Introduction

Globally, 5 million deaths are attributed to smoking each year, with trends driving an increase to 10 million deaths per year by the 2030s. Substantial evidence indicates that higher cigarette taxes, smoke-free air laws and advertising bans can appreciably reduce adult smoking rates, especially when combined as a comprehensive strategy. The World Health Organization has set out the Framework Convention for Tobacco Control (FCTC) consistent policies are also implemented, the model projects that smoking prevalence will fall by another 28% with an additional 168 000 deaths averted by 2040.
to tobacco-related harm. Yet, smoking prevalence remains high in many of those nations. For example, relative to its initial level, France’s rate fell by 8% from 2000 to 2005, but appears to have risen back to its initial level by 2010. Italy’s rate fell 9%, between 1999 and 2008, but male rates are 29%; the Netherlands’ rate fell by 20% between 1998 and 2008 but was still 30% for males; and Spain's rate decreased by 15% between 2001 and 2007, but male rates are still 35%. Meanwhile, smoking prevalence in the UK dropped from 28% in 1998 to 21% (22% for males) in 2007—a 25% reduction. Like other countries, the UK has increased cigarette taxes, implemented stronger advertising and smoke-free legislation and bolstered health warnings. Unlike other countries, the UK has implemented a comprehensive cessation treatment policy, thus combining the ‘medical’ model of targeting high-risk individuals with the ‘public health’ model of targeting populations.

This article adopts the 'SimSmoke' tobacco control policy simulation model11,12 to examine the contribution of tobacco control policies to the steep decline in the UK’s smoking prevalence. While the ability of purely statistical studies to distinguish effects of the different policies is limited, simulation models combine information from different sources to examine how the effects of public policies unfold over time in complex social systems. Using data from England, Wales and Scotland, the ‘UK SimSmoke’ (UKSS) distinguishes the effect of tobacco control policies and estimates the resulting number of smoking-attributable deaths (SADs) averted.

Methods

UKSS uses 1998 as the baseline year with the population divided into smokers, never smokers and former smokers by age and gender. The baseline year was chosen as a period of relative stability in smoking rates (smoking rates had levelled off in the mid- to late nineties) before major tobacco policy changes. Thereby, long-term trends in smoking rates could be distinguished from recent effects of policies. UKSS encompasses England, Scotland and Wales, and does not distinguish smoking patterns of these member states. Northern Ireland, <3% of the UK population, is excluded, because comparable smoking data were not readily available.

A discrete time, first-order Markov process is employed to project future population growth through fertility and deaths, and smoking rates through initiation, cessation and relapse. Smoking rates and, thereby SADs, change over time in response to changes in tobacco control policies.

Population model


Smoking model

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

Smoking prevalence data are from the interviewer-administered Smoking and Drinking Among Adults Reports of the General Lifestyle Survey (GLS, previously known as the General Household Survey). The GLS surveys individuals in private households. It is designed to be representative of the population of Great Britain, and is recognized as the measure national smoking prevalence. The annual sample size has varied from 12,900 to 17,200. In 1998, respondents’ smoking status was assessed by asking: ‘Do you smoke, even if only occasionally?’ followed by a question ascertaining whether they smoke cigarettes. Since data on former smokers was not available by years quit, we used 2002 US data to distribute former smokers by years quit.

Due to empirical challenges in measuring initiation and cessation at younger ages, initiation rates at each age were measured as the difference between the smoking rate at that age and the rate at the previous age. Cessation is tracked from age 24 years, since quitting before that age does not have discernable health effects. The Netherlands data (1996) were used to calculate the 1998 cessation rate (as (quit <12 months)/(current smokers + quit <12 months)). US-relapse rates were used. With ~50% relapse of those who quit in the last year, a 2% net first year quit rate is obtained, consistent with the Netherlands estimates.

Actual data from the GLS for 1998 through 2000 and past trends were used to calibrate UKSS. We adjusted first year relapse downward for those aged 50–59 years to 40% and for those aged 60 years and above to 30%, consistent with the findings that older smokers more successfully stay quit.

Smoking-attributable deaths

SADs are based on the excess risks of current and former smokers relative to never smokers. Death rates by age, gender and smoking status were calculated from death rates, smoking rates and relative risks. The number of current and former smokers at each age was multiplied by their respective excess risk and summed to obtain total SADs.

Since the UK has a similar smoking history to the US, we use relative mortality risk estimates from the US Cancer Prevention Study II. Doll, Peto, Boreham and Sutherland found similar, albeit slightly higher risks for UK doctors. Relative risks of former smokers decline at the rate observed in US studies, again similar to British studies.

Policy models

‘SimSmoke’ includes a separate policy module for each of the major policies. Policy effect sizes are in terms of relative (percentage) reductions applied to smoking prevalence in the year when the policy was implemented, and applied to initiation and cessation rates in future years unless otherwise specified. Table 1 summarizes policies and effect sizes applied in UKSS.

The effect of implementing a policy depends on its prior level (e.g. the incremental effect of a complete work site ban will depend on whether there is already a partial worksite ban). We input policy levels for each year through 2009, based on MPower reports with corroboration from tobacco control staff in the UK. If only one of the three countries within the UK implemented a policy then only a percentage of the total was applied based on their percentage of the population.

In 'SimSmoke', cigarette taxes affect cigarette prices, and changes in price are translated into changes in smoking prevalence through elasticities. Incorporating studies for the UK and variations by age from other high-income nations, UKSS' uses prevalence elasticities of -0.4 for those through age 17 years, -0.3 for those through ages 18–24 years, -0.2 for those aged 25–34 years, and -0.1 for those aged 35 years and above. A cigarette price and the consumer price index were used to calculate inflation-adjusted prices. From 1998 to 2002, the adjusted retail price increased by 25% with tax increases and had risen an additional 15% by 2009.

'Smoke-free air policy' considers smoking restrictions in: (i) worksites; (ii) restaurants and bars; and (iii) other places, with their effect dependent on enforcement and publicity (based on the level of tobacco control campaigns). With strong enforcement and publicity, the effect of a ban in workplaces, restaurants, pubs and bars and in other public places is 10%. One study of the effect of UK smoke-free air laws on quit attempts obtained consistent results.
Table 1 Policies, descriptions and effect sizes of the UKSS model

<table>
<thead>
<tr>
<th>Policies</th>
<th>Descriptions</th>
<th>Potential percentage effects*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tax policy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increase in tobacco price</td>
<td>Cigarette price index, taxes measured in percentage terms</td>
<td>For each 10% price increase: 4.0% reduction ages 15–17 years, 3.0% reduction ages 18–24 years, 2.0% reduction ages 25–34 years and 1.0% reduction ages 35 years &amp; above</td>
</tr>
<tr>
<td><strong>Smoke-free air policies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehensive ban</td>
<td>Ban in all areas</td>
<td>10.0% reduction</td>
</tr>
<tr>
<td>Enforcement and publicity</td>
<td>Government agency is designated to enforce and publicize the laws</td>
<td>Effects reduced by as much as 50% if zero enforcement</td>
</tr>
<tr>
<td><strong>Mass media campaigns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium level campaign</td>
<td>Campaign publicized heavily on TV (at least two months of the year) and at least some other media.</td>
<td>3.25% reduction</td>
</tr>
<tr>
<td>Low level campaign</td>
<td>Campaign publicized only sporadically in newspaper, billboard or some other media.</td>
<td>1.0% reduction</td>
</tr>
<tr>
<td><strong>Marketing bans</strong></td>
<td></td>
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</tr>
<tr>
<td>Comprehensive marketing ban</td>
<td>Ban applied to television, radio, print, billboards, in-store displays, sponsorships and free samples</td>
<td>5.0% reduction in prevalence, 6.0% reduction in initiation, 3.0% increase in cessation rates</td>
</tr>
<tr>
<td>Weak advertising ban</td>
<td>Ban applied to some of television, radio, print and billboards</td>
<td>1.0% reduction in prevalence and initiation only</td>
</tr>
<tr>
<td>Enforcement and publicity</td>
<td>Government agency is designated to enforce the laws</td>
<td>Effects reduced by as much as 50% if zero enforcement</td>
</tr>
<tr>
<td><strong>Warning labels</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>Labels cover at least one-third of the package and include seven pack warning criteria</td>
<td>0.75% reduction in prevalence and 0.5% reduction in initiation, 2.5 increase in cessation rate</td>
</tr>
<tr>
<td>Weak</td>
<td>Labels cover less than one-third of package, not bold or graphic</td>
<td>0.5% reduction in prevalence &amp; initiation rates, 1.0% increase in cessation rates</td>
</tr>
<tr>
<td><strong>Cessation treatment policy</strong></td>
<td>Complete availability and reimbursement of pharmaco-behavioural treatments, quitlines and brief intervention</td>
<td>4.75% reduction in prevalence, 39.0% increase in cessation rate</td>
</tr>
<tr>
<td><strong>Youth access restrictions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly enforced and publicized</td>
<td>Compliance checks are conducted regularly, penalties are heavy, and publicity is strong, with vending machine and self-service bans</td>
<td>30.0% reduction for age &lt; 16 years in prevalence and initiation only, 20.0% reduction for ages 16–17 years in prevalence and initiation only</td>
</tr>
<tr>
<td>Low enforcement</td>
<td>Compliance checks are not conducted, penalties are weak, and there is no publicity</td>
<td>3.0% reduction for age &lt; 16 years in prevalence and initiation only, 2.0% reduction for ages 16–17 years in prevalence and initiation only</td>
</tr>
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</table>

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

From minimal laws in 1998, smoke-free legislation covering virtually all enclosed public places and workplaces including bars and restaurants was implemented first by Scotland in 2006, followed by Wales and England in 2007. Enforcement is set at 10 (on a 10 point scale) for all years. MPOWER distinguishes enforcement and four levels of ‘direct (advertising and point of sale) and indirect (sponsorships, branding, or promotional discounts) marketing’ as: (i) none; (ii) minimal (up to 3 direct); (iii) moderate (4–6 direct with 1 indirect); and (iv) complete (all direct and indirect). With a complete marketing ban, prevalence is reduced by 5% and initiation by 6%, and cessation is increased by 5%.27 UK had a partial advertising ban in 1998. Direct mail advertising, as well as billboards, newspapers and magazines advertising were banned in 2003, followed by a ban of tobacco-sponsored sporting events and regulations governing point of sales advertising and brand sharing by 2006. At level 2 in 1998, marketing bans are increased in steps from 2002 to level 3 in 2004, followed by level 3.5 in 2005. Enforcement is set at 10 for all years.

MPOWER provides four levels for ‘health warnings’ on cigarette packs: none, minimal (< 30% of the principal display area), moderate (covering at least 30% of the display area and including seven pack warning criteria) and complete (covers at least 50% of the display area and includes all seven warning criteria and a ban on deceitful terms). UK had minimal warnings in 1998 increasing to moderate in 2003. Based on a review and recent studies, this change reduces prevalence by 0.25% and increases cessation by 1.5%.

‘SimSmoke’ specifies three levels for ‘media campaigns’: low (a national agency and minimal funding), medium [a national agency per capita expenditures over $0.10 (USD) per capita] and high (a national agency and expenditures over $0.50 (USD) per capita). No substantive media campaigns were in place in 1998. In 2001, media campaigns were increased to a low level, and then to a medium level in 2004. Reviews indicate that a low campaign yields an effect size of 1% increasing to 3.25% for a medium campaign.

A strongly enforced policy ‘restricting youth cigarette purchases’ reduces prevalence of those below age 16 years by 30% and those aged 16–17 years by 20%. The minimum purchase age for tobacco was raised from 16 to 18 years in 2007. From no policy until 2007, it becomes low. There were no bans on vending machines and self-service displays until 2010.

‘Cessation treatment’ includes four sub-policies: treatment access, quitlines, treatment availability and health-care provider interventions. Treatment coverage is based on the places providing cessation treatments (physician offices, hospitals, community centres, provider offices and other). In the UK, cessation treatment is classified as provided in no places in 1998 increasing to sometimes in all places in 2000, and then to all places at all times in 2003. Starting in 1998, passive quitline services were available and this became active with follow-up in 2001. In the UK, nicotine replacement therapy became available by prescription in 1995, but became available without a prescription in 2001. Bupropion became available by prescription in 2001. Although National Guidelines stress the importance of physician advice, advice with follow-up has been minimal and is set at 25% in 1998 increasing...
to 50% by 2006. With all sub-policies simultaneously implemented, prevalence is reduced by 4.75% and cessation is increased by 39%.

Model outcomes

‘UKSS’ predicts smoking prevalence and SADs over time by gender and age. To validate ‘UKSS’, we compare percentage changes in the model’s predicted smoking rates to percentage changes in annual smoking rates by age and gender from the GLS. To distinguish the effect of policies implemented between 1998 and 2009, we set policies through 2009 to their 1998 levels to obtain the counterfactual with no policies. The difference between the actual and counterfactual smoking yield rates the net effect of policies implemented since 1998. To gauge the effect of a single policy, we estimate the percentage reduction with only that policy relative to the counterfactual, and compare that reduction to the summed effect of all policies. We also estimate the impact of policies on SADs through the year 2040 by subtracting the number of deaths with policies to the number of deaths with policies kept at their 1998 levels.

Results

Smoking prevalence from 1998 to 2010

Smoking prevalence is reported as a percent of the population aged 16 years and above, as reported in UK data. Incorporating the effect of newly implemented policies, ‘UKSS’ predicts that male smoking rates decrease from 29.4% in 1998 to 23.2% in 2009, a 21.2% relative decline, and that female smoking rates fall from 26.3% to 20.8% over the same period, a 21.0% relative decline. As shown in figure 1, this is less than the 26.7% drop for males and 23.1% drop for females observed using the British GLS. Comparing the percentage change in smoking prevalence from 1998 to 2009 by age (table 2), ‘UKSS’ overpredicts the reduction for males 16–19 years old (24.3% predicted vs. 20.0% in surveys). For other age groups, the percentage reductions in smoking prevalence are underpredicted by UKSS (especially for males aged 20–24 years: 22.3% predicted vs. 41.5% according to surveys and females aged 25–34 years: 15.8% predicted vs. 27.3% according to surveys) or are close to the reductions seen in the British survey data.

The role of policies

For the counterfactual scenario of policies left at their 1998 levels, ‘UKSS’ projected a slow downward trend for both male and female smoking prevalence. Compared to the (actual) trends with policies implemented, male and female smoking prevalence under the counterfactual were 22.9% and 22.3%, respectively, below the levels that they would have been in 2009. The effects grow to 37% (33%) for males (females) below the 2040 counterfactual prevalence. As a consequence of the policies implemented between 1998 and 2009, ‘UKSS’ estimated a cumulative total of 9161 deaths averted by 2040. About two-thirds of the SADs were males due to their higher smoking rates, especially at later ages.

The policy-induced reduction in male smoking prevalence by 2010 was decomposed into the component contributions of each policy. Of the policies implemented between 1998 and 2010, 31% of the reduction was from increased prices, 23% from stricter smoke-free air laws, 13% from stricter marketing restrictions (many were already in place in 1998), 10% from increased media campaigns, 2% from stronger health warnings and 21% from cessation programmes.

Discussion

‘UKSS’ applies population, smoking prevalence and policy data for the UK to the established ‘SimSmoke’ model, and has been validated for the UK and other countries and states. The analysis shows that policies played a major role in the steep decline in the UK’s smoking rates, responsible for 23% relative decline in smoking prevalence between 1998 and 2009 and as much as a 35% reduction by 2040. Furthermore, the data indicate that rates fell more than predicted by ‘UKSS’, suggesting that policies may be more effective than predicted by ‘UKSS’. About 30% of the reduction in prevalence by 2009 is explained by price increases, whereas smoke-free air and cessation treatment policies each account for ~20% of the reduction. However, some physicians still do not ask their patients regularly if they smoke, and are even less likely to follow-up with advice to quit and suggestions on how best to quit. Levy et al. suggest further reductions may be possible.
with better integration and follow-up through the health-care system.

As a result of the policies implemented between 1998 and 2009, ‘UKSS’ estimates 210 973 premature deaths will be averted by 2040. Since actual reductions in smoking prevalence were more than we predicted, these estimates may be understated. The projections also do not include deaths averted due to reduced second-hand smoke exposure.37

‘SimSmoke’ has been applied to 14 other European nations,38 but the UK is the only active tobacco control nation where reductions in smoking rates are underpredicted, suggesting that the package of policies adopted in the UK may be more effective than that adopted in other countries. The UK has distinguished itself from other countries by implementing a relatively comprehensive cessation treatment policy. In a model where quit attempts are distinguished from treatment use, ‘public health’ approaches, such as tax increases and smoke-free air laws, are shown to primarily increase quit attempts, while treatment policies suggested by the ‘medical’ model make those quit attempts more successful.39 Thus, cessation treatment policies may act synergistically with other policies. These effects are not captured in the policy evaluations used to develop effect sizes for cessation treatment policies in the SimSmoke model developed here, and may explain the better than predicted reduction in smoking rates. However, the under-reporting of smoking behaviours as antismoking norms become more prominent may also explain the larger than expected reduction in smoking rates.

Our results depend on reliability of the data and the estimated parameters and on assumptions used in the model. Data on population were compared with the estimated population in 2010 and projections for later years and found to be accurate within 5%, but immigration is not considered in ‘UKSS’ and may have kept the smoking rates higher than they might have been. For example, immigrants from Poland to Ireland were found to have average smoking rates of 45%,39 substantially higher than the average rates within the UK. In addition, the flattening of the UK’s smoking rates since 2007 may reflect a tendency for smoking to increase during economic hard times, as seen in Italy,6 or the curtailing of mass media expenditures since 2005.10

The policy effect sizes in ‘UKSS’ depend on underlying assumptions, estimated parameters of the predicted effect of initiation and cessation, and assumptions about the interdependence of policies. Knowledge of the different effects of each policy varies.2 For example, relatively consistent results have been found for price/tax policies, with fewer studies and less consistent results for smoke-free air, media/tobacco control campaigns and advertising bans. Further study is needed on health warnings and cessation treatment policies and on the interactive effects of policies. ‘UKSS’ highlights the relative contribution of various policies to reducing the tobacco health burden and indicates that an optimal policy combines the ‘medical’ with the ‘public health’ model.4 Nevertheless, smoking rates might be further reduced; when specific taxes are increased to 70% of the retail price, youth access laws and advertising restrictions are enforced, and stronger warning labels (due to be implemented this year), support for health-care provider interventions and media campaigns are implemented, ‘UKSS’ projects that smoking prevalence would fall by another 28% with an additional 168 000 deaths averted by 2040.

Acknowledgements

We would like to thank Anna Gilmore, Esteve Fernandez and Colin Fischbacher for their helpful comments on previous drafts of this article.

Funding

This is a deliverable within the PPACTE Project ‘Pricing Policies and Control of Tobacco in Europe’ and is partly funded by the European Commission through FP7 HEALTH-F2-2009-223323. L Currie is an HRB PhD Scholar in Health Services Research partly funded by the HRB in Ireland under grant no. PhD/2007/16

Conflicts of interest: None declared.

Key points

● From 1998 to 2009, the UK implemented strict tobacco policies, including a comprehensive cessation treatment programme.

● A 23% reduction in smoking is due to policies, mainly tax increases.

● As a result of UK SimSmoke projects that 210 000 deaths will be averted by the year 2040.

● With stricter policies, prevalence will fall by another 28%.

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Impact of economic crisis and other demographic and socio-economic factors on self-rated health in Greece

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Background: Financial crisis and worsened socio-economic conditions are associated with greater morbidity, less utilization of health services and deteriorated population’s health status. The aim of the present study was to investigate the determinants of self-rated health in Greece. Methods: Two national cross-sectional surveys conducted in 2006 and 2011 were combined, and their data were pooled giving information for 10 572 individuals. The sample in both studies was random and stratified by gender, age, degree of urbanization and geographic region. Logistic regression analysis was used to determine the impact of several factors on self-rated health. Results: Poor self-rated health was most common in older people, unemployed, pensioners, housewives and those suffering from chronic disease. Men, individuals with higher education and those with higher income have higher probability to report better self-rated health. Furthermore, the probability of reporting poor self-rated health is higher at times of economic crisis. Conclusion: Our findings confirm the association of self-rated health with economic crisis and certain demographic and socio-economic factors. Given that the economic recession in Greece deepens, immediate and effective actions targeting health inequalities and improvements in health status are deemed necessary.

Introduction

In 2009, Greece entered into one of the most serious economic downturns in its modern history. In May 2010, the country was put under the supervision of the European Commission, the European Bank and the International Monetary Fund and signed the Economic Adjustment Program and its revision in autumn 2010.