Predicting the future prevalence of smoking in Italy over the next three decades

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Background: Smoking prevalence in Italy decreased by 37% from 1980 to now. This is due to changes in smoking initiation and cessation rates and is in part attributable to the development of tobacco control policies. This work aims to estimate the age- and sex-specific smoking initiation and cessation probabilities for different time periods and to predict the future smoking prevalence in Italy, assuming different scenarios. Methods: A dynamic model describing the evolution of current, former and never smokers was developed. Cessation and relapse rates were estimated by fitting the model with smoking prevalence in Italy, 1986–2009. The estimated parameters were used to predict prevalence, according to scenarios: (1) 2000–09 initiation/cessation; (2) half initiation; (3) double cessation; (4) Scenarios 2 + 3; (5) triple cessation; and (6) Scenarios 2 + 5. Results: Maintaining the 2000–09 initiation/cessation, the 10% goal will not be achieved within next three decades: prevalence will stabilize at 12.1% for women and 20.3% for men. The goal could be rapidly achieved for women by halving initiation and tripling cessation; and (6) Scenarios 2 + 5.

Introduction

In Italy, male smoking prevalence declined from 41.6% in 1986 to 29.5% in 2009, an average annual drop of 1.2%. Meanwhile, female smoking prevalence declined from 19.2% in 1986 to 17.0% in 1993, and stalled at that level.¹ The reduction in smoking prevalence was in part attributable to the development of tobacco control policies in Italy from the 1970s onwards. A smoking ban in hospitals, schools, cinemas and public transportation was introduced in 1975, followed by a smoking ban in front-offices of public administrations in 1995, and finally by a comprehensive smoking ban in all workplaces and in the hospitality sector in 2005.² Since 1991 tobacco advertising and promotion were almost totally banned in Italy, as in most European countries.³ Moreover, the real price of cigarettes in 1990–2000 increased at an annual 3% rate.⁴ The price for a pack of Marlboro, standardized for consumer price index, remained stable between 1990 and 2003, then increased by 25% between 2003 and 2009 (at annual 4% rate). Moreover, after the trial against Philip Morris and RJ Reynolds brought by the European Community, smuggling in Italy dropped from ~15% of cigarette trades in 1998 to 1–2% in 2006, further decreasing to <1% in 2008.⁵ Finally, since the end of the 1990s several smoking cessation services (SCS) were established, including about 260 National Health System (NHS) SCS, about 80 Italian League against Cancer (LILT); a non-governmental organization) smoking cessation centres and two National quitlines.⁶ The implementation of these policies notwithstanding, male smoking prevalence in Italy is today relatively high, compared with several North European countries and the USA.

A recent report of the US Institute of Medicine on the future of tobacco control suggested a 10% threshold as a policy goal for the USA.⁷ No policy target for smoking prevalence is available for Italy and Europe.

The aim of this article is to estimate the smoking cessation and initiation rates needed to reduce smoking prevalence to 10% for both
genders within the next few decades in Italy. A model that is capable of estimating past smoking habits and of predicting future smoking prevalence as function of changes in initiation and cessation rates was developed. The model was based on assumptions regarding the population smoking behaviour. By examining the role of initiation and cessation rates, the types of strategies needed to achieve the 10% goal under the model assumptions could be estimated.

Methods
A dynamic model on smoking habits (figure 1 and Supplementary Appendix), similar to those developed for the USA and Australia,8–10 was developed in two steps: a base case and a forecast case. In the base case, unknown smoking parameters (sex and age-specific cessation rates and sex-specific relapse rates) were estimated on the basis of observed smoking prevalence, Italy 1986–2009. In the forecast case, parameters estimated in the base case were used to forecast future smoking prevalence.

Data
Smoking prevalence and initiation rate data by gender and age-group were available from the Italian Institute of Statistics (ISTAT) (Appendix table A1 in Supplementary Data). In particular, data on smoking initiation by age were available for the years 1994, 2000 and 2005 from the ISTAT Multipurpose Surveys ‘Health conditions and access to health services’,1 which were carried out every 5 years from 1980 to 2005. Data for 1986–87 and 1990–91 on smoking prevalence came from the same Multipurpose Surveys. The subsequent prevalence data were from the Multipurpose Surveys ‘Aspects of daily living’, carried out from 1993 onwards. These surveys were carried out almost every year on representative samples of the Italian population (about 24,000 families and 54,000 persons distributed in about 850 Italian municipalities of different population sizes). Smoking status was based on participant self-report as never, former, or current smoker.1

Smoking prevalence and initiation rate figures were linearly interpolated to obtain data for the missing years. Sex and age-specific death probabilities were provided by ISTAT and refer to the time period 1986–2007.1 For years 2008 and 2009, death probabilities of the year 2007 were used. Figures on the subdivision of former smokers by duration since quitting were derived from the ISTAT Multipurpose Surveys ‘Aspects of daily living’.1

Sex and age specific population data (time period 1986–2009), as well as sex and age-specific population prediction (2010–40) used to inform the model, were available from ISTAT. Mortality rates for current, former and never smokers were derived from the Cancer Prevention Study II.7

Model assumptions
Initial values of the model (boundary conditions) were the population distribution observed in 1986 and in 2009 for the base case and the forecast case, respectively. Each year the number of newborns was the number of children aged 0 observed in that calendar year in base case and forecasted by ISTAT in forecast case.

In defining the model, population was stratified into three mutually exclusive groups: current, never and former smokers, the latter distinguished as ≤1 and >1 year since quitting. The model was simulated to describe the dynamics of population in time and began with the numbers of current, never and former smokers observed in the baseline year. As each of these cohorts moved through time, the model allowed for births and deaths, and for initiation, cessation and relapse of smoking.

Since smoking initiation rates fall after 24 years of age, initiation in the model occurs between 18 and 24 years (Appendix table A1 in Supplementary Data). Cessation was tracked from age 25 years, since the relative risks of mortality from smoking are not discernable for those who quit smoking before that age.7 Cessation rates were distinguished by age class, whereas relapse rates were distinguished by time since quitting (≤ or >1 year) (figure 1 and Supplementary Appendix).

Base case
Sex and age-specific smoking cessation and relapse rates for three time periods (1986–92, 1993–99, 2000–09) were estimated by selecting the rates that best reproduced the observed smoking prevalence.8–10 This selection was carried out with a weighted least squares (WLS) method. The inverse variances of the observed prevalence for each age class were used as weights, to take into account the age-composition of the population.8–10

To account for uncertainty of smoking prevalence data, a probabilistic sensitivity analysis (PSA) approach was used: prevalence of current, former and never smokers were assumed to jointly follow a probabilistic distribution function.11 Using this approach the prevalence data used in the WLS to estimate the cessation and relapse rates were not considered as point estimates, but could vary in a range of values in accord to a suitable distribution function.

PSA was based on simulation: for each iteration, a value for the prevalence of current, former and never smokers was randomly assigned within its probabilistic distribution. A set of cessation and relapse rates were estimated for each iteration by WLS. The resulting variability in the cessation and relapse rates was then suitably summarized.

The Dirichlet distribution was selected as the joint distribution function for prevalence:10,11 this distribution is generally used for
Results

Estimates for the cessation and relapse rates and corresponding 95% confidence intervals arising from the base case are reported in table 1. In women and men cessation rates were higher both in the youngest and oldest age groups. In fact, for women aged 25–30 years and >50 years cessation rates had a 69.8% and 9.4% increase, respectively, from 1986–92 to 2000–09. In men aged 25–30 years cessation rates had a 10.0% decrease in cessation rates were estimated for both genders aged 31–49 years and >50 years, and slight increases in other age-classes, respectively (table A1). Relapse rates for former smokers who quitted some decades ago since >1 year constitute a large and composite group, e.g. it contains former smokers who quitted some decades ago.

The base case model produced a good fit for observed prevalence in all age classes ($R^2 = 0.954$ and 0.960 for women and men, respectively) (Supplementary Appendix figure A1). Projected smoking prevalence in 2020, 2030 and 2040 under the different scenarios for women and men are shown in table 2 and figure 2. Continuing the 2000–09 initiation and cessation rates (status quo scenario), smoking prevalence in 2040 will stabilize at 12.1% (from 17.0%, 2009) and 20.3% (from 29.5%, 2009) for women and men, respectively, and the 10% goal will not be achieved within the next three decades for women and men.

For women, the 10% goal could be achieved by halving initiation rates and tripling cessation rates (Scenario 6: 9.9 in 2016), tripling cessation rates only (Scenario 5: 10.4%, 2017), doubling cessation rates and halving initiation rates (Scenario 4: 10.2%, 2019), doubling cessation rates only (Scenario 3: 10.1%, 2024), or halving initiation rates only (Scenario 2: 10.1%, 2031). Prevalence in men could reach the 10% goal by halving initiation rates and tripling cessation rates (Scenario 6: 10.8%, 2024), doubling cessation rates and halving initiation rates (Scenario 4: 10.5%, 2033), or tripling cessation rates only (Scenario 5: 10.8%, 2033).

Enhancing cessation rates has a stronger effect than reducing initiation rates, both in men and women. In fact, smoking prevalence from Scenarios 3 and 5 decreases faster as compared to the prevalence obtained under Scenarios 2 and 4, respectively (figure 2).

Discussion

The model here presented is an useful tool to estimate cessation and relapse as function of past observed smoking prevalence (base case), and to predict future smoking prevalence as function of changes in smoking initiation and cessation rates (forecast case).

Results from the base case showed that in the last 30 years cessation rates did not increase in Italy (table 1). In fact, we recorded considerable decreases in cessation rates in both genders aged 31–49 years, a slight decrease for men aged ≥50 years, and slight increases in other age-classes, respectively for women <30 years. At the same time, figures on initiation rates, 1986–2009, showed a 15.0 and 28.2% decrease for women and men, respectively (table A1).

Results from the forecast case showed that, continuing present trends of smoking habits within the next three decades (status quo scenario), smoking prevalence will not reach the 10% policy goal, and will stall at ~12% and 20% in women and men, respectively. For women, the 10% goal could be rapidly achieved by halving initiation and tripling cessation rates (Scenario 6: 9.9% 2016), or tripling cessation only (Scenario 5: 10.4%, 2017). Prevalence in men could reach the 10% goal halving initiation and tripling cessation rates (Scenario 6: 10.8%, 2024), or halving initiation and doubling cessation (Scenario 4: 10.5%, 2033), or tripling cessation rates only (Scenario 5: 10.8%, 2033).

Similar modelling for smoking prevalence in USA estimated that continuing the 1981–93 initiation rates of 25%, the smoking prevalence would have stabilized at 15–16% by 2050. Another study for Australia estimated that the 2001–07 initiation and cessation rates would lead to a

### Table 1 Estimated cessation and relapse rates and corresponding 95% confidence intervals (95% CIs) obtained from the PSA

<table>
<thead>
<tr>
<th>Women</th>
<th>1986–92 rate (95% CI)</th>
<th>1993–99 rate (95% CI)</th>
<th>2000–09 rate (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cessation rate, 25–30 years old</td>
<td>0.0539 (0.0501–0.0567)</td>
<td>0.1006 (0.09249–0.1088)</td>
<td>0.0915 (0.0899–0.0932)</td>
</tr>
<tr>
<td>Cessation rate, 31–49 years old</td>
<td>0.0212 (0.0195–0.0229)</td>
<td>0.0062 (0.0040–0.0085)</td>
<td>0.0139 (0.0127–0.0151)</td>
</tr>
<tr>
<td>Cessation rate, ≥50 years old</td>
<td>0.0502 (0.0482–0.0523)</td>
<td>0.0644 (0.0575–0.0713)</td>
<td>0.0549 (0.0538–0.0560)</td>
</tr>
<tr>
<td>Relapse rate (for former smoker since ≤1 year)</td>
<td>1.0000 (1.0000–1.0000)</td>
<td>0.8281 (0.7438–0.9124)</td>
<td>0.5677 (0.5104–0.6249)</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cessation rate, 25–30 years old</td>
<td>0.0481 (0.0425–0.0537)</td>
<td>0.0608 (0.0593–0.0623)</td>
<td>0.0529 (0.0501–0.0557)</td>
</tr>
<tr>
<td>Cessation rate, 31–49 years old</td>
<td>0.0245 (0.0192–0.0298)</td>
<td>0.0250 (0.0214–0.0287)</td>
<td>0.0154 (0.0137–0.0171)</td>
</tr>
<tr>
<td>Cessation rate, ≥50 years old</td>
<td>0.0553 (0.0388–0.0717)</td>
<td>0.0780 (0.0727–0.0834)</td>
<td>0.0506 (0.0474–0.0538)</td>
</tr>
<tr>
<td>Relapse rate (for former smoker since ≤1 year)</td>
<td>1.0000 (1.0000–1.0000)</td>
<td>0.6183 (0.5257–0.7109)</td>
<td>0.2769 (0.1969–0.3569)</td>
</tr>
</tbody>
</table>
smoking prevalence stabilizing at around 10% in 2045. To reach a target goal of 12% in 2020, smoking prevalence in UK would require a sustained combination of doubling cessation and halving initiation rates from 2000 onwards.

In summary, results from the base and the forecast cases of our model both give to Italian policymakers indications on the importance of increasing cessation rates in Italy, particularly for smokers aged 31–49 years.

This result highlights the importance of the implementation of policies targeted to smokers. Policies targeted to the young population that produce a decrease in initiation rates are also important, but their effect is especially in the long period. Primary prevention policies, targeted to the general population, are not taken into account in this model.

Thus, there are indications for a focalization on cessation policies. Currently, the NHS does not reimburse smokers for pharmacotherapy or behavioural treatments that have been shown to improve cessation. According to seven population-based surveys conducted by DOXA, the Italian branch of the Gallup International Association, between 2002 and 2008 in Italy, pharmacotherapy for smoking cessation was used only by 9.4–9.9% of current smokers who previously tried to quit at least once. Behavioural treatments and pharmacotherapy for smoking cessation had been used only by 2.7% and 3.0% of former smokers in 2008, respectively. In spite of the low use of pharmacotherapy, 75.0% of interviewed smokers in 2008 perceived as relevant the influence of free pharmacotherapy to reduce smoking prevalence and consumption. Only 22% of smokers reported having received advice to quit by their general practitioners. It is noteworthy that prevalence of hardcore smoking in Italy (smokers aged ≥21 years, consuming ≥15 cigarettes per day who have not attempted and have no future intentions to quit) is high: 33.1% of all smokers in 2007, compared to 13.7% in 1998–99 in USA and 16% in 1994–97 in UK.

Italian smokers were estimated at 11.8 million in 2007. In the same year, only 15 000 smokers (0.13% of all smokers) requested help from the 267 NHS SCSs. Each SCS in 2007 treated an average of only 70 smokers per year. Several SCSs are not adequately funded and their activities are only periodically implemented. The number of smokers treated at the SCS could increase by developing stronger ties between local SCS and general practitioners, who can direct patients to the local SCS.

The two Italian quitlines together, the ‘SOS FUMO’ of the non-governmental organization LILT, and the ‘Green-line against smoking’ of the Italian National Institute of Health, according to the
available data, annually receive ~7000–8000 calls, thus reaching only ~0.06–0.07% of Italian smokers.21,22 According to the US CDC Best Practices for Comprehensive Tobacco Control Programs, US quitlines should reach 8% of smokers each year and deliver services to 6% of all smokers.23

Of course, interventions aimed at increasing smoking cessation should be supported and improved by synergistic interventions aimed at reducing normalization of smoking and thus contributing to reduce initiation and increase motivation to quit.

The model here presented simulates hypothetical policies that have the effect of doubling and tripling cessation rates. These effects give us an indication of the optimal policy’s effect for the reduction of smoking prevalence. A further step of this work will be to evaluate specific tobacco control policies by estimating their effect on cessation and initiation rates. Future smoking prevalence under such interventions could then be estimated. The model could therefore become an instrument for designing the future tobacco control policies. However, since estimates of the effect of new policies are not available, several assumptions should be made on this.

Limitations
Our model did not attempt to include the effects of smokers moving in and out of the population due to migration because of the inadequate data on smoking prevalence among migrants. While smoking prevalence among immigrants may differ from that in the resident population,14 it is unlikely that the difference would significantly influence our results, since the resident population is large with respect to immigrants.

The excess risk of death is modelled simply as the relative risk for current and former smokers, although smoking-related mortality depends on many factors, including the duration of smoking, smoking intensity and time since quitting. However, incorporating these factors would greatly increase the model complexity, and we expect not much affect the results.

The model reliability also depends on quality of the data used. Smoking data are based on a well-established methodology and reasonably large sample sizes.1 However, there is a need for better data on smoking prevalence for adolescents. A better former smokers' stratification by time since quitting would improve estimates of relapse rates, even if relapse rates are not one of the outcome under study in this work. In particular, in the first time period 100% of former smokers since <1 year relapsed. This extreme value was a result of numerical fitting; however it highlighted the major difficulty in quitting smoking in the first time period with respect to the others. In addition, relapse rates for former smokers since >1 year resulted all near 0. Since is well known a persistent risk of relapse even years after the quit attempt, this result clearly follows from the limiting assumption of former smokers since >1 year in a unique class.

The model did not account for uncertainty on mortality rates for current, former and never smokers. PSA on initiation rates and on the stratification of former smokers was also not considered. However uncertainty on these parameters was intrinsically incorporated through the PSA on smoking data.

The model simulates policies that have the effect of modifying the cessation rates estimated for time period 2000–09, or the initiation rates observed in recent years. No changes on cessation and initiation rates due to other factors, i.e. demographic or life style changes are taken into account.

Conclusions
In conclusion, the model developed could be an useful tool for public health purposes to predict smoking prevalence in other European countries, to predict the effects of natural changes in initiation and cessation rates, but also as a base for predicting the effects of different control and prevention policies, as well as for designing future policies.

For Italy our model indicates that the goal of a reduction to 10% of smoking prevalence can be achieved in 2020 for women and in 2030 for men mainly by reducing cessation rates. This could be achieved by increasing cigarette taxes, introducing total reimbursement of cessation treatments, with a further development of quitlines and SCS. These measures are not yet fully implemented in Italy, and need to be strongly encouraged. Of course, such interventions should be supported and improved by synergistic interventions aimed at reducing normalization of smoking and thus contributing to reduce initiation and increase motivation to quit.

Supplementary Data
Supplementary Data are available at EURPUB online.

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Conflicts of interest: None declared.

Key points
- Smoking prevalence in Italy decreased from 1980 to now, thanks to changes in smoking habits, i.e. smoking initiation and cessation rates. This model estimates past smoking habits and predicts future smoking prevalence as function of changes in initiation and cessation rates for Italy.
- Smoking habits needed to decrease smoking prevalence to 10% in Italy are estimated.
- Different scenarios that may arise from the development of tobacco control policies are analyzed and their effect on smoking prevalence is presented.
- The goal of a reduction to 10% of smoking prevalence can be achieved in 2020 for women and in 2030 for men mainly by reducing cessation rates. Tobacco control policies directed to increase cessation rates and not yet fully implemented in Italy should be strongly encouraged.

References
Patterns of adult tobacco use in Uzbekistan

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Background: Little is known about the prevalence of tobacco use in Uzbekistan, a country targeted intensively by the international tobacco industry. Methods: A national household survey elicited information about cigarette smoking and naswasy use (a form of smokeless tobacco). Results: Prevalence of past-month smoking and naswasy use among men (N = 1795) was 19.6% and 22.3%, respectively, and 1.6% and 0.5% among women (N = 1831). Among men, smoking was independently associated with Uzbek ethnicity, urban residence, age and occupation; naswasy use was associated with rural residence, age, being married and occupation. Conclusions: The smoking rate in Uzbekistan remains low relative to neighbouring countries, perhaps due to widespread use of cheaper naswasy. These findings establish a baseline for future surveys and highlight the importance of smokeless tobacco in assessing overall consumption.

Introduction

Tobacco is the leading cause of preventable death worldwide, estimated to kill more than 5 million people each year and up to 8 million by 2030 if current trends persist, with 80% of these avoidable deaths in low- and middle-income countries.1

Cross-national comparisons reveal 10-fold variation in the prevalence of daily smoking, ranging, among men, from 5% to 10% in some African countries, 20% to 35% in Latin American countries, to >60% in Russia, Greece and Jordan.2 Among women, daily smoking ranges from <1% in many African and Eastern Mediterranean countries to >25% in countries as diverse as Cuba, Chile, Nepal, Greece and Austria.2 Within countries, smoking patterns often differ by socio-demographic and economic characteristics.2,3

Uzbekistan, the most populous country in central Asia to have emerged from the Soviet Union, has pursued an explicit policy of gradual economic reform that contrasts with those of some of its neighbours.2 Tashkent is a modern capital city, yet much of the country has retained a traditional lifestyle, including widespread adherence to the tenets of Islam, differentiating it from its neighbours Kazakhstan and Kyrgyzstan.

Naswasy, a sublingually used smokeless tobacco made of tobacco, butter and slaked lime,6 is known to be common in Uzbekistan.7 Recent estimates indicate that the use of smokeless tobacco is extremely uncommon in Russia and Ukraine—1% and 0.5% of men in these countries report smokeless tobacco use.8,9 Little is known about the prevalence of smokeless tobacco elsewhere in the former Soviet bloc.

As with other former Soviet republics, Uzbekistan has been targeted by the international tobacco industry.4 Elsewhere in this region, smoking rates have risen, initially among young women in urban areas,10 although subsequently in women in rural areas.11 Such evidence is currently lacking from Uzbekistan, despite WHO recommendations to monitor tobacco use to inform tobacco control policies. It should be noted that while Uzbekistan has yet to ratify the WHO Framework Convention on Tobacco Control (FCTC), in 2010 the government of the Republic of Uzbekistan initiated the development of a national