THE HEALTH CARE COSTS OF SMOKING

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ABSTRACT

Background Although smoking cessation is desirable from a public health perspective, its consequences with respect to health care costs are still debated. Smokers have more disease than nonsmokers, but nonsmokers live longer and can incur more health costs at advanced ages. We analyzed health care costs for smokers and nonsmokers and estimated the economic consequences of smoking cessation.

Methods We used three life tables to examine the effect of smoking on health care costs — one for a mixed population of smokers and nonsmokers, one for a population of smokers, and one for a population of nonsmokers. We also used a dynamic method to estimate the effects of smoking cessation on health care costs over time.

Results Health care costs for smokers at a given age are as much as 40 percent higher than those for nonsmokers, but in a population in which no one smoked the costs would be 7 percent higher among men and 4 percent higher among women than the costs in the current mixed population of smokers and nonsmokers. If all smokers quit, health care costs would be lower at first, but after 15 years they would become higher than at present. In the long term, complete smoking cessation would produce a net increase in health care costs, but it could still be seen as economically favorable under reasonable assumptions of discount rate and evaluation period.

Conclusions If people stopped smoking, there would be a savings in health care costs, but only in the short term. Eventually, smoking cessation would lead to increased health care costs. (N Engl J Med 1997;337:1052-7.)

SMOKING is a major health hazard, and since nonsmokers are healthier than smokers, it seems only natural that not smoking would save money spent on health care. Yet in economic studies of health care it has been difficult to determine who uses more dollars — smokers, who tend to suffer more from a large variety of diseases, or nonsmokers, who can accumulate more health care costs because they live longer. The Surgeon General reported in 1992 that "the estimated average lifetime medical costs for a smoker exceed those for a nonsmoker by more than $6,000."[1] On the other hand, Lippiatt estimated that a 1 percent decline in cigarette sales increases costs for medical care by $405 million among persons 25 to 79 years old.[2] Manning et al. argued that although smokers incur higher medical costs, these are balanced by tobacco taxes and by smokers' shorter life spans (and hence their lower use of pensions and nursing homes).[3] Leu and Schaub showed that even when only health care expenditures are considered, the longer life expectancy of nonsmokers more than offsets their lower annual expenditures.[4]

We have analyzed comprehensively the health care costs of smoking. In doing so we have distinguished between the assessment of differences between smokers and nonsmokers and the assessment of what would happen after interventions that changed smoking behavior. Would a nonsmoking population have lower health care costs than one in which some people smoke? Are antismoking interventions economically attractive? We sought to answer these questions and to determine the consequences for health policy.

METHODS

Analysis of Smokers and Nonsmokers

We examined the effect of smoking in the general population (a mixture of smokers and nonsmokers). We studied the incidence, prevalence, and mortality associated with five major categories of disease — heart disease, stroke, lung cancer, a heterogeneous group of other cancers, and chronic obstructive pulmonary disease (COPD). We used data on these diseases, in addition to mortality from all other causes, in an extension of the standard life table, the multistate life table, that includes multiple health states, such as "alive, healthy" and "alive, with heart disease."[5,6]

Differences in the frequency of the smoking-related diseases between smokers and nonsmokers are commonly expressed as rate ratios. Using these rate ratios, the prevalence of smoking in the population, and the age- and sex-specific incidence of the smoking-related diseases in the mixed population of smokers and nonsmokers, we can estimate the incidence of the diseases separately among smokers and nonsmokers.[6]

Assuming that the relative survival of persons with these diseases is the same among both smokers and nonsmokers, two additional life tables can be calculated — one for smokers and one for nonsmokers. The three life tables differ with regard to the incidence of the smoking-related diseases and therefore in their associated prevalence, disease-specific mortality, and overall mortality. Because of the difference in mortality, more people remain alive in the life table for nonsmokers than in the table for smokers, particularly in the older age groups, and there are corresponding differences in life expectancies.

In constructing the life tables, we used epidemiologic data on the incidence and prevalence of the diseases,[7-10] data on mortality from Statistics Netherlands,[11] data on smoking (Table 1),[12] and rate ratios from an overview of the literature.[13] We tested the sen-

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sitivity of the analysis by recalculating the life tables with excess risks (the rate ratio − 1) that were 50 percent higher and 50 percent lower (Table 2).

The medical costs we used were based on a study that allocated the total costs for health care in the Netherlands in 1988 (39.8 billion guilders, or $19.9 billion, at the present exchange rate) to categories of age, sex, and disease.[14] We used the Dutch population in 1988 and the prevalence rates of the smoking-related diseases from the life table for mixed smokers and nonsmokers to estimate the costs per case of disease according to age and sex. The remaining costs were assigned to "per capita costs for all other diseases" (in categories according to age and sex) by dividing the costs by the number of people in the category in question. Using the per capita costs for each disease and the "all other disease" costs, we calculated the health care costs for the populations included in the three life tables.

Assessment of the Effect of Complete Smoking Cessation

The estimated health care cost derived from the life table of nonsmokers can be seen as an estimate of the cost of health care if no one ever smoked. It does not provide an estimate of the health care cost if all smokers stopped smoking. In the latter case, the size of the elderly population would initially be the same as in the mixed population of smokers and nonsmokers. For it to become similar in size to the elderly population among nonsmokers, in which more elderly people are alive, would take several years, even if mortality declined rapidly.

To describe the epidemiologic changes and the changes in the population over time, a dynamic model is needed. For this purpose, we needed a series of linked life tables, one for each point in time, with the population at a given age (a) and time (t) depending on the population at age $a-1$ and time $t-1$, and on the incidence of disease and the associated mortality between $t-1$ and t. We used the Prevent Plus computer program, which is designed to evaluate interventions concerning risk factors dynamically.[6,15]

This dynamic analysis produces a projection of future health care costs. To assess the economic attractiveness of an intervention that would make smokers quit, these costs are compared with those expected when no intervention is made. One difficulty in such an evaluation is the fact that most people prefer to receive benefits as soon as possible and to postpone payments. Economists call this phenomenon "time preference,"[16,17] and it is taken into account by discounting the future benefits and costs — that is, those further away in time are given lower weights in the overall evaluation.

The degree of time preference is expressed in the discount rate. Typical values range from 0 to 10 percent, with 0 percent meaning that there is no discounting and no time preference and 10 percent meaning that there is a strong time preference. Since there is no generally agreed-upon discount rate, we used various rates (0, 3, 5 and 10 percent) in evaluating the intervention.

A second difficulty in evaluating future costs and benefits is deciding how far into the future the analysis should go. There is no generally agreed-upon duration of follow-up in this type of analysis. For each projection of discounted costs and benefits, we therefore report the duration of follow-up at which the benefits and costs expected in the future exactly balance each other (the break-even year) — the point at which carrying out the intervention is neither more nor less economically attractive than not doing so.

RESULTS

Figure 1 shows the annual per capita health care costs for male smokers and nonsmokers 40 to 89 years old, in 5-year age groups (the costs for women in the same age groups are very similar). Per capita costs rise sharply with age, increasing almost 10 times from persons 40 to 44 years of age to those 85 to 89 years of age. In each age group, smokers incur higher costs than nonsmokers. The difference varies with the age group, but among 65-to-74-year-olds the costs for smokers are as much as 40 percent higher among men and as much as 25 percent higher among women.

However, the annual cost per capita ignores the differences in longevity between smokers and nonsmokers. These differences are substantial: for smokers, the life expectancies at birth are 69.7 years in men and 75.6 years in women; for nonsmokers, the life expectancies are 77.0 and 81.6 years (these life-table estimates agree very well with the empirical findings of Doll et al.[18]). This means that many more nonsmokers than smokers live to old age. At age 70, 78 percent of male nonsmokers are still alive, as compared with only 57 percent of smokers (among women, the figures are 86 percent and 75 percent); at age 80, men's

Table 1. Prevalence of Smoking.*

Age (yr)	Smokers: Male	Smokers: Female
	percent	
0–14	0	0
15–19	20	20
20–34	39	37
35–49	42	36
50–64	39	27
≥65	34	13

*Data are averages for 1988–1992 in the Netherlands.[12]

Table 2. Rate Ratios and Sensitivity Ranges Associated with Five Categories of Disease.

Category	Rate Ratio (Sensitivity Range)*
Heart	3 (2–4)
Lung cancer	10 (5.5–14.5)
Stroke	2 (1.5–2.5)
Other cancers†	2 (1.5–2.5)
COPD‡	25 (13–37)

*Rate ratios refer to the rate of the disease in smokers as compared with nonsmokers. The lower and upper bounds of the sensitivity range were calculated as 1+0.5(RR−1) and 1+1.5(RR−1), respectively, where RR denotes the rate ratio.

†This category includes neoplasms except for stomach, colorectal, lung, breast, prostate, and skin cancers, and benign tumors.

‡COPD denotes chronic obstructive pulmonary disease.

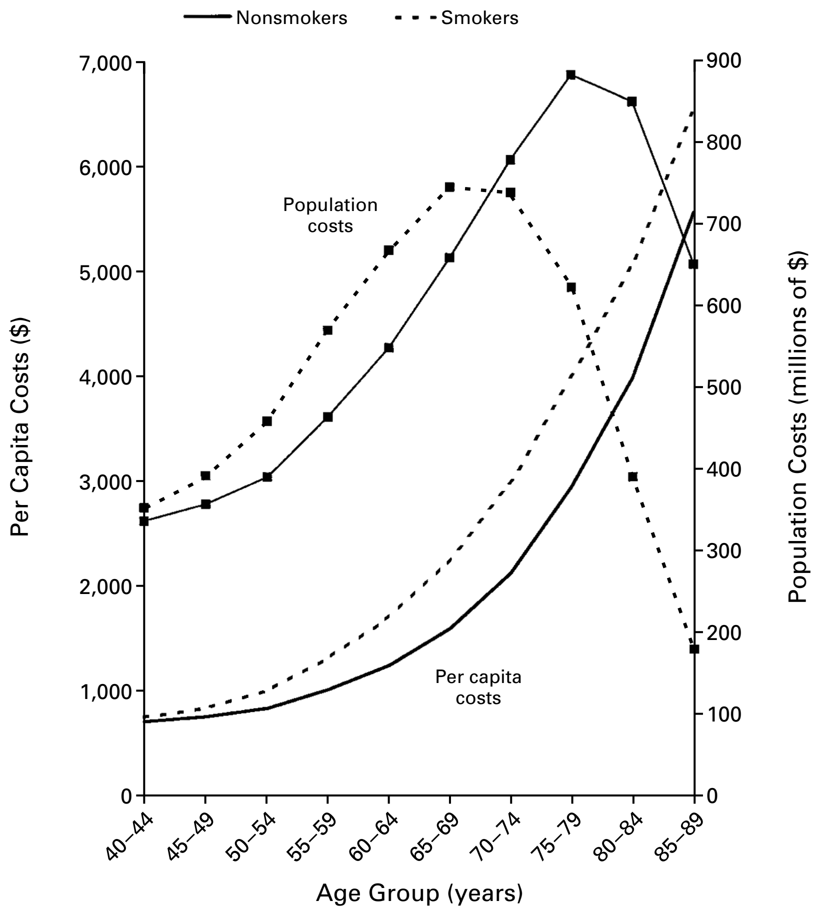

Figure 1. Estimated Annual per Capita Health Care Costs for Dutch Men in 1988 and for the Male Population in a Life Table, According to Age and Smoking Status.

Per capita health care costs for women in the same age groups are very similar to those for men.

survival is 50 percent and 21 percent, respectively (among women, 67 percent and 43 percent).

These differences in the numbers of elderly people have a profound effect on the health care costs for the population, as Figure 1 shows. In the younger age groups, in which mortality even among smokers is quite low, a population of smokers has higher health care costs than a population of nonsmokers, but in the groups of men 70 to 74 and over (and those of women 75 to 79 and over), the lower per capita cost of the nonsmokers is outweighed by the greater number of people remaining alive.

As Figure 1 shows, the nonsmoking population as a whole is more expensive than the smoking population. The area between the curves in which the smokers have higher health care costs than the nonsmokers is smaller than the area between the curves in which the nonsmokers have higher health care costs than the smokers. This is shown in greater detail in Table 3, where the total health care costs for the mixed, the smoking, and the nonsmoking populations are presented according to disease category.

All the smoking-related diseases (with the notable exception of stroke among men) are associated with higher costs in a population of smokers and lower costs in a population of nonsmokers. This relation is particularly strong for the diseases with the highest excess risk: lung cancer and COPD. However, in the mixed population of smokers and nonsmokers, smoking-related diseases account for only 19 percent of total costs among men and 12 percent of total costs among women, and the costs of all the other diseases have precisely the opposite relation. In a population of smokers, the costs associated with all the other diseases are less than those in the mixed population: 14 percent less for men and 18 percent less for women. Among nonsmokers, the costs of all the other diseases are 15 percent higher for men and 7 percent higher for women.

The risk of the diseases not related to smoking is considered equal for smokers and nonsmokers, but the nonsmoking population lives longer and therefore incurs more costs due to those diseases, particularly in old age, when the costs are highest. On balance, the total costs for male and female nonsmokers are 7 percent and 4 percent higher, respectively, than for a mixed population, whereas for smokers the total costs are 7 percent and 11 percent lower.

Table 3 also shows that changing the assumptions about the excess risk associated with smoking-related diseases by as much as 50 percent in either direction does not change the conclusion, except in the case of stroke. The age-related increase in incidence is steepest for stroke, and there is also an age-related increase for stroke in the cost per case; therefore the health care costs associated with stroke are the most sensitive to changes in life expectancy.

Because of the costs of other diseases, the population of nonsmokers has higher health care costs, partly because these costs increase with age. To test the sensitivity of the analysis to this age-related increase, we recalculated the three life tables, keeping

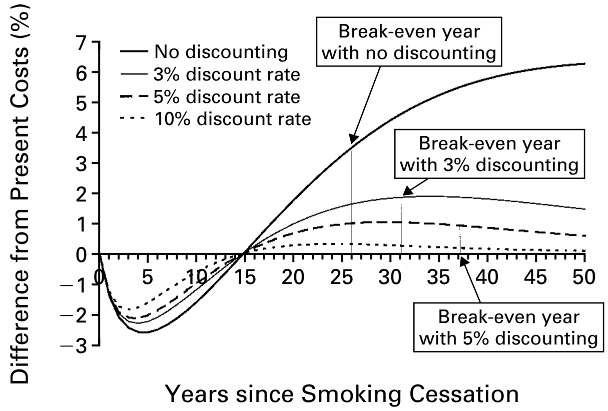

Figure 2. Percent Changes in Total Health Care Costs for the Male Population after Smoking Cessation, as Determined in a Dynamic Analysis, According to the Number of Years since Cessation, with No Discounting and with Three Discount Rates.

The labels show the "break-even" years, when the cost and benefit of the intervention balance each other. Shorter follow-up times make smoking cessation attractive economically, and longer follow-up makes it unattractive. With 10 percent discounting, the break-even year is later than 50 years.

TABLE 3. Health Care Costs for the Three Populations Studied with Life Tables, According to Sex and Disease Category, with the Ratios of the Costs for Smokers and Nonsmokers to Those for the Mixed Population Containing Both.

Sex and Disease Category*	Population			Smokers: Mixed Population	Nonsmokers: Mixed Population
	Mixed	Smokers	Nonsmokers		
	millions of $			cost ratio (sensitivity range)†	
Men					
Heart	525	676	371	1.29 (1.18–1.35)	0.71 (0.84–0.61)
Stroke	416	390	428	0.94 (0.91–0.97)	1.03 (1.06–0.98)
Lung cancer	114	211	33	1.85 (1.76–1.87)	0.29 (0.44–0.22)
Other cancers	226	254	203	1.12 (1.05–1.18)	0.90 (0.97–0.83)
COPD	165	275	23	1.67 (1.72–1.63)	0.14 (0.23–0.11)
All other	6,360	5,463	7,284	0.86 (0.89–0.84)	1.15 (1.09–1.18)
Total	7,806	7,270	8,342	0.93 (0.95–0.92)	1.07 (1.04–1.09)
Women					
Heart	386	538	330	1.39 (1.24–1.48)	0.86 (0.93–0.79)
Stroke	510	571	502	1.12 (1.04–1.19)	0.98 (1.01–0.96)
Lung cancer	23	70	9	3.10 (2.61–3.32)	0.39 (0.55–0.31)
Other cancers	297	387	264	1.30 (1.16–1.42)	0.89 (0.95–0.84)
COPD	102	254	20	2.48 (2.45–2.45)	0.20 (0.31–0.15)
All other	9,358	7,653	10,013	0.82 (0.87–0.79)	1.07 (1.04–1.09)
Total	10,676	9,473	11,138	0.89 (0.92–0.87)	1.04 (1.03–1.05)

*COPD denotes chronic obstructive pulmonary disease.

†The sensitivity range was calculated with the lower and upper bounds of the rate ratios in Table 2. A lower rate ratio reduces the difference between smokers and nonsmokers in the incidence, prevalence, and mortality from smoking-related disease. Therefore, nonsmokers avert fewer cases of smoking-related disease (leading to lower savings) but simultaneously gain less in life expectancy (leading to lower added costs from "other" diseases). For most smoking-related diseases and "other" diseases, lower rate ratios make the difference in costs smaller.

the health care costs associated with "all other disease" at the 65-to-69-year-old level for people over the age of 65. The costs for the mixed population and for the nonsmoking population became virtually the same, and those for the smoking population were still the smallest, albeit by a small margin.

Figure 2 shows what the economic consequences would be if all smokers stopped smoking. After this abrupt change, the total health care costs for men (the "no discounting" curve) would initially be lower than they would have been (by up to 2.5 percent), because the incidence of smoking-related diseases among the former smokers would decline to the level among nonsmokers. Prevalence rates start to decline, costs decline, and the intervention shows a benefit. With time, however, the benefit reverses itself to become a cost. The reason is that along with incidence and prevalence, smoking-related mortality declines and the population starts to age. Growing numbers of people in the older age groups mean higher costs for health care. By year 5, the benefit derived from the presence of the new nonsmokers starts to shrink, and by year 15 these former smokers are producing excess costs. Eventually a new steady state is reached in which costs are about 7 percent higher — the difference between the mixed and the nonsmoking populations.

Figure 2 shows the consequences of discounting the projected costs and benefits by various percentages. It is apparent that discounting, even at a rate as low as 3 percent, has a huge impact, and this impact becomes greater as the costs become more distant in time.

Having all smokers quit becomes economically attractive when the future benefits are larger than the future costs or, in terms of Figure 2, when the area below the x axis is bigger than the area above it. From the figure it is clear that this depends heavily on the duration of follow-up considered and on the discount rate. With a shorter evaluation period and higher discount rates, stopping smoking looks economically more attractive. With a longer evaluation period and lower discount rates, quitting smoking loses its economic advantages. The break-even year, when the initial benefit is exactly balanced by the eventual cost, occurs after 26 years of follow-up when there is no discounting, after 31 years with 3 percent discounting, and after 37 years with 5 percent discounting. At 10 percent discounting, the break-even year occurs after more than 50 years and may not occur at all.

DISCUSSION

This study shows that although per capita health care costs for smokers are higher than those of nonsmokers, a nonsmoking population would have higher health care costs than the current mixed population of smokers and nonsmokers. Yet given a short enough period of follow-up and a high enough discount rate, it would be economically attractive to eliminate smoking.

Some earlier studies have had differing results, partly because many have focused on costs attributable to smoking. From rate ratios and the prevalence of smoking in a population, the proportion of the total number of cases of a disease that can be attributed to smoking — the population attributable risk — can be calculated.[19] Given the costs according to disease, one can calculate the costs attributable to smoking.[20] For instance, in the life-table population of mixed smokers and nonsmokers about 8 percent of total health care costs among men and almost 3 percent of total costs among women can be attributed to smoking. Attributable costs, however, can be interpreted as potential savings only when the diseases do not affect mortality. In the case of most smoking-related diseases, reductions in smoking reduce mortality, creating new possibilities for morbidity from other diseases in the years of life gained.

Other studies of this subject estimate lifetime health care costs, taking the differences in life expectancy into account, and find that smokers have higher medical costs.[3,21,22] In our study, lifetime costs for smokers can be calculated as $72,700 among men and $94,700 among women, and lifetime costs among nonsmokers can be calculated as $83,400 and $111,000, respectively. This amounts to lifetime costs for nonsmokers that are higher by 15 percent among men and 18 percent among women.

The studies cited above apply discounting to the lifetime cost estimate. Because costs incurred at older ages are discounted more, this approach reduces lifetime costs for nonsmokers more than those for smokers. For example, when one applies discounting to our life tables for smokers and nonsmokers, smokers have higher health care costs when the discount rate is at least 4.5 percent in men or at least 5.5 percent in women. We disagree with this approach, however. Discounting should be used for purposes of evaluation and should not be applied in a descriptive context, such as the estimation of lifetime costs.

Our analysis is not very sensitive to substantially different values in the rate ratio. Neither is it very sensitive to the age-related increase in the cost of "all other diseases"; that is, an increase that is less steep in the United States than in the Netherlands will not lead to different conclusions. Including additional smoking-related diseases could change the results only if those diseases generate morbidity and costs without raising the excess risk of mortality. There may be some of these conditions, such as cataracts, but they are unlikely to change outcome. For example, in our data all eye diseases, most of which are not related to smoking, account for about 1 percent of total health care costs.

This study relied on rate ratios from epidemiologic studies to express the differences between smokers and nonsmokers. To the extent that the rate ratios do not describe these differences sufficiently, the results will be affected. For example, the much lower cost for lung cancer among female smokers than among male smokers (Table 3) is hard to explain physiologically. But as long as the smokers have higher rates of lung cancer than the nonsmokers, such shortcomings of the data will not affect the overall conclusions.

The results of this study illustrate the ambiguities in any economic method of evaluation. Even a well-designed study of this type is marred by inevitable arbitrariness concerning what costs to include, which discount rate to apply, and what duration of follow-up to use. There are differences of opinion — on the discounting of lifetime costs, for example, and the evaluation of long-term effects.[23,24] Recent efforts at standardization will remedy some of the arbitrariness,[25-27] but fundamental problems with the method still remain.

Finally, with respect to public health policy, how important are the costs of smoking? Society clearly has an interest in this matter, now that several states are trying to recoup Medicaid expenditures from tobacco firms and the tobacco companies have agreed to a settlement. Yet we believe that in formulating public health policy, whether or not smokers impose a net financial burden ought to be of very limited importance. Public health policy is concerned with health. Smoking is a major health hazard, so the objective of a policy on smoking should be simple and clear: smoking should be discouraged.

Since we as a society are clearly willing to spend money on added years of life and on healthier years, the method of choice in evaluating medical interventions is cost-effectiveness analysis, which yields costs per year of life gained. Decision makers then implement the interventions that yield the highest return in health for the budget.[28] We have no doubt that an effective antismoking policy fits the bill.

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