves over time through birth and births and deaths, and the smoking population evolves through initiation, cessation and relapse.

Demographics Model

Sim Smoke 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 and racial ethnic group). 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:

$$Pop_{t,0} = 0.5 \times (1 - MortRate_0) \times \sum a(Pop_{t,a,1} \times Fert_a),$$
$$\text{where t=1,...,20; a=14,...,49}$$

After the first year, the population evolves as:

$$Pop_{t,a} = Pop_{t-1,a-1} \times (1 - MortRate_a)$$

Smoking Rates

SimSmoke categorizes the population at any time as never, current, and ex-smokers. We distinguish never smokers (NS), smokers (S), and 16 categories of ex-smokers (ExS) $n = 1, \ldots, 16+$, corresponding to years since last smoking. Individuals are classified as never smokers from birth until they initiate smoking or die. They are tracked over time as:

$$NS_{t,a} =$$
$$\mathrm{NS}_{t-1,a-1} \times (1 - MortRate_{a,ns}) \times (1 - Initiationrate_a)$$

Through age 24, the number of smokers (designated by s) is tracked as:

$$S_{t,a} = S_{t-1,a-1} \times (1 - MortRate_{a,s}) +$$
$$\mathrm{NS}_{t-1,a-1} \times (1 - MortRate_{a,ns}) \times Initiationrate_a$$

Once individuals become smokers (designated by s), they continue in that category until they quit or die or re-enter the group through relapse. After age 24, smokers are tracked as:

$$S_{t,a} = S_{t-1,a-1} \times (1 - MortRate_{t,a,s}) \times (1 - Cessationrate_a) + \sum_{n=1}^{16} ExS_{t-1,a-1,n} \times (1 - MortRate_t, a, n) \times (Relapserate_{a,n})$$

First year ex-smokers are determined by the first year cessation rate applied to smokers in the previous year and age that do not die. Individuals who have been ex-smokers for between $n = 2, \ldots, 15$, are defined as:

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$$ExS_{t,a,n} =$$
$$\mathrm{ExS}_{t-1,a-1,n-1} \times (1 - MortRate_a, n)$$
$$\times(1 - Relapserate_{a,n-1})$$

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 had quit for more than fifteen years and have not died or relapsed in the previous year.
The prevalence, cessation and initiation rates are affected by policies as described in the below and in the policy sections section.

Smoking-Attributable Deaths

To estimate death rates, $DR_{a,s}$, for each smoking group and never smokers were calculated for each age group and gender using relative risks $RR_{a,s}$ and death rates DR_a. The death rate of an age group can be expressed as:

$$DR_a = NS_{a,ns} \times DR_{a,ns} + S_{a,s}$$
$$\times DR_{a,s} + \sum^n (ExS_{a,n} \times DR_{a,n})$$

Because $RR_{a,s} = \frac{DR_{a,s}}{DR_{a,ns}}$ and similarly for ex-smokers, and $RR_{a,ns} = 1$, and rearranging terms, the death rate for never smokers becomes:

$$DR_{a,ns} = \frac{DR_a}{(NS_{a,s} \times S_{a,s} \times RR_{a,s} + \sum^n (ExS_{a,n} \times RR_{a,n}))}$$

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

$$DR_{a,s^*} = \frac{DR_{a.g} \times RR_{a.s^*}}{NS_{a,s} \times S_{a,s^*} RR_{a,s} + \sum^n (ExS_{a,n} \times RR_{a,n})}$$

The relative risk of smoker and ex-smoker groups is based on estimates of the relative risks of smokers $\frac{DRs^*}{DR_{ns}}$ obtained by gender group. For smokers, relative risks also vary by age, but sufficient data were not available to distinguish by age for ex-smoker groups. To age-adjust relative risks for ex-smokers, we first measure the proportional reduction in risks by time since quitting, PRR, for each ex-smoker group s^* as:

$$PRR_{s^*} = \frac{ln(RR_{s^*})}{ln(RR_s)},$$

which is then multiplied by the age appropriate smoker risks to obtain ex-smokers' RR by age:

$$RR_{s^*,a} = exp[PRRs^* \times ln(RR_{s,a})]$$

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Excess risk rates due to smoking are calculated as the difference between the death rate of a smoker or ex-smoker group and the death rate of a never smoker. Smoking attributable deaths are then calculated by age as the excess risks of smokers or ex-smokers relative to never smokers.

Policy Effects

Separate policy modules are adopted for each of the policies. See descriptions, assumptions and parameters for each by clicking on prompt.

- The tax module examines the effect of changes in taxes, and is described in Tax Module.
- The clean air policy module examines the effect of four types of laws: worksite, restaurant, school, and other public places, and considers the role of enforcement and media publicity, and is described in Clean Air Law Module.
- The mass media module examines the effect of mass media campaigns directed at adults and at youth, and is described in Mass Media Module.
- The advertising ban module assesses the impact of restrictions on advertising and of health warning labels, and is described in Advertising Ban Module.
- The youth access policy module examines the effect of policies (including compliance checks, penalties and community mobilization), and is described in Youth Access Policy Module.
- The cessation policy module examines public policies that mandate the coverage of cessation treatments and encourage brief interventions delivered by health-care providers, and is described in Cessation Treatment Module.

Each policy effect is expressed in terms of an estimated percentage change, *PC* in the smoking rate, SR, as $PC_t = \frac{SR_t - SR_{t-1}}{SR_{t-1}}$, which is based on empirical studies and the opinion of an expert panel. The EPC is negative whenever a policy is made stronger. In each of the policy modules, policies generally have their greatest effect on cessation directly through an additive effect on smoking prevalence, i.e., $Smokers_{t,a} \times (1 + PC_{i,t,a})$, for policy i at time period t and which may vary by age a. The effect is generally spread equally over the first three years that the policy is in effect. The percentage reduction is also applied to the initiation rate as $\text{Initiation rate}_a \times (1 - PCi, t, a)$ and to the first year cessation rate as $\text{Cessation rate}_a \times (1 + PC_{i,t,a})$ throughout the years t during which the policy is in effect.

When more than one policy is in effect, the percentage reductions are multiplicatively applied, e.g., $(1 + PC_{i,t,a}) \times (1 + PC_{j,t,a})$ for policies i and j, which implies that the absolute effect from policy $i (PC_{i,t,a} < 0)$ is smaller when policy j is in effect $(PC_{j,t,a} < 0)$.

Sim Smoke enables the user to consider different types or different components of policies entered in combination. The model has been used to show the importance of a multi-pronged policy (Levy et al. 2003, 2004). The user also can set policy parameters to 1993 levels to track the effect of specific policies through the most recent year and can change key policy parameters that affect smoking rates and smoking-attributable deaths to conduct sensitivity testing.

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Output Overview

Summary

The document describes a general outputs of the Sim Smoke model, and serves to provide an introduction to the types of outputs generated by the model

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Overview

Sim Smoke produces two main output types: smoking rates and deaths due to smoking. The model distinguishes these outcomes by age, gender and racial/ethnic group.

The primary smoking rate variable is smoking prevalence, but the model also develops estimates of smoking initiation and cessation rates over time. Smoking prevalence and lung cancer death outputs are closely tied to the model's purpose, while the initiation and cessation rate outputs are generated for model testing and validation. We are also developing estimates of quantity smoked per smoker and duration of smoking.

Besides total smoking attributable deaths, Sim Smoke distinguishes smoking-attributable deaths due to lung cancer, heart disease, stroke and COPD. We focus on death directly due to smoking, but future versions of the model will estimate deaths due to second hand smoke.

Sim Smoke yields predictions over a tracking period and future predictions. Policy inputs are provided in the model over the tracking period, while future predictions are based on policy inputs provided by the user.

Output Listing

Sim Smoke produces two main outcomes: smoking prevalence rates and deaths due to smoking. The model can also provide outputs for variables that explain smoking prevalence, such as initiation and cessation rates. Smoking prevalence is intermediary to explaining deaths attributable to smoking.

Smoking prevalence is based on a commonly used definition of established smokers. Smokers are defined as individuals who have smoked more than 100 cigarettes in their lifetime and are currently smoking some or all days. Ex-smokers are defined as those who have smoked more than 100 cigarettes and are not currently smoking. Cessation and relapse are tracked after age 24, when ex-smokers have been found to have elevated mortality risks. Ex-smoker relapse rates are distinguished by years since quitting. Smoking prevalence rates are validating by comparing model predictions to estimates derived from the National Health Interview and the Tobacco Use Supplement of the Current Population Survey.

Over time, smoking prevalence depends on initiation, cessation and relapse rates in Sim Smoke. Initiation rates at a particular age are measured as the difference between the prevalence of smoking at that age and the prevalence of smoking among individuals one year younger. This measure of initiation net of quitting avoids relying on separate, relatively unreliable measures of initiation and cessation for those under age 24, and increases the stability of the model. First-year quit rates are based on our

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cessation module. The module employs a model of the decision to quit and the choice of treatments (none, over-the-counter or prescription pharmaceutical, behavioral therapy, or combinations of the therapies). The population cessation rate is predicted over the years 1993-2003 based on treatment use and effectiveness. To account for differences by age, gender, and racial/ethnic groups, the one-year quit rates are multiplied by a demographic adjuster variable. Relapse rates are obtained from various sources corresponding to years since quitting, as described in Parameter Overview.

As well as estimating total smoking attributable deaths, Sim Smoke distinguishes smoking-attributable deaths due to lung cancer, heart disease, stroke and COPD. These estimates depend on the number of smokers and ex-smokers at any point in time, as well as relative risks. The estimates for recent years have been compared to estimates by others (especially CDC estimates). Using population estimates from the model, we convert deaths to death rates. To examine trends, we have also computed age-adjusted rates, which are compared to those from the National Center for Health Statistics (NCHS). In comparing smoking-attributable lung cancer deaths to actual lung cancer deaths, which includes non smoking-attributable deaths, we make assumptions regarding the synergistic relationship of these non-smoking deaths.

Sim Smoke distinguishes smoking rates and smoking attributable deaths by age, gender and racial/ethnic group as well providing estimates for the total population. In particular, the model is able to distinguish prevalence rates for those below the age of 18 and those ages 18-24. These age groups which are of particular interest to tobacco control policy, since they are a leading indicator of future trends in adult smoking rates. The model shows that reductions in these rates are followed by reductions in smoking-attributable deaths only after 20 years. Gender and racial ethnic differences in smoking rates and smoking attributable deaths can also be observed, and are important in developing strong policies.

Sim Smoke provides predictions over a tracking period, defined from the baseline year to the most recent year for which inputs on actual tobacco control policies is available. The model is validated by considering levels as well as trends in the outcomes, with an emphasis on explaining any turning points in the trends. Smoking prevalence is the primary outcome used to validate the model. The cessation and initiation rate variables over the tracking period are also compared to actual rates to validate the model. While levels of smoking-attributable death are compared to estimates of other studies, we focus on lung cancer rates in validating the model, since a large portion of lung cancer deaths are due to smoking. We may also consider COPD deaths.

Besides being used to validate the model, the tracking period can be used to examine the role of particular policies. We first set all policies to their baseline level. We then

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examine the effect of each policy individually by entering the actual levels of all policy components for each of the years from the baseline to the most recent year, and then comparing the predicted smoking rates to their baseline levels. We examine the percent change in smoking prevalence due to particular policies, as well as distinguish the role of trends in the outcome variables prior to the policy changes.

The model is also used to project future trends in smoking prevalence and smoking attributable deaths, as well as the effect of policies on those outcomes. We first assume that policies remain constant at the most recent tracking year, which we call the status quo scenario. We project future trends in smoking prevalence and deaths attributable to smoking under the status quo. We then consider the effect of implementing different policies on smoking prevalence from the year 2005, the earliest year from which we expect policies could be implemented.

Sim Smoke can be used to examine the effect of each policy individually by implementing the policy at a specific level for the year 2005 and holding that level constant in all future years. These estimates provide a gauge of the potential role of individual policies. After individually examining policies, Sim Smoke can be used to project the impact of a comprehensive strategy, by enter a combination of the policies. Comparisons are made to the status quo policy.

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RESULTS OVERVIEW

SUMMARY

This section provides the results from the the Sim Smoke model for two basic outcomes, smoking prevalence and smoking-attributable deaths. We examine these outcomes over the tracking period to validate the model and consider the effect of policies in the future.

OVERVIEW

Sim Smoke projects smoking prevalence and deaths due to smoking (total as well as lung cancer), and the impact of tobacco control policies on those outcomes. The model considers a set of tobacco control policy objectives, including tax increases, the passage of clean air laws, media campaigns and educational programs, enforcement of youth access laws, and cessation treatment programs. Five separate studies are summarized.

- We use Sim Smoke to consider the trends in smoking prevalence between 1993 and 2003. This study serves to validate the model and to consider the role of policies in determing those trends (Levy, Nikolayev et al. 2004).

- In a separate report (ref), we consider future trends in smoking prevalence and how policies might affect those rates. Specifically, we consider the policies suggested in the Healthy People 2010 report, and the ability to reach the smoking prevalence goals if those policies are implemented.

- The model considers total deaths and other types of death due to smoking, including lung cancer, heart disease, COPD and stroke. We present the results for lung cancer (ref). Specifically, we consider how well Sim Smoke predicts lung cancer rates over the 1993-2003 time period, and project future trends in lung cancer rates and the ability of policies to affect those trends.

- Finally, we present the results of two separate Sim Smoke models for California (ref) and Arizona (ref), two states that have actively pursued tobacco control policy objectives. We examine how well the model predicts smoking rates over the period before active policies were implemented to the present, and examine how those policies and other additional policies might affect smoking-attributable deaths.

RESULTS LIST

Five separate studies are summarized below:

1. Recent Trends in Smoking and the Role of Public Policies[1]

The purpose of this study is to examine national smoking rates during the period from 1993 through 2003 and the role of public policies in explaining those rates using the

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Sim Smoke simulation model. To examine smoking rates, we first compare the projections of Sim Smoke to that of recent surveys of smoking rates as a way of more systematically examining trends and of validating the model. We then consider the effect of policies on those rates as explained by the model. Specifically, we attempt to gauge how much of the change in smoking rates between 1993 and 2003 is due to price changes, clean air laws, media campaigns, and youth access enforcement.

Both the Sim Smoke model and data for recent years indicates that adult smoking prevalence changed little between 1993 and 1997, and even increased among youth. Between 1997 and 2003, smoking prevalence has been declining. Sim Smoke predictions are very close to the NHIS reductions (1.3% vs. 1.2% decline) over the 1993 to 1997 period with our relatively flat trend, but slightly over-predicts the decline in smoking rates between 1997 and 2003 (13.1% vs. 12.6% decline). Sim Smoke also predicts the slight upturn in 1994. Most age, gender and racial-ethnic groups show patterns similar to that of the entire population, with some important differences. Generally, Sim Smoke predicts quite well, including changes in trend, but does not predict as well for various socio-demographic groups, including 18-24 year olds and those above age 65.

When decomposed into policy changes, the predominant trends were mostly explained by changes in price/taxes, with some residual effect of clean air laws, media campaigns and enforcement of youth access laws.

1. The Healthy People 2010 Smoking Prevalence and Tobacco Control Objectives[2]

Healthy People 2010 (HP2010) set a goal of reducing the adult smoking prevalence to 12% by 2010. Smoking prevalence rates do not appear to be declining at or near the rate targeted in the HP2010 goals. This paper to examine the attainability of HP2010 smoking prevalence objectives through the stricter tobacco control policies suggested in HP2010 using the Sim Smoke model. We consider the effect of changes in taxes/ prices, clean air laws, media campaigns, cessation programs and youth access policies on projected smoking prevalence over the period 2003-2020, focusing on the levels in 2010.

Sim Smoke projects that the aging of older cohorts and the impact of policies in years prior to 2004 will yield a reduction in smoking rates to 18.4% by 2010, which is substantially above the 2010 target of 12%. When policies similar to the HP 2010 tobacco control policy objectives are implemented, Sim Smoke projects that smoking rates could be reduced to 16.1%. Although we are unlikely to reach the goals by meeting the HP 2010 policy objectives, they could get us much closer to our goal. Emphasis should be placed on meeting the tax, clean air, media/comprehensive campaigns, and cessation treatment objectives. Further reductions might be realized by increasing the tax rate by $1.00.

1. Tracking Past and Predicting Future Lung Cancer Rates: Evaluating the Healthy People (HP) 2010 Goals[3]

HP 2010 set a goal of reducing the U.S. lung cancer death rate from the 1999 baseline

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year rate of 56.0 per 100,000 to 44.9 per 100,000 by 2010. Most lung cancer deaths are attributable to smoking. The purpose of this paper is to examine the attainability of HP 2010 lung cancer objectives through the smoking prevalence and tobacco control policy objectives in HP 2010 using the Sim Smoke model. We convert predicted smoking-attributable lung cancer deaths to overall lung cancer deaths using alternative assumptions about the effect of non-smoking determinants of lung cancer deaths. After converting to age-adjusted rates, we compare those rates to trends in lung cancer deaths rates as estimated by NCHS.

The model tracks trends in lung cancer death rates well for the period 1993-2002; the predicted number of smoking attributable lung cancer deaths was quite close to the level predicted CDC and by other; and the smoking attributable lung cancer death rate is estimated in the range of others when a four-year lag is applied to the effect of smoking. The rates with the four-year lag, however, did not track as well over time as the un-lagged rate. There was little change in trend during the period considered, so that further validation of the model is needed.

Sim Smoke predicts that the aging of older cohorts and the impact of policies in years prior to 2004 will yield a reduction in the smoking-attributable death rate to 49.1-50.2 per 100,000 by 2010, which is substantially above the 2010 target of 44.9. When policies similar to the HP 2010 tobacco control policy objectives are implemented, Sim Smoke projects that smoking-attributable death rate could be reduced to 48.1-49.4 per 100,000. The model suggests that the HP 2010 smoking lung cancer objective is unlikely to be attained. More stringent policies, in line with the HP 2010 objectives for tobacco control policies, could get us closer to the goals in 2010 and reach the goals in 2015.

1. The Role of Public Policies in Reducing Smoking Prevalence in California: Results from the California Tobacco Policy Simulation Model[4]

This study focuses on the impact of the California Tobacco Education and Prevention Program (CTCP) that was implemented in 1990. Tobacco control policies in California are examined utilizing Sim Smoke model. Modeling begins in 1987-8 and by year to 2003. We consider the role of taxes, mass media, clean air laws, and youth access policies in the recent reductions in California smoking prevalence, and consider how these policies affected smoking attributable deaths.

Overall, Sim Smoke predicted a 41% prevalence decline from 1988 to 2003. With policies were all maintained at their 1988 level (i.e., no new policies as a result of the CTCP), the model predicts that smoking prevalence among adults would have fallen from 25.5% in 1988 to 19.3% in 2003 (24% reduction) to 14.8% by 2010 (42% reduction). In the presence of the CTCP, smoking rates are estimated to decline from 25.5% in 1988 to 15.0% in 2003 (41% reduction) to 13.1% by 2010 (49% reduction). The model reliably

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estimates the observed smoking rates between 1988 and 2003, and the change in trends in 1990, 1993, and 1999

The model shows that the price increases, resulting from higher taxes or industry initiated increase, account for a majority of the overall predicted reduction in smoking prevalence in all years with an increasing percentage from 1997 to 2010. The contribution of clean indoor air policies peaked at 19% in 1995 and declines to 0% over time as smoke-free worksites become the norm. The effect of the media campaign predicts 40% of the overall reduction in 1989 and decreases in years when funding for the media campaign was reduced. The impact of youth access policies is low, although it begins to increase to 5% by 2010 as the policies effects on young people begin to diffuse into the adult population as they age.

The model estimated that before the comprehensive tobacco control policies were implemented, about 5,000 people died annually from smoking. After these tobacco control policies were enacted, smoking prevalence diminished. The Sim Smoke model projected these factors into the future and provided a prediction on how many lives would be saved. The model predicts that over 25,000 lives will be saved over the next 40 years.

1. The Role of Public Policies in Reducing Smoking Prevalence and Deaths Caused by Smoking in Arizona: Results from the Arizona Tobacco Policy Simulation Model[5]

Tobacco control policies in Arizona are examined utilizing Sim Smoke model. We focus on the impact of the Arizona Department of Health Services (ADHS) Tobacco Education and Prevention Program (TEPP) that was implemented in the mid-1990â€™s. Modeling begins in 1993 and progresses chronologically to 2000. The basic model is described and policy inputs examined for each of four types of policies (taxes, mass media, clean air laws, and youth access policies) independently and also as a policy package. We consider the role of each of these policies in the recent reductions in Arizona smoking prevalence, and the effect of the policies on deaths attributable to smoking.

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If policies were all maintained at their 1994 level, the model predicts that smoking prevalence among adults would have fallen from 22.5% in 1993 to 21.6% in 2000, substantially less than the fall with TEPP to 16.7%. Relative to the 2000 level in the absence of TEPP (21.6%), the level with TEPP (16.7%) represents a difference of 4.9 percentage points or a reduction of 22%. The predictions are reasonably close to actual trends, as indicated by several different data sources.

Results suggest that large potential gains can be realized from the implementation of a comprehensive tobacco control policy package. Arizona Sim Smoke estimates that tobacco control policies implemented through TEPP reduced smoking rates in Arizona by over 20%. Much of the reduction, almost 70%, was attributed in the model to price increases between the years 1994 and 2000. The model also attributed over 20% of the overall effect to media/cessation policies. Finally, the model estimated that only a small percent of the smoking reductions could be attributed to clean air laws and youth access policies.

The model estimated that before the comprehensive tobacco control policies were implemented, about 5,000 people died annually from smoking. The model predicts that over 25,000 lives will be saved over the next 40 years as a result of the TEPP program.

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[2] Levy, David , Nikolayev, Leonid , Mumford, Elizabeth "The Healthy People 2010 Smoking Prevalence and Tobacco Control Objectives: Results from the SimSmoke Tobacco Control Policy Simulation Model" in Cancer Causes and Control (in press) 2005;

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SIM SMOKE

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TAX MODULE

The tax module examines the effect of price changes over the tracking years and the effect of changes in taxes in future years. Based on a large set of empirical literature, the tax module shows immediate and substantial effects of tax policies on smoking rates in all age groups, particularly youth and young adults, and how the overall effect depends on the size of the tax and increasing taxes over time to keep up with inflation[1].

Assumptions:

a) The tax is assumed constant per unit (the most common method). This assumption could be modified for taxes as a percentage of price or other tax forms.

b) The retail price increases by the amount of the tax change as justified by studies. This assumption could be modified based on data for an individual nation or state.

c) Over time the effects of a tax depend on its level relative to the price of other goods (inflation). It is assumed that the non-tax portion of price increases with the rate of inflation and the tax portion does not change unless specified by the user. These assumptions could be modified to let the effect of price depend more directly on the standard of living.

d) The effects are modeled as constant proportional total price (retail price including taxes) effects, based on the studies of the form that best fits the data. This form is easiest to model, but can be easily modified.

e) Based on previous studies, the simulation model assigns an elasticity of -0.6 for individuals younger than age 20, -0.3 for those age 20 to 25, -0.25 for those age 26 to 35 and -0.15 for those age 36 and above. These could be easily modified in the model based on data for the individual nation. For a less developed nation, elasticities are expected to be higher based on previous studies. Effects may also be modified to take into account gender differences, or other factors.

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f) The multiplicative effects on cessation and initiation rates are immediate, while the additive effects on cessation through prevalence are applied over a one-year period. Could be modified to allow for slower or quicker adjustment, but data is currently lacking to make more accurate assessments.

g) There is no explicit modeling of smuggling or other non-taxed leakage. The module could be modified to explicitly allow for smuggling to affect the extent of effects through modifying the elasticity. The module could be extended to incorporate public policies to counteract smuggling.

h) The model does not consider the effect of the price of related goods, such as cigars, chewing tobacco, betel nuts, alcohol, other drugs, etc. They would be difficult to explicitly consider, but could influence the elasticity estimates used in the model.

Policy Parameters:

The policy effects are in terms of percentage changes in smoking rates as described in the Assumptions profile along with other assumptions. We list the policy lever, a policy, description, data source, and the percentage effect.

1. Price and tax rates- In the tax module, the user changes the tax rate on cigarettes. The model uses the average cigarette price, tax rate and inflation rate of the nation. The model also takes into account the rate of inflation, and allows for taxes to be adjusted to the rate of inflation.
2. The national average price for a pack of cigarettes is computed as the weighted average of single pack, carton, and vending machine cigarette prices, including state excise taxes. Prices of both branded and generic cigarettes are used in the average. Taxes are weighted at the state level
3. Source

- Cigarette Prices, Taxes: Tobacco Institute
- CPI: www.bls.gov/cpi/home.htm
- Effects are based on price elasticities, which are used to estimate the proportionate effect via a formula described in Levy et al. (2000). The effects are based on a large amount of literature.

-0.6 ages 10-17
-0.3 ages 18-24
-0.25 ages 25-34
-0.15 ages 35 and above

These parameters yield overall effects consistent with a price elasticity of around -0.3 in the three years following a tax change, but which increases to -0.6 as youth age.

REFERENCES:

[1] Levy, D, Cummings, KM, Hyland, A "Increasing Taxes as a Strategy To Reduce Cigarette Use and Deaths: Results of the SimSmoke Computer Model " in Preventive Medicine 2000; 31: 279-86

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Clean Air Law Module

The clean air policy module examines the effect of four types of laws: work site, restaurant, schools, and other public places. The effectiveness of clean air restrictions will depend on whether there is publicity and enforcement surrounding the law, and whether total or partial bans are implemented. Clean air laws have the potential to have large effects on smoking prevalence, as much as 7-8% for work bans and 2-3% for restaurant bans, with relatively immediate effects on smoking attributable deaths. We have published a paper describing the results from the simulation model in Tobacco Control (Levy, Friend et al. 2001), plus two papers reviewing past research and providing guidance to future research needs (Levy and Friend 2002, 2003).

Assumptions:

a) For restaurant and worksite laws, we distinguish total bans from partial bans. Partial bans allow smoking in designated areas, and thus enable smokers to avoid or circumvent the laws. Enforcement is particularly difficult for worksite laws. Thus, for worksite laws only, we also distinguish whether there is public acceptance of laws, as gauged by the percent of male smokers and whether firms have privately implemented and been able to enforce the laws. Other public places and schools are only designated at one level. Laws are assumed to be constant in a given year; in other words, the user can only select one each of the worksite and restaurant law categories for any particular year. The module could be modified to explicitly allow for other distinctions in the level of laws

b) The module predicts an 11% reduction in prevalence rates with all policies fully implemented and with strong enforcement and media publicity. Work site laws have the largest effect, 7%, with restaurant laws producing a 2% effect, and laws covering schools and other places each having about a 1% effect on youth. The module could be easily modified by the user to explicitly allow for other effect sizes. The size of effects may depend on other factors not in the Excel model, such as the percent of the population who works indoors. For example, in rural areas, clean air laws are likely to be of little consequence. The impact of a new clean air law may also depend on the percentage of the population already covered by private restrictions. When worksite laws are enacted, smokers in firms already subject to smoking restrictions have probably already been influenced by the restriction, but the new law may impose stricter requirements than those previously adopted by the firm and the public sanctioning of restrictions may change public attitudes, thereby increasing compliance. While these are not characteristics that you currently can enter into the Sim Smoke model, they may be added to Sim Smoke, or at a minimum they may be taken into account in determining effect sizes.

c) The effects of worksite laws for particular age groups are based on differences in labor participation rates and in the effect on workers who smoke. Effects increase between ages 26 to 39 but decrease at later ages. This could be modified to allow for

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other differential effects. For example, the C++ model allows for African Americans and Hispanics to experience 60% of the effect of workplace laws compared to other racial/ethnic groups. Females experience 80% of the effect compared to males.

d) The model allows the user to distinguish whether there is a media campaign to publicize the law and a government agency to enforce the laws. Greater government enforcement and media publicity also increase compliance by one percent each. This assumption could be modified to explicitly allow for other factors that may affect the effects of the law.

e) The multiplicative effects on cessation and initiation rates are immediate, while the additive effects on cessation are applied over a three-year period. This time pattern could be modified to allow for slower or quicker adjustment.

Policy Parameters:

The policy effects are in terms of percentage changes in smoking rates as described in the Assumptions profile along with other assumptions. We list the policy lever, a policy, description, data source, and the percentage effect.

1. The effect of clean air laws depends on the type of clean air law, whether it is a partial or total ban, and whether there is enforcement and publicity.
2. The clean air policy module examines the effect of four types of laws: work site, restaurant, schools, and other public places. The effectiveness of clean air restrictions will depend on whether there is publicity and enforcement surrounding the law. The module also distinguishes total and partial bans. For each type of law the effects during the tracking period are weighted over states by smoker population.
3. Sources

- www2.cdc.gov/nccdphp/osh/state/report_index.asp and slati.lungusa.org/search-form.asp, CPS-TUS data on extent of different types of laws and their stringency
- Labor participation rates from www.census.labor.gov.
- Effects for work site laws are based on a large set of literature examining the effect of worksite restrictions, as well as literature on clean air laws. The expert panel played an important role examining the role of publicity and enforcement.

    a. Type of law

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Worksite
Total Ban is a well-enforced ban in all indoor worksites in all areas, with strong public acceptance and enforcement of laws. Also consider less well enforced ban and ban limited to designated areas (2/3 of effect), and working areas (1/3 of effect).
Maximum 6% reduction.

Restaurant
Total Ban is a ban in all indoor restaurants in all areas. Also consider ban to designated areas (1/2 the effect).
Maximum 2% reduction

Other Places Bans
Ban in 3 of 4 (government buildings, retail stores, public transportation and elevators).
Maximum 1% reduction

Schools (requires strict ban on student and teacher smoking in all areas).
Maximum 1% reduction

b. Enforcement adds a .05% additional effect
c. Publicity adds a .05% additional effect

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Mass Media Module

The mass media module examines the effect of mass media campaigns. The effectiveness of mass media campaigns will depend on their scale and duration. The user in the original model varies the level of expenditures to determine the size of effects. This policy module distinguishes policies directed at all smokers from those targeting youth and considers the effects of scale and duration (Levy & Friend 2001), a review and framework article (Levy and Friend 2000; Friend and Levy 2001). The module also shows how the effect of media policies is enhanced by other public policies that lead to publicity on the harmful effects of smoking. A policy aimed at the total population can reduce smoking prevalence by as much as 7%, and can have a significant impact on deaths.

Assumptions:

a) An S-shaped curve determines the relationship between advertising expenditure and effect sizes, implying that media expenditures must be high enough for messages to reach potential smokers and quitters a sufficient number of times, but after a threshold additional expenditures show diminishing returns. This form is based on studies of the marketing literature and information theory.

In the excel version of the model, three levels of implementation are available:

Highly publicized campaign- Campaign publicized heavily on TV (at least two months of the year) and at least some other media. Campaign is well targeted with a social marketing approach.

Moderately publicized campaign- Campaign publicized sporadically on TV and in at least some other media.

Low Publicity media campaign- Campaign publicized in newspaper, billboard or some other media. Could be modified to explicitly allow for other distinctions in the level of laws.

b) Mass media policy directed at all smokers may yield up to a 7% reduction (heavily publicized campaign) in smoking rates over the entire population when combined with other policies. A moderately publicized campaign yields half the effect, and a low publicized campaign yields one fourth the effect. These effects could be easily modified by the user to explicitly allow for other effect sizes. The effectiveness of different media may differ from state to state or nation to nation and hence the categories of what constitutes a larger scale campaign may need to be modified for particular countries. The size of effects may depend on other factors not in the Excel model, such as the cost and reach of media. Ad content may also affect campaign success. Effectiveness is likely to depend on the characteristics of the targeted population. In less developed countries, ads with informational content may be more effective if the population has not been sufficiently exposed to prior educational policies. The effectiveness parameters may be changed to reflect how effectively the content is developed and coordinated with other tobacco control policies.

c) For each of the levels of mass media campaign, the model also distinguishes whether

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other policies are in place. Evidence indicates that the more effective campaigns are those that are conducted in conjunction with other tobacco control policies. Other policies, such as tax increases, cessation programs, and clean air initiatives, may have a synergistic effect, because of the media publicity (e.g., in the newspaper or television) that they generate. Other information relevant to smoking behavior, such as news coverage of tobacco-related policies, may both increase the effectiveness of messages from the media campaign and reduce the level of information needed to overcome advertising by tobacco manufacturers. This assumption can be modified to more explicitly incorporate the related effects of other policies.

d) The level of tobacco industry advertising is held constant. The effect sizes for media campaigns are based on studies that do not control for industry advertising. It would be difficult to model the effect of industry advertising, since no studies have been done.

e) The multiplicative effects on cessation and initiation rates are immediate, while the additive effects on cessation are applied over a three-year period. This could be modified to allow for slower or quicker adjustment.

Policy Parameters:

The policy effects are in terms of percentage changes in smoking rates as described in the Assumptions profile along with other assumptions. We list the policy lever, a policy, description, data source, and the percentage effect.

1. The user in the original model varies the level of expenditure to determine the size of effects, and whether the policy is directed at the total population or at youth. The mass media policy module distinguishes policies directed at all smokers from those targeting youth and considers the effects of scale and duration.
2. The effectiveness of mass media campaigns will depend on their scale and duration, as well as other policies in effect (i.e.,a comprehensive campaign, usually tax financed). The effects of state campaigns are weighted over states by smoker population.
3. Source

- Expenditures per capita and by audience (adult vs. youth) from CDC and various state websites, and assorted articles.
- Effect sizes are based on numerous studies and an expert panel. The mass media policy module effects are based largely on recent experiences in California, Massachusetts and Arizona, but also combine information on other policies. The effects below are with other policies in effect. The effects are reduced by half in the absence of other policies. For policies directed at the adult population the effects are on the entire adult population (18+), with half the effect on those under age 18. Youth oriented campaigns only affect those under age 18.

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Highly publicized media campaign- Campaign publicized heavily on TV (at least two months of the year) and at least some other media, with a social marketing approach. Also consider less extensive ban with proportionately less effect.
Maximum 6.5% reduction.

Moderately publicized media campaign-Campaign publicized sporadically on TV and in at least some other media, and a local program.
Maximum 3.6% effect

Low publicity media campaign- Campaign publicized only sporadically in newspaper, billboard or some other media.
Maximum 1.2% effect

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Advertising Ban Module

The advertising ban module assesses the impact of restrictions on advertising and of health warning labels. For advertising bans to be effective, a total ban is applied to all media, whereas a partial ban is applied to at least television and some other media. Advertising and promotions can increase the attractiveness of smoking by creating an image favorable to individuals contemplating or already engaged in smoking. The user independently chooses whether to have health warnings and advertising bans, and advertising bans differ by level.

Assumptions:

a) A total ban is applied to all media, while a partial ban is applied to at least television and some other media. Health warnings are defined only at one level. A health warning is defined as present if it is bold and graphic, and covers at least one fourth of the front of the package. We do not designate other levels of health warnings because lesser warnings have not been found to be effective. The effectiveness of different media may differ from state to state or nation to nation and hence the categories could be modified to explicitly allow for other distinctions in the level of laws.

b) A comprehensive ban leads to a 4% reduction in prevalence, a 2% increase in the cessation rates, and a 6% reduction in initiation, while a partial ban leads to a 1% reduction in prevalence and initiation only. The larger effects on initiation reflect the evidence that youth appear to be particularly amenable to the effects of advertising. Health warnings reduce the initiation and prevalence rates by 1% and increase the cessation rate by 2%. Health warnings are expected to primarily affect the cessation rate, because they provide continuous warnings to the smoker. Studies of advertising bans have obtained mixed results, but indicate that a comprehensive ban is needed to have sizable effects. The module can be easily modified to allow for different effects. The larger effects on initiation reflect evidence that youth appear to be particularly amenable to advertising. Other factors may be important and considered in the magnitude of effects. Health warnings and advertising bans coupled with other government information dissemination programs (e.g., government sanctioned health reports or media campaigns) may be effective in low-income countries where tobacco

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use is growing and consumers are less informed of the health risks. In addition, advertising may play an important role in those countries in establishing pro-smoking attitudes. In that case, advertising bans coupled with health warnings and other information dissemination policies may have a more potent effect than predicted in the model, particularly as they affect initiation.

c) The previous level of tobacco industry advertising is not considered. The effect sizes are based on studies that do not control for industry advertising. It would be difficult to model the effect of industry advertising, since no studies have been done.

d) The multiplicative effects on cessation and initiation rates are immediate, while the additive effects on cessation are applied over a three-year period. This assumption could be modified to allow for slower or quicker adjustment over time.

Policy Parameters:

The policy effects are in terms of percentage changes in smoking rates as described in the Assumptions profile along with other assumptions. We list the policy lever, a policy, description, data source, and the percentage effect.

1. The user independently chooses whether to have health warnings and advertising bans, and advertising bans differ by level (total vs. partial).
2. A total ban is applied to all media, while a partial ban is applied to at least television and some other media. Health warnings are defined only at one level. A health warning is defined as present if it is bold and graphic, and covers at least one fourth of the front of the package. The levels of bans are weighted over states based on smoker population.
3. Source

- Extent of bans and warnings by state: CDC website
- Effects are based on a literature review (unpublished), but described in Levy, Mumford et al. (2003).

Total (comprehensive ban) - applied to all media.
4% reduction in prevalence, 2% increase in the cessation rates, and 6% reduction in initiation.

Partial ban - applied to at least television and some other media.
1% reduction in prevalence and initiation only.

Health warnings must be bold and graphic
Reduces initiation and prevalence by 1% and increases cessation by 2%.

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YOUTH ACCESS POLICY MODULE

The youth access module considers the effect of restrictions or bans on self-service and vending machines, and three components of retail compliance (enforcement through compliance checks, penalties, and merchant awareness/ community mobilization). The model incorporates interactive effects between the policy components and diminishing returns to each of them. The youth access module also takes into account that, as retail sales to youth are reduced, youth switch to non-retail sources such as theft, older peers and parents.

The youth-access module shows how, as retail sales to youth are reduced, youth switch to non-retail sources such as theft, older peers, and parents. This substitution limits the effect of youth-access policies to a maximum estimated 25% reduction in youth smoking prevalence, with the effects on smoking deaths delayed at least 20 years into the future. Our papers are widely cited, and have helped the practitioners in the field recognize the importance of youth obtaining cigarettes from non-retail sources, such as parents and older peers. We have published four papers in this area, including papers in the Journal of Health Politics, Policy and Law and in Tobacco Control.

Assumptions:

a) In the C++ model the user may pick different levels of compliance checks, penalties, and merchant support policies, as well as self-service and vending machine bans. In the excel version, the following choices are available:

Strongly enforced & publicized - Compliance checks are conducted 4 times per year per outlet, when penalties are potent and enforced, and with publicity and heavy community participation.

Well enforced - Compliance checks are conducted 4 times per year per outlet, when penalties are potent, and with publicity and merchant training, but little community support.

Low enforcement - Compliance checks are conducted sporadically, with weak penalties, and with little merchant awareness and community participation.
This module could be modified to explicitly allow for other distinctions in the level of policies.

b) The youth access module considers the effect of restrictions or bans on self-service and vending machines, and three components of retail compliance (enforcement through compliance checks, penalties, and merchant awareness/ community mobilization). The model incorporates interactive effects between the policy components and diminishing returns to each as individually applied. In the C++ model, the different policies are multiplicatively applied in a Cobb-Douglas type of model, assuming interactive effects to determine retail compliance.

c) Youth smoking prevalence depends on retail compliance through an S-shaped curve, which assumes increasing returns over some range (about 70%) followed by diminishing returns.

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d) The youth access module also takes into account that, as retail sales to youth are reduced, youth switch to non-retail sources such as theft, older peers and parents. The substitution to non-retail sources limits the effect of youth access policies to a maximum estimated 25% reduction in youth smoking prevalence. These relationships could be easily modified to explicitly allow for other effect sizes. The effectiveness of different media may differ from state to state or nation to nation and hence the categories. Youth access policies, like clean air laws, may depend on anti-smoking attitudes that engender support for the policy. Therefore, it may be important for there to be other policies in effect, such as high taxes, advertising bans and anti-tobacco media campaigns before such policies are effective.

e) The effect on 10-15 year olds is 1.5 times that on 16 and 17 year olds, based on the greater access of older youth to non-retail sources. This assumption could be easily modified to allow for other differential effects.

e) The multiplicative effect on initiation rates and an additive effect on cessation rates through prevalence are immediate. This assumption could be easily modified to allow for slower or quicker adjustment.

Policy Parameters:

The policy effects are in terms of percentage changes in smoking rates as described in the Assumptions profile along with other assumptions. We list the policy lever, a policy, description, data source, and the percentage effect.

1. The youth access module considers the effect of restrictions or bans on self-service and vending machines, and three components of retail compliance (enforcement through compliance checks, penalties, and merchant awareness/ community mobilization).
2. Data is collected by state on policies in effect and retail compliance rates
3. Source

- Enforcement checks, penalties, community campaigns, self-service and vending machine bans by state from CDC website, SAMHSA website
- Effects are based on a thorough literature search and the advice of our expert panel, who were instrumental in developing the models described above.

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Strongly enforced & publicized policy- compliance checks are conducted 4 times per year per outlet, penalties are potent and enforced, and with heavy publicity and community involvement.
Maximum 25% reduction

Well enforced- Compliance checks are conducted regularly, penalties are potent, and publicity and merchant training are included, but there is little community support.
Maximum 12.5% reduction

Low enforcement- Compliance checks are conducted sporadically, penalties are weak, there is little merchant awareness and minimal community participation.
Maximum 2.5% reduction

The effect on 10-15 year olds is 1.5 times that on 16 and 17 year olds. This module could be easily modified to allow for other differential effects.

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Cessation Treatment Module

The cessation policy module examines public policies that mandate the coverage of cessation treatments and encourage brief interventions delivered by health-care providers. The Cessation treatment module predicts the effects of policies on average quit rates. First, a basic model of cessation rates in the absence of policy changes is described. This model is used to predict cessation rates between 1993 and 2003. The effects of mandatory coverage are then addressed in the policy model, which predicts the effect of policies on quit rates for the year 2003 onward. The effects of cessation policies on smoking rates and on smoking-attributable deaths of the general population are projected from the year 2003 onward using the Sim Smoke model.

The effects on smoking prevalence rates are small at first, but increase over time. When policies are combined and implemented at high levels, the Sim Smoke model predicts that smoking rates can be substantially reduced. Policies work through cessation rates and predict as much as a 50% increase in those rates. Policies with the broadest coverage and supplemented with physician reinforcement are predicted to be most effective. Because of the limited evidence on key parameters, estimates of the cessation module are viewed as tentative, but they provide a framework for considering the different ways of implementing cessation treatment policies. We have published three papers in this area, including modeling papers in Medical Decision Making and in Tobacco Control (Levy & Friend 2002a,b), and one framework/review paper by Friend and Levy (2002) in Nicotine and Tobacco Research.

Unlike in other policy module sections, we discuss assumptions and parameters together in a section related to model development, including the quit model used to predict quit rates over the tracking period and the policy model which extends the quit model to predict the future effects of public policies.

Quit Model

a) Those who quit choose among six treatment options: 1) self-quitting or minimal intervention (pamphlets, cutting down, etc.); 2) pharmacotherapy (PT) in the form of prescription (Rx) only; 3) over-the-counter pharmacotherapy (OTC PT) only; 4) behavioral therapy (BT) only; 5) Rx PT and BT in combination; or 6) OTC PT and BT in combination. The choice of treatment categories is based on the need for simplicity, differences in effectiveness, and policy relevance. In addition, insurers must decide whether to require BT use with PT. We distinguish OTC from Rx PT, because of different use patterns and the importance to public policy of whether to cover OTC as well as Rx PT.

b) The smoker first decides to quit, and then chooses among the treatment options. This framework is used to calculate the average quit rate of smokers in the population. Specifically, the population quit rate is obtained by multiplying the percent of the smoking population that attempts to quit by the average quit rate per attempt. The quit rate of those making a quit attempt is estimated by multiplying the percent of smokers making quit attempts using each of the six options by the effectiveness of that option, and then summing over options.

c) Since empirical studies usually examine periods of one year or less, the model

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focuses on the one-year cessation rate of current smokers. Estimates of treatment effectiveness indicate that use of PT or of BT alone about doubles quit rates compared to no intervention or unassisted quitting, and combined PT and BT use about doubles quit rates of either BT or PT alone. Using a base quit rate of 5 percent for minimal intervention, the success of either BT or PT alone would be 10 percent, and of BT and PT combined would be 20 percent for those who make a single quit attempt. Since smokers generally make multiple quit attempts, however, these rates were adjusted upward based on data in the Tobacco Use Supplement of the CPS. The final quit rates were estimated to be 8 percent for unassisted quitting, 13 percent for Rx PT, OTC PT, and BT, and 20 percent for combined Rx or OTC PT and BT, reflecting that those using the more assisted methods are less likely to make a repeat attempt.

d) The quit rate model incorporates trends in treatment usage in the 1993-2003 period. The effectiveness of treatments is assumed to be constant, but their relative use changes and quit attempts change. We estimate that 16 percent of attempted quits in 1993 involved Rx PT use (13 percent without and 3 percent with BT), and 10 percent BT use (7 percent alone and 3 percent with Rx PT), leaving 79 percent of unassisted quit attempts (Burton et al., 2000), because 1992-3 were peak years for Rx PT use due to the introduction of the patch. Consequently, Rx PT use declines in 1994 and 1995. In 1997, the first full year of OTC PT availability, it is estimated that Rx PT use declines further as quitters substitute OTC PT, such that 8 percent of attempted quits involved Rx PTs (3 percent without and 3 percent with BT). The ratio of OTC PT to Rx PT use is 2.5 (as found by another study), with 20 percent of quit attempts involving using OTC PT (16 percent alone and 4 percent with BT). We estimate that 10 percent of attempts involve BT (3 percent alone, 3 percent with Rx PTs and 4 percent with OTC PTs). By 2000, it is estimated that 8 percent of attempted quits involve Rx PTs (6 percent without and 2 percent with BT), 15 percent involve OTC PTs (12 percent alone and 3 percent with BT), and 8 percent use BT (2 percent alone, 3 percent with Rx PTs and 3 percent with OTC PTs). The relative use of OTC PTs is expected to have fallen due to recent introductions of Rx PTs (Zyban in particular) and a decline in OTC PT use from when they were first introduced. About 25 percent of PT users were estimated to also use BT.
Estimates of the attempted quit rate per smokers for the years 1993-2000 are based the primarily on CDC data in MMWR as discussed in Friend and Levy (2000). The estimated attempted quit rate is 46 percent in 1993. After a slight drop in quit attempts between 1993 and 1994 (due to the decrease in Rx PT use), attempted quits increase in 1996 from 44 percent to 46 percent with the introduction of OTC PT. When OTC falls, new Rx PTs are introduced in 1998, leaving the attempted quit rate constant.

e) The quit rate in 1993 is predicted to be 4.3 percent. Due to the recent introduction of the patch, quit rates were high in 1993, but fall in 1994 and 1995 as Rx PT use fall. They

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decline about 10 percent to 3.9% percent in 1995. Population quit rates are predicted to rise in 1996 with the introduction of OTC PTs in May of that year. Quit rates peak at 4.5 percent in 1997, the first full year after OTC PT is introduced, about 15 percent above the 1995 level. Average treatment effectiveness increases from 0.091 in 1995 to 0.103 in 1997, mostly due to the increased use of treatments and consequent reduction in self quits. This increase primarily reflects the increase in OTC PT usage and in attempted quits. Population quit rates fall slightly to 4.4 percent in 1998 through 2000 as use of OTC PT falls, but new prescription PTs come onto the market.

The Policy Model

The policy model considers the effect of mandating access to treatment and providing brief interventions (BIs) by health care providers. For uninsured smokers, it is assumed that the provision of treatment is subsidized. In the model, access policies directly affect treatment use through financial coverage of treatments, while BI policies provide additional information and increase the number of quit attempts. The model considers the potential effects if the mandates are followed, but does not consider how the policies will be enforced.

1. Access policies

Access policies directly affect the use of treatments by treatment costs to the user. We simply assume that payers fully cover particular cessation treatments, subject to a small co-payment. Access policies may also affect use by reducing barriers, such as travel, time or inconvenience, or lack of information. The ability to reduce these obstacles will depend on the restrictions on treatment use, and the type of treatments covered.

a) We consider access policies that may provide PT or BT alone or in combination. Policies affecting OTC PTs are further distinguished from those affecting Rx PTs due to the implications for physician involvement. Specifically, the reimbursement plans considered in the model are: 1) Rx PTs alone (with minimal health care involvement), 2) Rx or OTC PT (without health care provider involvement) alone, 3) BT alone, 4) PTs only when used with BTs (e.g., enrollment in formal cessation program) or BT alone, and 5) any PTs and BT, alone or in combination. Option 4 is similar to the "comprehensive approach" advocated by AHCPR, while option 5 provides a "flexible approach".

b) In addition to restricting use to particular types or combinations of treatment, payers may restrict coverage to specific types of pharmacologic agents, e.g., the patch or Zyban, to specific types of behavioral therapy, e.g., group or individual therapy, hypnosis or acupuncture, or to certain providers, e.g., physicians or psychologists. The duration, frequency, and intensity of use may also be restricted. While explicitly considered in the model, payers are expected to adopt such restrictions to encourage proper use and reduce costs.

c) Access policies increase the use of particular types of treatment by current smokers through their treatment rates. The use of treatment as a result of a particular policy depends on the initial use multiplied by the additional percent of the smoking

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population using treatment and the percent change in use of a treatment resulting from full coverage. We require that the extent of additional population coverage is limited by those already covered for the treatments, which is determined by summing over policies that cover that treatment.

d) Few studies have examined the effect of access policies on treatment use and quit rates. Rx PT coverage is estimated to increase use by 140 percent and coverage of all PTs increases use by 90 percent. The smaller effect of broader coverage was based on the higher base rate of use (due to a relatively high percentage of OTC PT use), suggesting that access barriers in the absence of policy are lower than for Rx PTs because a physician's prescription is not required. BT coverage is estimated to increase BT use by 70 percent. Coverage of combined Rx PT and BT is estimated to increase use by 180 percent. This estimate is relatively high, because initial combined BT and PT use is low and smokers are expected to be more motivated to try medications that will help alleviate withdrawal symptoms than when only BT is covered. The flexible option increases treatment use by 120 percent from its higher base rate.

e) Current levels of coverage are based on a literature review, and adjusted downward to reflect that many smokers are uninsured. It is estimated that 3 percent of insurers cover Rx PTs and 2 percent also cover OTC PTs, 11 percent cover BTs only, 13 percent cover Rx PTs with BTs, and 2 percent cover any PT or BT, for a total of 31 percent coverage.

f) A policy option that covers only one treatment may affect more than one treatment type. For example, coverage of Rx PTs alone makes combined BT and Rx PTs more accessible because the medication portion is less expensive. Similarly BT coverage reduces the cost of combined PT and BT use. The flexible option increases access to all treatments. The coverage elasticity is assumed to be the same for each of the treatments affected by a policy and is invariant to the percent of the population already covered. While access may affect a broad array of treatments, use of those treatments may come from smokers switching from another treatment rather than smokers initiating a new quit attempt. This group of potential quitters would have attempted to stop smoking even in the absence of the new policy, but the policy leads them to substitute the treatment or combination of treatments that they use. For example, Rx PT coverage may cause some OTC PT users to switch to the now cheaper Rx PT. In the model, we distinguish the effect of an access policy on those who would not otherwise have tried to quit from those who substitute from other treatments. Those who do not substitute the use of the covered treatment for the use of other treatments or self-quitting are added to quit attempts.

g) No empirical literature specifically addressed the extent to which increased access would yield new quitters and substitution between treatment methods. Estimates of the percentage (relative to one) of those substituting from each of the other sources were developed based on observed practices in previous studies and consultation with our advisers. For all but BT alone and BT combined with Rx PT, we make the conservative assumption that approximately 50 percent of new use is assumed to involve new quitters, and the other 50 percent involves substitution of quitters previously using other types of treatment. For BT coverage, 40 percent is from new quitters, due to more potential for substitution. For BT and Rx PT combined, 60 percent is from new quitters.

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No substitution occurs from the treatments affected by a policy (i.e., the policy elasticities in the model represent net additional users). All of the substitution is from self-quitters for the flexible policy since all treatments are options. For the other policies, most substitution is from self-quitters. Otherwise, for the policy covering Rx PTs, 20 percent of substitution is from OTC PT, 15 percent is from OTC PT with BT and 5 percent is from BT. For the policy covering all PTs, 20 percent of substitution is from BT. For BT coverage, 10 percent each are from Rx PTs and OTC PTs. For combined Rx PT and BT, 10 percent each are from OTC PTs and BT.

h) While greater access may increase the intensity or duration of use, the effects of access policies may be dampened if smokers less suited or committed or with less information about proper use are induced to try a treatment. In the absence of access policies, paying a price, in effect, serves the role of screening out smokers less committed or well-suited to quitting. As those less motivated or appropriate for treatment are treated, the average effectiveness of a treatment across the entire population of attempted quitters declines as the number of treatment users increases (i.e., diminishing returns). We assume that the reduction in effectiveness declines in direct proportion with the additional use of the policy.

i) Due to the absence of direct evidence of the effects on new users, limited tendencies to diminishing returns were estimated. Treatment effectiveness falls 10 percent as treatment use doubles for all treatment categories, except the combined PT and BT, for which a 20 percent reduction is estimated. A greater tendency to diminishing returns is expected for the combined PT/BT policy because some of the BT new users are expected to have switched in order to receive PT coverage.

j) Changes in policy affect first year cessation rate. The policy model estimates a 25 percent increase in cessation rates from a policy that combines mandated brief interventions with coverage of all proven cessation treatments. Smaller effects are predicted from policies that provide more restricted coverage of treatments, especially those limited to behavioral treatment. These policies translate into small reductions in the smoking rate at first, but increase to as much as a 5 percent reduction in smoking rates within 20 years. They also lead to substantial savings in lives, especially relative to policies directed at youth only.

2. Brief Interventions

Brief interventions (BIs) are modeled as minimal brief interventions involving screening and minimal advice, taking less than 5 minutes. More extensive interventions would involve more time and more extensive counseling and follow-up. More extensive BIs may be considered in the model as policies that involve coverage of BT alone or in combination with PT, since they overlap to varying degrees with BT and often involve steering smokers to BT and PT use.

a) BIs are assumed to increase quit attempts. Since evidence is lacking that minimal BIs steer patients towards use of any particular treatment, it is conservatively assumed that patients' choice of treatments will be the same as that of current treatment users. Similar to the access model, the effect of mandating BIs depends on the percentage increase in attempted quit rates as a result of the policy and the percentage of the population newly receiving BIs as a result of a policy change. Those newly receiving

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BI, in turn, depend on the percent of smokers that already receive BIs and the percent of smokers that visit physicians each year.

b) The percent of physicians currently providing BIs is estimated as 60 percent based on a variety of sources. The effect of BIs for new populations may differ from the effects on those already exposed before the policy change. Health care providers newly providing the intervention as a result of a mandate may be less inclined or able to faithfully follow the recommended procedures, either because they are not properly trained or are skeptical about the effectiveness of BIs. Moreover, they may decide it is not a worthwhile endeavor to provide advice and counseling and the risk of getting caught or penalized for not doing so is low. Prior to mandated BIs, health care providers may have also limited their advice and counsel to those smokers more likely to amenable to cessation. Thus, as more physicians are induced to conduct BIs, average effectiveness may fall.

c) Most studies examine the effectiveness of BIs in controlled settings, but little is known about how to effectively implement BIs in the population. It is assumed that average effectiveness of those newly providing BI falls by 20 percent as a result of a policy mandate.

d) BIs affect first year cessation rates in the Sim Smoke model. Alone or in combination with access policies, they increase quit rates by about 7 percent.

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