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An economic analysis of tobacco elimination policies in Turkey

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ABSTRACT

Objective: We aim to evaluate the costs and benefits of various tobacco elimination policies, specifically, an immediate taxation option and eight tax-combined long-term cessation programs.
Methods: We combine demographic projections for the period 2012–2050 with incidence and mortality rates of four major cigarette related diseases, price elasticity of cigarette demand and unit costs of nonprice measures to reduce demand in order to estimate the net present discounted values of policy alternatives.
Results: The tax-combined cessation programs yield lower net costs to households and the society when they phase out smoking earlier. However, immediate taxation option is found to be superior, for both households and the society, to all tax-combined cessation programs irrespective of the duration of intervention. While all policies are estimated to yield significant reductions in the expected number of smoking related diseases and deaths, a class-based 20-year intervention is found to be the most effective program.
Conclusions: Although immediate taxation policy and tax-combined class-based 20-year intervention program emerge as the best tobacco elimination policies for the society, more research is needed on assessing the cost-effectiveness, applicability and social desirability of these alternatives and on designing additional policies to overcome their limitations.

1. Introduction

It is well-known that tobacco companies have taken their business to the developing world as smoking prevalence in developed countries declines. Pricing and price related promotions are among the most important marketing tools employed by tobacco companies. Turkey, a developing country, has become one of the major consumers of cigarettes with nearly 16 million adult smokers and as the 10th in the world in terms of the amount of tobacco products consumed [1]. Demographic projections of the Turkish population point to a substantial increase in the number of smokers within the next 40 years, unless smoking prevalence declines (see Section 2.2). Such an increase will undoubtedly lead to a surge in healthcare expenditures and a drop in productivity and income tax revenue. An early study by Murray and Lopez [2] shows that the increase in adverse health effects is in fact a worldwide problem: smoking is predicted to be the largest cause of disease burden in 2020, triggering between eight and nine million deaths in the world; and more strikingly, much of this increase in death is expected to occur in the developing world. To control tobacco use, government intervention has been recommended for several reasons including the existence of externalities (such as environmental tobacco

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smoke (ETS) and information problems about the health consequences of smoking (such as addiction) (see for example [3,4]).

Since the 1990s, Turkish governments have enacted several laws to regulate smoking. However, with an overall smoking rate of 31% and a declining average age of uptake, cigarette consumption is still a major health problem in Turkey [5]. Clearly, it is essential that effective strategies be implemented without delay to discourage smoking especially among young people. There are only a few studies on smoking in Turkey; no comprehensive analyses of the costs and benefits of smoking and of various anti-smoking policies exist. No studies are available on tobacco elimination in particular. Bilir and Onder [6] estimated the effect of the ban on smoking in public places based on survey data. Onder [7], Onder and Yurekli [8] and Yurekli et al. [9] estimated price elasticity of cigarette demand and showed that the government could increase tax revenues by increasing tax rate. The few studies that have been conducted on other countries on costs of smoking use micro-level survey data in a particular year and base their estimates on the concept of smoking attributable fraction (see for example [10,11]).

In this study, we make a first attempt to evaluate how taxation and smoking cessation programs can be used to eliminate smoking in Turkey. We present a detailed analysis of the costs and benefits of alternative “end-game” policies for the 2012–2050 period, namely an immediate taxation policy on the one side and on the other side various smoking cessation programs carried on until 2031 or 2041 followed by a tax hike. We estimate *effects of elimination policies on smoking, smoking related diseases and deaths as well as* the net benefits of these policies for the public sector, households, and the whole society.

2. Data and methods

We estimate the costs and benefits of alternative tobacco elimination policies. We consider three plans. (See Fig. 1.) The first is raising the tax rate in 2012 to eliminate smoking thereafter. The other two plans start with intervention programs and continue by taxation. As explained below, the number of smokers is expected to increase in 2012–2050 period, towards the end of which the number stabilizes. We choose 2012–2050 as our simulation period in order to be able to incorporate these effects of demographic change.

To measure the impact of alternative policies during this period, we need projections of smoking prevalence in the absence of any policies. These projections require information about the demographic transition of the country over the estimation period. Besides, we need data for incidence and mortality rates of major smoking-related diseases, expenditures for illness due to smoking, income loss from premature death of smokers due to smoking, productivity loss due to absenteeism of smokers and non-smokers, and implementation costs of tobacco elimination policies.

2.1. Demographic transition

We use population projection data for males and females and for age-groups 18–34, 35–64, 65+ (the categorization that best fits our incidence and mortality rate data). TURKSTAT [12] provides these projections up to year 2025, after which (for 2026–2050) we use the projections prepared by the United Nations [13].

Turkey's population, which was 72,698 million in 2010, is expected to increase by about 10.4% in 10 years to reach 80,257 million by year 2020. Within the following decades, the growth rate of the population is expected to taper off; the estimates are 7.9% in 2020–2030, 5.7% in 2030–2040 and 3.2% in 2040–2050. The decline in the population growth rate is expected to change the age composition of the country. The share of the young is expected to decline while the shares of the middle aged and the elderly are expected to increase. This is the well-known demographic transition that many countries, including those in Eastern Europe and the Former Soviet Union, have been going through [14].

2.2. Cigarette consumption

Cigarette consumption in Turkey went up by 80.95% between years 1990 and 2000. While population growth was partly responsible, the more important reason was the increase in per capita consumption [7], which is as high as 304.31 packages per year as of the end of 2010.

We use the smoking rate data in Çan et al. [15] but adjust them to match the overall smoking rate in OECD Health Data [16] (See Table 1).

We estimate the number of smokers, quitters and never smokers by age and sex groups in 2012–2050 by multiplying the smoking rate with the projected population in the group. Due to the changing age composition of the population, the total number of smokers is expected to increase in 2012–2050 (assuming that with no change in tobacco control policies smoking rates within age and sex-groups will remain constant over time), however the rate of increase will slow down and the number of smokers will stabilize by year 2050, as shown in Fig. 2.

2.3. Incidence and mortality rates of some smoking-related diseases

We take lung cancer, chronic obstructive pulmonary disease (COPD), chronic cardiovascular disease (CVD) and stroke as the most prominent diseases that are associated with smoking and for which data are available. We obtain incidence and mortality rates for these diseases from different data sources. Usually the source studies use slightly different age groups, requiring some adjustments to be made. For lung cancer we find Turkish data (Ferlay et al. [17]). For COPD, incidence rates are for EURO B1 group that includes Turkey (Shibuya et al. [18]), Turkish mortality rates are from MoH [19]. For CVD, we get Turkish data from Onat [20]. For stroke, country averages are obtained from Sarti et al. [21].

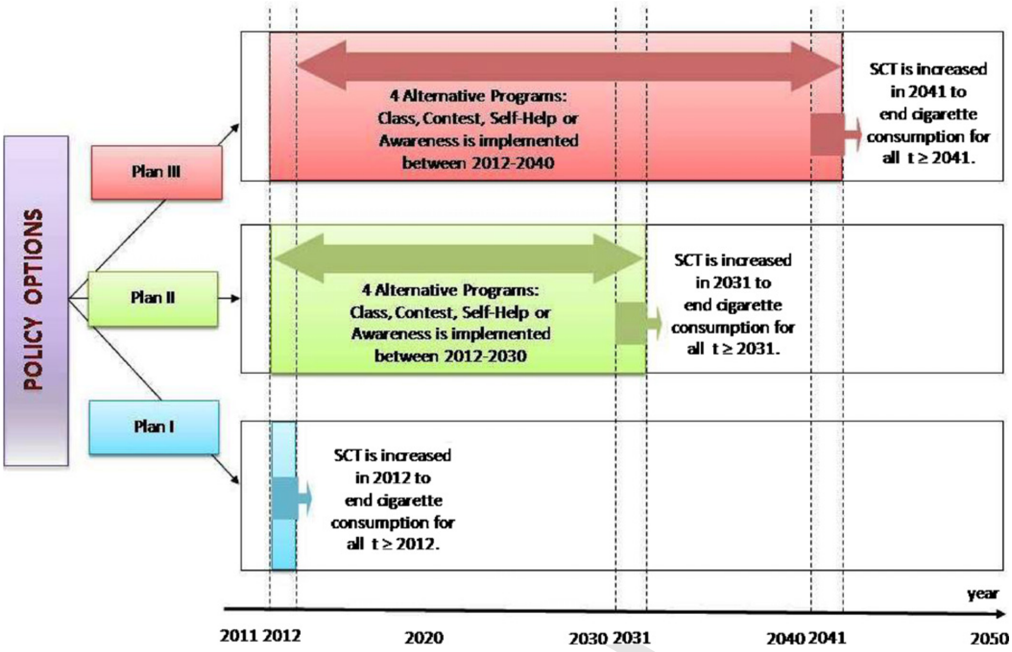

Fig. 1. Decision tree of policy options.

Notes. Plan I is immediate taxation. Plan II is composed of an intervention program run during 2012–2031 and taxation during 2031–2050. The four intervention programs under Plan II are called Class-20, Contest-20, Self-Help-20, and Awareness-20. Plan III is the same as Plan II except that the intervention program operates during 2012–2041. The four intervention programs under Plan III are called Class-30, Contest-30, Self-Help-30, and Awareness-30. SCT is special consumption tax. See Section 2.4 for information on intervention programs.

Table 1
Sex, age and smoking status in the beginning of the simulation period, 2012.

	Current smoker (%)	Quitter (%)	Never smoker (%)
Adult males			
Ages 18–34	51.7	10.7	37.5
Ages 35–64	50.2	19.0	30.8
Ages 65+	26.5	35.6	37.9
All	48.8	16.8	34.4
Adult females			
Ages 18–34	17.9	5.8	76.3
Ages 35–64	10.9	5.1	84.0
Ages 65+	1.4	3.5	95.1
All	12.8	5.2	82

Source: Çan et al. [15], OECD Health Data [16].

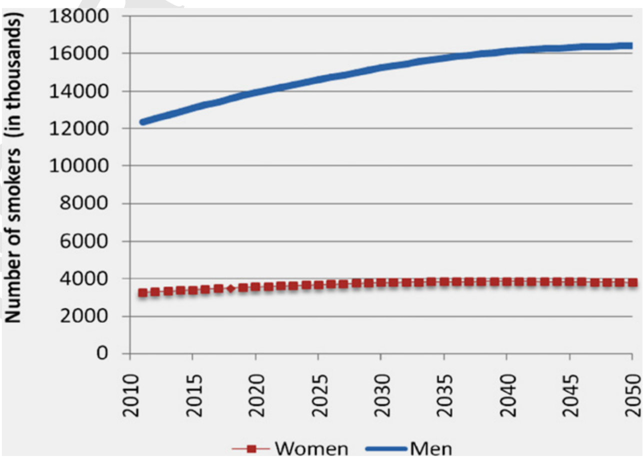

Fig. 2. Number of smokers in 2011–2050.

Source. Authors' calculations.

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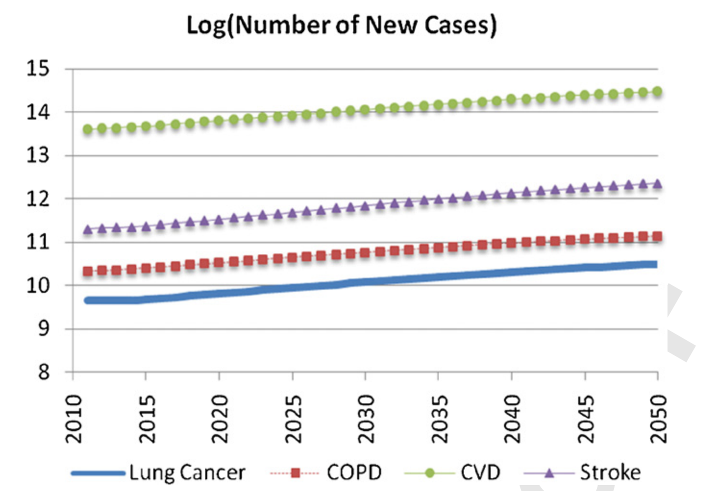

Fig. 3. Estimated numbers of new cases, 2012–2050.

Source. Authors' calculations.

Using our population projections along with the incidence and mortality rates borrowed from the literature, we estimate the numbers of new cases and deaths during 2012–2050. We plot the logarithms of these numbers in Figs. 3 and 4.

These diseases contain different incidence and mortality risks for current smokers, quitters and never smokers. In order to estimate the costs incurred due to these diseases, we need to know the incidence and mortality rates for age and sex-groups differentiated by smoking status. Since there are no data differentiated by smoking status, we devise a method (described in Appendix A) to estimate them. This method is based on risk (hazard) ratios by sex and age group (from Thun et al. [22]), which show the risk of death for smokers and quitters relative to never smokers. We assume that the information in [22] can be used for both incidence and mortality rates and differentiate the rates by smoking status according to the proportions in risk ratios.

2.4. Tobacco elimination policies

One of our elimination policies is the immediate change in the taxes on smoking to end cigarette consumption starting from 2012 (Plan I). For this purpose, we keep the value added tax (VAT) on cigarettes constant and increase the special consumption tax (SCT). Using the price elasticity of cigarette consumption (–67%) (Onder and Yurekli [8]), we find that a price increase by 149.3% (1/(0.67)) eliminates smoking. This corresponds to a tax hike by 12.8%. Although we are mainly interested in estimating the tax rate that eliminates cigarette use, we examine also the relationship between net benefits and the tax rate on cigarettes. Therefore, in our simulations, we fix the VAT rate at its 2011 level and vary SCT rate in 2012 from 0.0% to 76.2%. The total tax on cigarettes as a percentage of tax-included retail price ranges between 15.3 and 91.5 (the limiting tax rate). Given the current prevalence of smoking, we calculate for each tax rate the resulting number of smokers in each

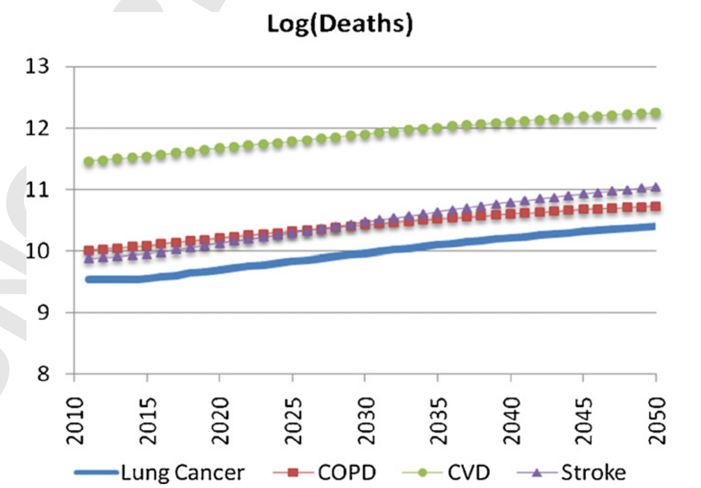

Fig. 4. Estimated numbers of deaths, 2012–2050.

Source. Authors' calculations.

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simulation year and their total cigarette consumption, using the tax (price) elasticity of amount of cigarette consumption (−67%), taken as fixed in the simulation period.

We assume that taxation is an effective tool as there is ample evidence for it (for example [23]). We ignore the possible effects of increased smuggling, home growing of tobacco and other factors on smoking eradication mainly for lack of reliable data. However, smuggling is attributed more to corruption and weak enforcement than to price differences. In fact, pre-tax price differences are often substantial and they already create a financial incentive to smuggle [9].

We consider two alternative plans that are composed of intervention programs that discourage smoking followed by taxation that completely eliminates smoking. One plan runs intervention programs during 2012–2031 (Plan II) and the other one during 2012–2041 (Plan III). At the end of the programs (2031 or 2041), cigarette price is increased instantaneously by 149.3%, which corresponds to a tax hike by 12.8% in both plans, exactly the same limiting tax rate in Plan I.

For Plans II and III, we evaluate four smoking intervention programs. Of these intervention programs, 'Smoking Cessation Class', 'Incentive-Based Smoking Cessation Contest', and 'Self-Help Quit Smoking Kit' (henceforth, 'Class', 'Contest' and 'Self-Help' respectively) are borrowed from Altman et al. [24]. These are community-based programs that were used between 1981 and 1983 in the Stanford Five City Project in the United States. 'Class' included eight one-hour sessions on quitting techniques. 'Contest', a six-week program was promoted through media. It entitled its participants the right to attend a lottery with several prizes, including a trip for two to Hawaii. 'Self-Help', consisted of a self-help quit kit, distributed via several channels such as libraries, health agencies, and physician offices, and included tips for quitting smoking. Of these three programs, 'Self-Help' was found to have the lowest quit rate, lowest time requirements for participants, and lowest per quitter costs. The program with the highest quit rate turned out to be 'Class', which required highest time for participants and had the highest per quitter costs. The 'Contest' program had the same time requirement for participants as the 'Self-Help' program; it ranked second among the three programs in terms of both the quit rate and per quitter costs.

The fourth intervention is 'Awareness' (Stevens et al. [25]). This program, which included a play, a poster and media campaign, and purpose-designed leaflets, was aimed, between 1996 and 1997, by Camden and Islington Health Authority in London at a Turkish community with a population around 8500. A baseline and a final survey revealed changes in smoking, attitudes to smoking and health outcomes. This program had higher per quitter cost and the lower success rate than the other three interventions ('Class', 'Contest' and 'Self-Help'). (For success rates and per quitter costs, see Section 2.6.5.)

2.5. Assessment of tobacco elimination policies

We evaluate the relative performance of alternative tobacco elimination policies in terms of their estimated costs and benefits. There are three approaches in the literature: economic cost-benefit analysis (ECBA), Gross Domestic Product (GDP)-based social cost analysis (GSCA), and expenditure-based cost analysis (EXBA) (see for example [26–28]). These differ mainly in the definition of costs, which are defined as opportunity costs in ECBA, as foregone flows of economic production in GSCA, and as non-production based monetary expenditures in EXBA. Unlike the other approaches, ECBA considers indirect and intangible costs as well as direct and tangible costs of smoking. Although ECBA is more comprehensive, we cannot follow it in our study as we do not have estimates of indirect and intangible costs of tobacco use in Turkey, such as the costs due to changes in type and quantity of investment and consumption of households, poor health of surviving household members, dissolution or reconstitution of households due to premature death of smokers [26]. Of the remaining two approaches, we prefer the EXBA since it allows us to estimate explicitly the direct costs to the public sector and to analyze policy alternatives to eliminate tobacco use.

For each cost or benefit item in the EXBA approach, we compute the total amount as the present discounted value of the amounts in years 2012–2050, using the real interest rate in Turkey in 2010 (1.5%) [29] as the discount rate. We look at three aggregate measures of comparison. We define 'net public benefit' as the tax revenues from cigarette sales net of costs which are publicly financed expenditures for illness of smokers due to smoking, income tax loss from premature death of smokers due to smoking, income tax loss associated with productivity loss due to absenteeism from work, and cost of tobacco elimination policies. To evaluate the social impact of alternative policies, we define 'net household cost' as the sum of household-financed part of expenditures for illness of smokers due to smoking, after-tax income loss from premature death of smokers due to smoking, productivity loss (net of income tax) due to absenteeism, and tax revenues of the public sector from cigarette sales. Finally, we define 'net social cost' as the difference between 'net household cost' and 'net public benefit'. All cost and benefit items included in this study are explained in Section 2.6.

2.6. Costs and benefits due to smoking

2.6.1. Expenditures for illness due to smoking or former smoking

The treatment costs of lung cancer, COPD, CVD and stroke are shown in Table 2. To estimate the expenditures for illness in each year, we multiply the estimated number of new cases of the four diseases by the per case treatment costs of these diseases. We estimate the expected cost to the public sector as 84% of this total, using the share of the public sector in total health expenditures [30].

2.6.2. Income loss from premature death of smokers and quitters due to smoking

By using the expected number of deaths in each year, we estimate the expected total income loss assuming that people who died prematurely could have worked until age 65 and earned an average salary. We take into account the sex-specific employment rates and the average income tax

Table 2
Treatment costs of some smoking related diseases (expressed in 2010 USD).

	Cost per case	References	Notes
Lung cancer	11,850	Edis and Karlikaya [31]	–
COPD	3068	Hacettepe Universitesi [32–35]	Per exacerbation. Estimated number of exacerbations = Expected number of cases × 0.4596 (the share of Level II patients) × 0.0807 (the share of Level III and IV patients, using data in [34]) × 2 (the median number of exacerbations using data in [35]
CVD	1923	Hacettepe Universitesi [32,33]	Average of the per-case treatment costs of unstable angina and myocardial enfarction
Stroke	4213	Hacettepe Universitesi [32,33]	–

rate to estimate the amount of taxes that could have been collected. Employment rate for women is 22.3% and for men 60.7% (TURKSTAT [36]); average gross earnings by sex and age group are from TURKSTAT [37]. Multiplying the calculated income loss by the average income tax rate of 20% (from [38]), we calculate the expected loss of the public sector.

2.6.3. Productivity loss due to absenteeism of smokers and non-smokers

Studies have shown that absenteeism and work related accidents are more common among smokers than non-smokers. Tsai et al. [39,Table 1] report that absenteeism among male (female) smokers is 1.06 (1.21) days higher compared to non-smokers. We estimate total productivity loss by multiplying the estimated sex-specific additional number of annual absent days among smokers relative to non-smokers, by the sex-specific employment rates and by the average employment cost per day.

We know that ETS can be as damaging as occasional smoking. Tsai et al. [39,Table 3] reports that sick days among ETS exposed male (female) non-smokers is 0.79 (0.96) days higher compared to those who are not exposed to ETS. We estimate total productivity loss by multiplying the estimated sex-specific additional number of sick days among non-smokers exposed to ETS relative to those who are not exposed to ETS, by the sex-specific employment rates and by the average employment cost per day.

In both cases, tax loss of the public sector is estimated by multiplying the productivity loss by the average income tax rate of 20% ([38]).

2.6.4. Tax revenues from cigarette sales

Average cigarette consumption is based on total consumption data from Cigarette and Health National Committee of Turkey [40] and our estimate of the number of smokers. The average price of cigarettes, 5.30 TL (3.41 USD) per pack in 2010 prices, is from TURKSTAT [41]. On average, in 2011, 78.7% of the retail price of a pack of cigarettes is tax, made up of 63.4% SCT and 15.3% VAT [42]. To calculate the estimated tax revenue, we multiply the estimated number of smokers by the average per smoker consumption, by average price of cigarettes and by the average tax rate in each year.

2.6.5. Costs of implementing tobacco elimination policies

We assume that changing the tax rate is costless and that the tax elasticity of cigarette prices is 100%, i.e., any change in the tax rate affects the price at the same rate. The costs and success rates of intervention programs (assumed to be the same for both Plans II and III) are in Table 3. Given the number of years to administer the program, we estimate the expected number of quitters in each campaign year for each intervention program by multiplying the number of participants of the program with its success (quit) rate. We multiply the expected number of quitters with the 1-year per-quitter cost to calculate the discounted sum of implementation costs over the campaign period.

3. Results

3.1. Effects of elimination programs on smoking, smoking related diseases and deaths

The results in Table 4 show that the average smoking prevalence over the period 2012–2050 can be reduced from its 2011 level of 0.3062 to as low as 0.1835 by Class-20. Looking at average smoking prevalence over the entire simulation period, Plan I is dominated only by Class-20.

Results in Table 4 also show that all three plans lead to significant reductions in the expected occurrences of smoking related diseases and deaths. However, the intervention programs Class-20, Contest-20, Self-Help-20, and Class-30 are found to perform better than Plan I over the entire period. Another observation is that each intervention program performs better when the termination horizon is shorter (compare Plan II to Plan III), since shorter programs induce earlier and sharper reductions in smoking prevalence.

3.2. Welfare effects of a tax increase in 2012

The results in Table 5 show that public cost, net social cost and cigarette consumption are decreasing in tax rate. The relationship observed between net public benefit and the tax rate on cigarettes deserves a note. Net public benefit is positive only for tax rates between 42.9% and 91.1%. In fact, between these two values, the relationship between net public benefit and tax rates is a single-hump shaped Laffer curve. This means that there is a tax rate that maximizes net public benefit. For the status quo in Turkey where the tax rate is 78.7%, net public benefit over the period

Table 3
Costs and success rates of intervention programs.

	Per-quitter cost (in 2011 USD)	Success rate	References	Notes
'Class'	698.64	35%	Altman et al. [24]	Adjusted using the total inflation rate of 153.13% between 1981 and 2011 [43]
'Contest'	382.23	22%	Altman et al. [24]	Same as above
'Self-Help'	126.57	21%	Altman et al. [24]	Same as above
'Awareness'	1631	6.4%	Stevens et al. [25]	Adjusting for the total UK inflation rate of 27.67% during 1998–2011 [44]

2012–2050 is a strikingly high figure yet found to be suboptimal. Net public benefit reaches its maximum at the tax rate of 84.6%, which, if implemented, would imply a drastic increase of the SCT from its current level of 63.4% to 69.3%. We should notice that cigarette consumption drops to 165,763 million packages at 84.6% tax rate.

The limiting tax rate of 91.5% completely eliminates cigarette consumption starting from 2012 onwards, and minimizes net social cost. With zero consumption, costs for the households and the public sector are still positive due to illnesses and deaths of quitters. At 91.5% tax rate, the increase in the average price with respect to its 2011 level is by 149.3%. With such an elimination policy, net social cost falls substantially, but the reduction in net household cost is even greater. While the greater part of this drastic reduction would result from the saved taxes on unconsumed cigarettes, reductions in the expenditures for illness and premature death of smokers due to smoking, which are 27% and 23% respectively, are also noteworthy.

3.3. *Welfare effects of smoking intervention programs combined with taxation*

We estimate costs and benefits for Plans II and III under four alternative intervention programs. Our simulation results (Table 6) show that for each tax-combined intervention program, households and the society at large would prefer Plan II, while the public sector would prefer Plan III. This result is not surprising since tax revenues on cigarettes obtained by the public sector in each additional year prior to ending intervention exceed by far the public costs due to smoking.

A second finding is that for each intervention horizon, net estimated costs for both the households and the society (rows 7 and 8 in Table 6) are increasing in the order of Class, Contest, Self-Help, and Awareness; thus 'Class', which has the highest smoking quit rate, turns out to be the most effective intervention program for both the households and the society. Interestingly, this is so despite the fact that the Class program has a higher implementation cost. On the other hand, the ranking of the intervention programs with respect to the produced net public benefits is the reverse (row 6, Table 6). As expected, net costs to the households of alternative programs are aligned with their success rates. We should mention that the discounted operating costs of tax-combined intervention programs are not high (about 0.2–0.6% of 2010 Turkish GDP). For comparison, total health expenditures were about 5.9% of GDP in 2010.

Compared to status quo, the reduction achieved by the intervention programs in net social cost is between 9% and 27%. While Plan I leads to a higher reduction (30%) in net social cost than all intervention programs, it is not clear whether this option could be chosen by the public sector, since it generates negative net public benefit. It is because public benefit (tax revenues from cigarette sales) becomes zero, while public cost is still positive (there are publicly financed expenditures for illnesses of quitters as well as income tax loss from premature death of quitters). The reduction in cigarette consumption is 100% with immediate taxation, which leads to a loss of 443,799 million USD in tax revenues. The reduction with respect to status quo is between 30% and 42% if cigarette consumption is zero starting from 2041 (Plan III) and between 56% and 64% in Plan II. Class-20, the intervention program with the highest smoking quit rate, leads to the highest reduction of cigarette consumption (64%).

4. Discussion

The aim of this study is to compare several non-prohibitory policy alternatives that governments in Turkey can use to eliminate smoking. In terms of net monetary benefits immediate taxation is better for the households, whereas Plans II and III are better for the public sector as they yield higher tax revenues. We should note that the tax rate required to end smoking immediately in Turkey is not unrealistically high. The current rate is the 16th highest in the EU [45]. The same rate applies in the Netherlands, where the average retail price of a pack of cigarettes is 6.36 USD (4.73 €), nearly twice the price in Turkey. It is interesting to also note that the limit tax rate (91.5%) is close to the current rate in the UK (90.14%), where the average price of cigarettes is 8.42 USD (5.44 £) and smoking prevalence is around 21% [45].

While concern about tobacco use has been shared in the last two decades by many countries including Turkey, Finland, a country with a smoking prevalence around 21%, became the first in 2010 to declare elimination of smoking in 30 years as a legal target. We believe that with the predicted increase in health costs due to tobacco use [2], more countries will consider the target of total elimination of smoking through strict bans or other policies. In this regard, our study provides to policy makers, especially to those in the developing countries with large numbers of smokers, a useful example of economic assessment of alternative interventions to eliminate tobacco use. While the effectiveness of tax increases is well known in the literature, our study shows under what conditions taxation is superior to cessation programs.

Table 4
Smoking prevalence, and the number of new cases of illnesses and deaths due to smoking.

	Period	Status Quo	Plan I: immediate taxation (tax rate = 91.5%)	Plan II (19 years of intervention followed by tax)				Plan III (29 years of intervention followed by tax)			
				Class-20	Contest-20	Self-Help-20	Awareness-20	Class-30	Contest-30	Self-Help-30	Awareness-30
Average smoking prevalence (2011 figure = 0.3062)	2012–2031	0.2997	0.2102	0.2361	0.2590	0.2608	0.2851	0.2577	0.2745	0.2757	0.2927
	2032–2041	0.2857	0.2004	0.1303	0.1563	0.1584	0.1876	0.1907	0.2234	0.2259	0.2618
	2042–2050	0.2755	0.1932	0.1256	0.1507	0.1527	0.1809	0.1256	0.1507	0.1527	0.1809
	All years	0.2905	0.2038	0.1835	0.2077	0.2096	0.2360	0.2100	0.2328	0.2345	0.2590
Total number of new cases of lung cancer	2012–2031	359,956	306,341	314,926	329,663	330,766	346,464	332,662	343,522	344,318	355,385
	2032–2041	260,495	222,706	191,625	203,169	204,057	217,023	217,892	232,409	233,514	249,469
	2042–2050	283,251	242,925	209,757	222,077	223,025	236,860	209,757	222,077	223,025	236,860
	All years	903,702	771,973	716,308	754,909	757,848	800,347	760,311	798,009	800,856	841,714
Total number of new cases of COPD	2012–2031	540,840	508,771	507,915	516,695	517,353	526,702	524,591	531,058	531,531	538,120
	2032–2041	385,706	363,770	345,728	352,429	352,945	360,471	361,006	369,432	370,073	379,333
	2042–2050	415,106	392,216	373,388	380,381	380,919	388,773	373,388	380,381	380,919	388,773
	All years	1,341,653	1,264,756	1,227,030	1,249,506	1,251,216	1,275,946	1,258,986	1,280,872	1,282,524	1,306,225
Total number of new cases of CVD	2012–2031	1,695,280	1,424,705	1,475,082	1,548,424	1,553,911	1,631,919	1,559,872	1,613,789	1,617,735	1,672,674
	2032–2041	1,102,016	931,602	791,437	843,498	847,503	905,972	910,836	976,265	981,242	1,053,117
	2042–2050	1,103,973	937,869	801,248	851,993	855,896	912,887	801,248	851,993	855,896	912,887
	All years	3,901,269	3,294,176	3,067,767	3,243,915	3,257,310	3,450,777	3,271,956	3,442,047	3,454,873	3,638,628
Total number of new cases of stroke	2012–2031	5,478,561	3,963,828	4,307,251	4,720,918	4,751,878	5,192,210	4,713,524	5,018,037	5,040,326	5,350,497
	2032–2041	3,668,944	2,654,365	1,819,874	2,129,828	2,153,670	2,501,772	2,527,582	2,917,948	2,946,893	3,375,062
	2042–2050	3,765,925	2,724,412	1,867,767	2,185,949	2,210,425	2,567,768	1,867,767	2,185,949	2,210,425	2,567,768
	All years	12,913,430	9,342,605	7,994,891	9,036,695	9,115,973	10,261,750	9,108,873	10,121,234	10,197,644	11,293,327
Total number of deaths due lung cancer	2012–2031	325,855	277,605	285,232	298,508	299,501	313,643	301,262	311,047	311,764	321,736
	2032–2041	237,547	203,283	175,101	185,569	186,374	198,130	198,906	212,070	213,071	227,539
	2042–2050	259,607	222,844	192,607	203,838	204,702	217,315	192,607	203,838	204,702	217,315
	All years	823,009	703,732	652,941	687,915	690,578	729,089	692,776	726,955	729,537	766,590
Total number of deaths due COPD	2012–2031	477,451	446,971	447,486	455,752	456,370	465,163	462,188	468,265	468,710	474,897
	2032–2041	312,796	293,508	277,644	283,536	283,990	290,607	291,153	298,558	299,122	307,257
	2042–2050	315,406	296,527	280,999	286,766	287,210	293,688	280,999	286,766	287,210	293,688
	All years	1,105,653	1,037,006	1,006,129	1,026,055	1,027,570	1,049,458	1,034,340	1,053,590	1,055,042	1,075,842
Total number of deaths due CVD	2012–2031	541,377	443,009	463,218	489,766	491,752	519,976	492,413	511,914	513,341	533,188
	2032–2041	336,238	276,628	227,599	245,810	247,211	267,663	269,487	292,369	294,109	319,241
	2042–2050	323,621	267,558	221,447	238,574	239,892	259,127	221,447	238,574	239,892	259,127
	All years	1,201,237	987,196	912,264	974,151	978,855	1,046,765	983,347	1,042,857	1,047,342	1,111,555
Total number of deaths due stroke	2012–2031	1,189,121	861,042	932,711	1,023,000	1,029,760	1,125,948	1,021,849	1,088,404	1,093,277	1,161,106
	2032–2041	845,604	612,212	420,247	491,549	497,033	577,110	582,379	672,045	678,867	777,416
	2042–2050	908,202	657,474	451,252	527,848	533,740	619,765	451,251	527,848	533,740	619,765
	All years	2,942,927	2,130,729	1,804,209	2,042,397	2,060,534	2,322,823	2,055,479	2,288,296	2,305,884	2,558,287

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Table 5
Costs and benefits under different tax rates on cigarettes (million USD).

	Tax rate on cigarettes (%)											
	15.3	25.3	35.3	42.9	50.0	60.0	70.0	78.7	80.0	84.6	91.1	91.5
(1a) Expenditures for illness of smokers due to smoking	62,550	62,254	61,867	61,481	61,017	60,081	58,522	55,974	55,403	52,635	43,780	42,863
(1a′) Publicly financed expenditures for illness of smokers due to smoking	52,542	52,293	51,968	51,644	51,254	50,468	49,158	47,018	46,539	44,213	36,775	36,005
(1b) Income loss from premature death of smokers due to smoking	324,998	323,668	321,925	320,188	318,099	313,889	306,871	295,407	292,837	280,378	240,530	236,402
(1b′) Income tax loss from premature death of smokers due to smoking	65,000	64,734	64,385	64,038	63,620	62,778	61,374	59,081	58,567	56,076	48,106	47,280
(2) Productivity loss due to absenteeism	65,149	64,502	63,647	62,782	61,728	59,553	55,766	49,096	47,510	39,279	4613	0
(2′) Income tax loss associated with productivity loss due to absenteeism	13,030	12,900	12,729	12,556	12,346	11,911	11,153	9819	9502	7856	923	0
(3) Cost of tobacco elimination policies	0	0	0	0	0	0	0	0	0	0	0	0
(4) Tax revenues from cigarette sales	32,578	60,165	94,986	128,238	166,307	236,604	334,720	443,799	459,530	490,534	85,803	0
(5) Public cost	130,571	129,927	129,083	128,238	127,219	125,156	121,686	115,919	114,608	108,145	85,804	83,285
(6) Net public benefit	−97,993	−69,762	−34,097	0	39,087	111,448	213,034	327,880	344,922	382,390	0	−83,285
(7) Net household cost	354,704	380,662	413,342	444,452	479,931	544,970	634,193	728,358	740,672	754,681	288,922	195,980
(8) Net social cost	452,697	450,424	447,439	444,452	440,844	433,522	421,159	400,477	395,750	372,292	288,922	279,265
(9) Cigarette consumption (million packages)	333,956	328,939	322,372	315,825	307,949	292,079	265,628	222,413	212,727	165,763	15,558	0

Notes: (1a′) = 0.84 × (1a); (1b′) = 0.20 × (1b); (2′) = 0.20 × (2); (5) = (1a′) + (1b′) + (2′) + (3); (6) = (4) – (5); (7) = (1a) – (1a′) + (1b) – (1b′) + (2) – (2′) + (4); (8) = (7) – (6).

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Table 6
Costs and benefits of alternative elimination policies (million USD).

	Status Quo	Plan I: immediate taxation (tax rate = 91.5%)	Plan II (19 years of intervention followed by tax)				Plan III (29 years of intervention followed by tax)			
			Class-20	Contest-20	Self-Help-20	Awareness-20	Class-30	Contest-30	Self-Help-30	Awareness-30
(1a) Expenditures for illness of smokers due to smoking	55,974	42,863	39,043	42,777	43,060	47,147	43,232	46,782	47,049	50,868
(1a′) Publicly financed expenditures for illness of smokers due to smoking	47,018	36,005	32,796	35,932	36,170	39,603	36,315	39,297	39,521	42,729
(1b) Income loss from premature death of smokers due to smoking	295,407	236,402	222,343	238,894	240,148	258,208	241,681	257,174	258,337	274,935
(1b′) Income tax loss from premature death of smokers due to smoking	59,081	47,280	44,469	47,779	48,030	51,642	48,336	51,435	51,667	54,987
(2) Productivity loss due to absenteeism	49,096	0	24,707	24,916	24,932	25,152	36,929	37,229	37,251	37,567
(2′) Income tax loss associated with productivity loss due to absenteeism	9,819	0	4941	4983	4986	5030	7386	7446	7450	7513
(3) Cost of tobacco elimination policies	0	0	4261	1470	465	1830	4426	1528	483	1903
(4) Tax revenues from cigarette sales	443,799	0	188,737	206,407	207,723	226,348	280,384	305,677	307,559	334,157
(5) Public cost	115,919	83,285	86,467	90,164	89,651	98,105	96,463	99,705	99,122	107,133
(6) Net public benefit	327,880	−83,285	102,269	116,243	118,071	128,243	183,921	205,972	208,437	227,024
(7) Net household cost	728,358	195,980	392,624	424,299	426,677	460,580	510,189	548,685	551,557	592,298
(8) Net social cost	400,477	279,265	290,354	308,057	308,605	332,337	326,268	342,712	343,120	365,274
(9) Cigarette consumption (2012–2030) (million packages)	101,458	0	80,942	88,897	89,490	97,902	87,348	92,989	93,400	99,110
(10) Cigarette consumption (2031–2040) (million packages)	59,665	0	0	0	0	0	41,477	48,366	48,889	56,418
(11) Cigarette consumption (2041–2050) (million packages)	61,291	0	0	0	0	0	0	0	0	0

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In comparison to previous studies on tobacco control in many countries including Turkey, our study takes a different path with regard to employed methodology. Instead of individual level expenditure data, our estimates are based on more meso-level variables. We conduct a more detailed analysis using variables such as the estimated incidence and mortality rates of smoking related diseases, the projected numbers of smokers and quitters and the predicted days of absenteeism from work.

Another novelty of our study is that we compare policy options over a long time frame, which enables us to incorporate the long-run effects of the demographic change in Turkey. This dynamic approach can be used in future research on the economics of tobacco control/elimination policies in other developing countries with different demographic trajectories. Besides, the estimation method we suggest in Section 2.3 can be used to study the cases in other developing countries where incidence and mortality rate data differentiated by smoking status are not available.

There are some limitations: in EXBA approach we followed, we ignore smokers' benefits in the form of reductions in expenditures for social insurance and medical expenditures that result from smoking. Due to lack of data, our study also omits some cost items in [26] (that can be argued to be of small magnitudes though), such as expenditures and tax losses of nonsmokers from illness and premature death of smokers due to smoking, producer tax revenues (that are not paid by smokers), net expenditures due to environmental pollution from tobacco production. Another limitation is that we assume intervention programs do not reduce the average cigarette consumption (as well as illness, mortality, and absenteeism) of non-quitters among participants, as there are no reported estimates of these effects in the literature. So, our results may underestimate the potential benefits of interventions to the public sector and the society. But, as a balancing argument, we are also likely to underestimate the costs of operating countrywide cessation programs by simply replicating small community-based programs, assuming away resource constraints and technical challenges. In fact, because of such constraints and challenges to implementation, we do not consider shorter horizons (such as 5 or 10 years) to eliminate smoking in Turkey.

In addition, the applicability of some interventions is disputable. For instance, Class-20, which we find to be the most successful program, assumes that on average 917,215 smokers per year attend classes. Obviously, voluntary participation of such a large number of smokers would require very effective persuasion. More research in needed on designing and implementing countrywide interventions and on collaboration with the public health authority.

Unlike intervention programs, the taxation option is implementable instantly. However, one limitation is vulnerability to tax evasion via unregistered sales. Another consequence might be the increase of smuggling or even the emergence of black market or self-production to substitute for the legal market. However, studies show that the correlation between smuggling and cigarette prices is low in many countries (for example [46]). A further concern is that cigarette taxes, like other consumption taxes, are regressive; they constitute a higher share of the incomes of poorer households. However, in the long run the health benefits to the poor may easily overcome the costs imposed due to a price increase. Finally, one can argue that tobacco elimination policies result in permanent job losses. But, it is also true that income saved on smoking will be spent by households on other goods generating alternative job opportunities.

5. Conclusions

The demographic transition in Turkey is predicted to generate a rapid increase in the number of smokers in the next four decades. Simulations of the costs and benefits of various smoking elimination policies show that ending tobacco use by the immediate increase in the tax rate on cigarettes yields lower costs to households and society than the tax-combined cessation programs (with 20 or 30 years to elimination) whose success (quitting) rates range from 6.4% to 22%. However, while both immediate taxation and intervention programs are estimated to yield significant reductions in the expected frequency of smoking related diseases and deaths, shorter-horizon intervention programs are more effective. In particular, a class-based intervention that has an elimination horizon of 20 years and a quitting rate as high as 35%, yields on average the lowest smoking prevalence over the next 40 years in Turkey than all other elimination programs, including immediate taxation, would do.

Competing interests

None.

Appendix A. Incidence and mortality rates by sex, age group and smoking status: estimation method

Let us define a through f as the number of people by smoking status in a particular sex–age group, as in the table below. What we need to know is the shares of a, c and e in the population, which give us the incidence or mortality rates for age and sex-groups differentiated by smoking status.

	Current smokers	Quitters	Never smokers
Number of new cases/deaths	a	c	e
Number of healthy people	b	d	f

What we know are the numerical values of:

- Hazard ratio of smokers $(a/(a+b))/(e/(e+f))$ and of quitters $(c/(c+d))/(e/(e+f))$, (Thun et al. [27]),
- Within each sex-age group, $(a+b)/(e+f)$, $(c+d)/(e+f)$ and $a+c+e$ (based on the estimated number of smokers, quitters, never smokers, and the number of new cases and deaths).

Knowing these, we calculate a, c and e. Incidence/mortality rates by sex, age and smoking status groups are estimated by dividing a, c and e by the population in the corresponding sex, age and smoking status groups.

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