

Estimation of the Cost of Smoking-Attributable Diseases (Five Selected Diseases): A Case in Kerman City, Iran, 2014

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Original Article

Abstract

Background: Cigarette seems to be the least valuable of addictive drugs. It is easily accessible to the public, and its harmful personal and social effects have attracted less attention. Therefore, the present research was carried out with the aim of presenting cost estimations of smoking-related diseases in smokers who aged 35 or higher in Kerman City, Iran, in 2014.

Methods: Using the prevalence approach, the direct and indirect costs of smoking-attributable diseases including lung cancer, gastric cancer, myocardial infarction, stroke, and chronic obstructive pulmonary disease (COPD) were estimated. The initial data were obtained from the information in documents of medical document units as well as the 2014 income statements of teaching hospitals of Kerman University of Medical Sciences, Kerman City.

Findings: In this research, total economic costs of diseases attributed to smoking were estimated to be 50 million dollars in 2014 in Kerman City, and calculations suggest that this figure accounts for 0.02% of Iran's gross domestic product (GDP). Total direct cost of diseases caused by smoking in Kerman City adds up to 17 million dollars, whereas the estimated indirect cost of diseases caused by smoking is 33 million dollars. The yearly per capita cost of any of the selected five diseases is 270 dollars.

Conclusion: Smoking places a high economic burden on health system and society as a whole. Therefore, stronger intervention measures against smoking should be taken without delay to reduce the health and financial losses caused by smoking.

Keywords: Cost of illness; Smoking; Relative risk; Stroke; Cancer; Chronic obstructive pulmonary disease; Myocardial infarction

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Introduction

Health is an issue closely related to comprehensive progress and development, which also includes economic growth and development. In general, it is said to be a relationship between health and economic growth.¹

Considering the mutual effects of economic growth and development and the concern for hygiene and treatment, optimal allocation of resources to these services is substantially important and necessary.² Barro believes that hygiene is a productive capital asset and the engine of economic growth.³ According to statistical evidence, hygiene and treatment costs account for about 10% to 15% of the gross domestic product (GDP) of developed countries. However, these costs make up about 8% and 1-3% of GDPs of developing and poor countries, respectively.¹ In 2014, share of health costs in Iran's GDP was 5%.⁴

The increased load of chronic diseases is one of the biggest challenges of the twenty first century, which is faced by health systems all over the globe. Only 20% of mortalities caused by chronic diseases occur in high-income countries, whereas the other 80% occur in average and low-income countries. Chronic diseases are constantly growing in low and average-income countries and are imposing heavier economic loads on poor societies. These diseases in poor families cause situations that are more complicated and worse than the disease and poverty.⁵

Epidemicity of smoking is a global problem, and smoking is apparently the least valuable substance among the addictive drugs, which is easily accessible to the public and its personal and social harmful side effects have attracted less attention. According to research results, currently 87%, 82%, and 15%-20% of mortalities are caused by lung cancer, obstructive pulmonary diseases, and other cigarette-induced cancers, respectively. In addition, 25% of mortalities caused by cardiovascular diseases (CVD) are basically triggered by smoking and compulsory inhalation of the smoke.⁶

Accordingly, it could be stated that cigarette smoking contributes to the prevalence of public health problems and preventable mortality. Therefore, cigarette is anticipated to be the main cause of death in 2030.⁷ Two percent of GDP of

countries is lost due to early deaths caused by smoking. Cigarette smoking also has huge negative adverse economic effects.⁵

On account of the World Health Organization (WHO)'s Tobacco Epidemiological Report of 2013, the last poll results suggest that (based on gender and age) the prevalence of cigarette smoking in Iran is 1.5% and 22.1% among men aged 13-15 years and 15-64 years, respectively. The respective prevalence of smoking among women of the same age groups is 0.9% and 1.3%.⁸

Identification of the economic costs of smoking is critically important in reducing the harmful economic and social effects of this immense problem with regard to materialistic issues as well as the loss of time and life of humans.⁹

Since the existing resources are limited and since smoking health care services make up 1% to 1.1% of GDPs of high-income countries as suggested by estimations of the World Bank,⁵ cost estimation of cigarette smoking can result in solutions for reducing these costs and frequency of smoking, which can ultimately improve economic growth and development. Cost estimation of diseases is the simplest way of partial economic evaluation in the field of health. The main objective of this estimation is to measure the economic load imposed by a patient on society. Cost estimation of diseases involves a descriptive study, which can provide information to support political processes as well as management functions on different levels of health care organizations. Disease costs are estimated by identifying costly factors and assigning monetary values to these factors.⁹

Estimation of costs incurred by cigarette smoking in developing countries may reduce the harmful effects of these dangerous substances similar to developed countries. Considering previous research on this issue, so far no study has been carried out on cost estimation of diseases caused by smoking in Iran. Hence, the present research was conducted to estimate costs of selected diseases caused by cigarette smoking in Kerman City, Iran, in 2014.

Methods

In this study, costs incurred by cigarette smoking are divided into two groups of direct and indirect costs.

Direct costs include all of the costs of health

care for smoking-induced diseases. Indirect costs include costs of transportation, food supplements, caregivers, per inpatient hospitalization, mortality and early deaths caused by smoking-attributable diseases.

Using the odds ratio and relative risk (RR) of diseases in society, the direct and indirect costs incurred by cigarette smoking were estimated in Kerman City.

Five cigarette-related diseases include lung cancer, gastric cancer, heart failure (HF), stroke, and chronic obstructive pulmonary disease (COPD), which were selected based on a review of relevant articles.¹⁰⁻¹² 1951 cases were evaluated in 5 selected diseases admitted to Kerman educational hospitals (Shafa, Bahonar, and Afzalipour). Examinations were carried out in the age groups of 35-59 and over 60 years by gender.

Attributable risk: Smoking-attributable fraction (SAF) is calculated using the following formula for the exposure group and the non-exposure group in the age group of concern.^{13,14}

$$SAF = \frac{\sum_{r=1}^n P_{risa}(RR_{risa}-1)}{\sum_{r=1}^n P_{risa}(RR_{risa}-1) + 1} \quad (1)$$

Where, RR_r shows the relative risk for exposure r , P_r stands for prevalence of the exposed factor, and n is the number of exposed groups. Moreover, i denotes disease type, s shows sex (gender), and a stands for age, which was divided into the 35-59 and over 60 years groups.

Direct costs: Direct costs include all of the health care costs incurred by treatment of smoking-induced diseases. These costs were derived from the insurance bills of patients hospitalized in teaching hospitals of Kerman City in 2014.

The costs attributable to smoking were determined for the urban population of the city in two age groups, and calculations were carried out using the following formula by multiplying the corresponding attributable cost of each disease for each gender (sex).

$$SAE_{isa} = [PH_{isa} \times QH_{isa} + PV_{isa} \times QV_{isa} \times 26 + PM_{isa} \times QM_{isa} \times 26] \times POP_{sa} \times SAF_{isa} \quad (2)$$

Where, PH is the average hospitalization costs of patients, and PV shows average cost of each outpatient case. In addition, PM shows average medicine costs per person along with positive

self-treatment costs within 2 weeks (Patients who have been discharged after recovery, are considered to have a positive self-treatment cost). $1/24$ the total cost of the first six months (24 weeks) of patients in 2014 is equal to the average cost of one week. QH shows the average times of hospitalization of each person within 2 weeks, QM shows ratio of patients with positive self-treatment costs within 2 weeks (14 days in 26 equals 364 days, i.e. 1 year), POP shows the 2014 population, and SAF is attributable risk of a smoking-related disease. Finally, i , s , and a also denote disease type, sex group (gender), and age, respectively.

Indirect costs: Indirect smoking-attributable costs including costs of transportation, food supplements, outpatient care, and duration of hospitalization (this information is taken by recorded information or enquiring from the patient/patient companion). These costs are incurred by treatment of related diseases and the lost productivity value caused by smoking. Number of hospitalization days is used instead of labor-induced productivity.

$$SAI_{isa} = [PHI_{isa} \times QH_{isa} + PVI_{isa} \times QV_{isa} \times 26 + IDAY_{isa} \times E_{isa} \times Y] \times POP_{sa} \times SAF_{isa} \quad (3)$$

Where, PHI shows average costs of transportation, food/nutritional supplements, and care providers. In addition, PVI shows average costs of transportation of each outpatient visit, $IDAY$ shows average annual number of hospitalization days to receive treatment, and E is the total employed population ratio. Moreover, Y is daily earnings measured by per capita family.

According to the statistics agency in 2014, the daily income of an urban household (Kerman City) is 9.13 dollars, and other symbols are used similar to formula 1-3.

Mortality indirect costs: Mortality indirect costs incurred by smoking-related diseases were estimated in four steps:

1. Number of deaths caused by smoking (SAD) was estimated by multiplying the attributable risk by the total number of smoking-induced deaths in different age and gender groups.
2. Number of years lost by smoking cigarette (SAYPLL) was calculated by multiplying the number of SAD and average expected life years by death age of age groups.

Table 1. Demographic information of the patients with five smoking-attributable diseases in Kerman City, 2014

Disease	Total number	Gender		Age group (year)		Hospitals		
		Men	Women	35-59	> 60	1	2	3
Lung cancer	92	63	28	31	60	38	-	54
Gastric cancer	102	67	35	62	40	-	44	-
Stroke	650	478	172	266	384	23	589	38
HF	321	218	103	137	184	7	307	7
COPD	786	430	356	292	494	626	-	160

COPD: Chronic obstructive pulmonary disease; HF: Heart failure
 1: Afzalipour Hospital, 2: Shafa Hospital, 3: Shahid Bahonar Hospital

3. Cost of chances lost by smoking (PVLE) was estimated based on the required parameters. In this calculation a 3% discount rate was assumed to calculate the actual cost, and an annual productivity growth rate of 10% was used formula 3.

4. In the end, the cost ratio of smoking-induced mortality (SAMC) was calculated based on PVLE and SAYPLL.

All of the following formulae are based on age group, gender, and disease type classifications.

$$SAD_{isa} = [DRATE_{isa} \times POP_{sa}] \times SAF_{isa} \quad (4)$$

$$SAYPLL_{isa} = SAD_{isa} \times LE_{sa} \quad (5)$$

$$PVLE_{sa} = \sum_{m=a}^{maxa} [SURV_{sa}(m)] [Y \times E_s(m)] \times (1 + g)^{m-a} / (1 + V)^{m-a} \quad (6)$$

$$SAMC_{isa} = SAD_{isa} \times PVLE_{sa} \quad (7)$$

Where, DRATE shows mortality rate in 100 thousand people, LE is the average remaining expected life years at the age of death, and SURV (m) is probability of survival of a person at age m. Moreover, V is the discount rate at the time of death, g shows the work force productivity plus growth rate, Y is the household's per capita income, E (m) is ratio of population at age m (i.e. the population employed in the labor market), and a is the age of death. Other symbols are similar to formula 1 and 10.

Results

Similar to many other developing countries, the Iranian population is currently experiencing substantial changes in its age structure due to the constant and continuous reduction in fertility and increased life expectancy. These changes are associated with important economic and social considerations in terms of economic and social policy making. Due to the changes in population composition, analysis of prevalence of smoking and cost estimation of smoking-attributable diseases are important. So far no study has been carried out in Iran on this topic. Table 1 shows the number of patients with five smoking-attributable diseases (namely lung cancer, gastric cancer, HF, stroke, and COPD) in teaching hospitals of Kerman University of Medical Sciences.

Table 2 presents the RR of smoking-induced diseases. SAF was estimated using equation 1. A review of local articles showed unavailability of information on RR of HF and lung cancer in Iran. Therefore, RR was estimated based on the odds ratio of local articles and using the RR estimation formula for experiment-control studies (formula 1). Since the RR and odds ratio of COPD were not calculated in Iran, the RR estimated by Asian countries was used to estimate the attributable risk.

Table 2. Relative risk (RR) of diseases attributed to smoking in Kerman City, based on gender, age, and disease type among adults aged 35 or more, 2014

Diseases	RR		SAF			
	Men	Women	Age group (year)		Men	Women
			35-59	> 60		
Lung cancer	6.60	3.01	50.40	50.40	2.60	2.60
Gastric cancer	2.32	2.32	20.96	20.96	1.68	1.68
HF	3.65	2.72	34.75	34.75	2.18	2.18
Stroke	1.17	1.17	3.30	3.30	0.22	0.22
COPD	5.60	15.60	48.40	48.40	15.90	15.90

HF: Heart failure; RR: Relative risk; SAF: Attributable risk of a smoking-related disease; COPD: Chronic obstructive pulmonary disease

Table 3. Direct costs (dollars) of diseases attributed to smoking in Kerman City, based on age, gender, and disease type for adults aged 35 or more, 2014

Diseases	Direct costs of diseases attributed to smoking			
	Age group (year)			
	Men		Women	
	35-59	> 60	35-59	> 60
Lung cancer	559522	555056	23401	11416947
Gastric cancer	209233	176076	123333	13385
HF	886301	1699786	5140	26260
Stroke	212168	171888	3839	25
COPD	475501	475430	82221	414959
Total	2342725	3078526	237934	11871576

HF: Heart failure; COPD: Chronic obstructive pulmonary disease
(Iranian currency vs. American dollar based on the 2014 rate of Central Bank of Iran: One dollar equals 26509 Rials)

The attributable risk for women was much lower than men, which could be explained by the low prevalence of smoking among women. Of the selected diseases, lung cancer and COPD posed the highest attributable risks in the order mentioned.

Table 3 shows estimation of direct costs of diseases induced by smoking in 2014 based on disease type, gender, and age group using formula 2. Total direct cost of diseases caused by smoking in 2014 in Kerman City was approximately 17.530.761 dollars. With a total cost of 12.554.926 dollars (72%), lung cancer had the largest share of direct costs. Moreover, 53% of direct costs of the five disease groups were caused by women aged 60 and more.

Table 4 shows indirect costs of smoking-induced diseases. According to the existing findings, lung cancer and HF had the largest shares of indirect costs. In addition, more indirect costs were incurred by men than women, and 76% of indirect costs of smoking-induced diseases belonged to adults aged 60 or more. This could also be explained by the increase in the number of old population.

Table 5 shows estimation of the SAYPLL based on disease, gender, and age group using formula 5. According to this information, men lost more years than women. HF, COPD, and lung cancer had the largest shares of lost years in the order mentioned. Frequency of death was also higher in men than women. Moreover, HF was the first cause of death.

Discussion

The present study was the first research in Iran to carry out a comprehensive cost estimation of smoking-attributable diseases in Kerman City. In this study, 5 diseases attributed to smoking were examined. The highest attributable risks belonged to lung cancer, COPD, HF, gastric cancer, and stroke in the order mentioned. The significant difference between attributable risks in the men and women groups is acceptable due to the higher prevalence of smoking among men. According to the 2015 WHO report, prevalence of cigarette smoking among Iranian men and women is 20.8% and 0.9%, respectively.¹⁵

Table 4. Total indirect costs (dollars) of smoking-attributable diseases in Kerman City (2014) based on age, gender, and diseases for adults aged 35 or more

Disease	Indirect costs of smoking-induced diseases			
	Age group (year)			
	Men		Women	
	35-59	> 60	35-59	> 60
Lung cancer	995700	1,109530	30309	11494056
Gastric cancer	1134758	848272	43369	12633
HF	2016581	11406766	20490	16609
Stroke	153183	268331	2068	326
COPD	817132	1867873	50839	110892
Total	5117354	15500783	121075	11634516

HF: Heart failure; COPD: Chronic obstructive pulmonary disease

Table 5. Frequency of mortality and potential years lost by diseases attributed to smoking in Kerman City, based on age, gender, and disease type for adults aged 35 and more, 2014

Variable	Mortality frequency		Lost years	
	35-59 year	> 60 year	35-59 year	> 60 year
Men	278760	287081	1124059	1022742
Women	13699	35047	70610	109957
Disease				
Lung cancer	12480	13416	68281	163943
Gastric cancer	7908	7908	45519	40254
HF	242949	120114	979989	535663
Stroke	2677	2666	12360	8092
COPD	26442	178012	88518	384744
Total	292459	322128	1194669	1132700

HF: Heart failure; COPD: Chronic obstructive pulmonary disease

In a local study conducted by Karimloo et al. about 21.7% of men and 3.6% of women were smokers.¹⁶ However, our findings suggest that prevalence of cigarette smoking has not increased in recent years in Iran. Although prevalence of smoking is lower than the global average in this country, there are several concerns regarding smoking in Iran.¹⁶ One of the problems is that the age of onset of smoking has decreased in past two decades in Iran.¹⁷ In a study by Halimi et al., prevalence of cigarette smoking among women aged 25 or higher was more than other age groups. However, considering the high ratio of young population in this country, an increase in cigarette smoking is predictable among Iranian women.¹⁸ This issue is important because women develop respiratory diseases such as lung cancer at a lower age and to a greater extent than men. It should also be noted that smoking during pregnancy and postpartum smoking have dangerous effects on maternal, fetal, and neonatal health. Some of these problems include low birth weight and sudden neonatal death.¹⁷

According to research findings, total estimated economic costs of diseases attributed to smoking in 2014 in Kerman City is 50 million dollars, and based on calculations, these costs make up 0.02% of Iran's GDP. The estimated costs of smoking-induced diseases in China,¹⁰ Korea,¹⁹ and Bangladesh²⁰ account for 0.7%, 0.82%-1.19%, and 1% of their GDPs, respectively. These figures suggest that a smoker costs 270.69 dollars a year. Among different expenses, smoking makes up 77% of total indirect costs. Direct costs caused by smoking in Kerman City in 2014 account for 0.2% of the health services share in Iran's GDP. The respective figures for China,¹⁰ Vietnam,²¹ India,²²

and United States²³ are 3.0%, 4.3%, 4.7%, and 6-8%, respectively. Research results also suggest that lung cancer and gastric cancer (with a share of 14 million dollars) have the largest share of total economic costs of diseases attributed to smoking in Kerman City, which are followed by HF with a share of 3 million dollars. Over half of deaths are caused by HF, and the highest frequency of mortality is seen among men. Currently, over 80% of mortalities in the world are caused by ischemic heart disease (IHD) in low or average-income countries. It shall be mentioned that rate of mortality caused by IHD among the working population is considerably higher in low and average-income countries than high-income countries.²⁴ Over one third of deaths in Iran are caused by CVDs, and the major cause of these deaths is HF (app. 50%).²⁵ CVDs make up one fourth (24%) of total lost years of life. More than two third of lost years of life are the result of CVDs triggered by HF and stroke.²⁶

In this study, total potential lost years were estimated to be 3 million years, and 40.7% of this loss belonged to the 35-59 years age group. HF has the largest share (51%) of lost potential years. Mortality in the working age group leads to loss of productivity. This figure reveals the number of useful years lost as a result of cigarette smoking, which impose an immense economic load on the country.

Several important points regarding this research, which could be considered as its most important limitations, shall be taken into account. In this study, smoking-attributable costs were estimated only based on 5 diseases (including lung cancer, gastric cancer, HF, stroke, and COPD) in Kerman City. However, cigarette

smoking influences almost all body organs. The risk of development of diseases such as asthma, osteoporosis, chronic respiratory diseases, cataracts, fertility disorders, cancers (such as larynx, oral, throat, esophageal, kidney, bladder, pancreas, and liver cancer), tuberculosis (TB), and diabetes escalates by cigarette smoking.^{10,20,27} Selection of a few number of diseases led to underestimation of actual costs of smoking. Moreover, this study only estimated costs of active smokers, and it overlooked the effect of cigarette smoke on non-smokers as well as estimation of economic costs of second-hand smoke. However, as stated in the 2009 report of the International Agency for Research on Cancer (IARC), prohibition of cigarette smoking in workplaces led to a 10% to 20% reduction in acute coronary incidents in the first year of prohibition.²⁷ Based on studies by Oberg et al., second-hand smoke results in 603000 deaths as well as 10.9 million disability-adjusted life years (DALYs) in one year. These findings reflect the considerable role of second-hand smoke in people's health and escalation of the smoking-induced economic load. Costs of losses caused by absence from work and relatives or non-official care providers of patients with smoking-attributable diseases were not calculated. Hence,

indirect smoking-induced costs may be higher than the calculated figures.²⁸

Interestingly, according to the 2009 report on contagious diseases risk factors in Kerman Province, smokers smoke 12 cigarettes a day on average. Moreover, the average cost of one cigarette (whether it is imported or is a joint domestic product) is 0.045 dollars (1210 Rials). Therefore, every smoker pays 212 dollars a year for cigarettes (provided that number of cigarettes smoked per day remains unchanged). Smokers in Kerman City spent 33 million dollars on cigarettes in 2014.

Conclusion

Smoking places a high economic burden on health system and society as a whole. Stronger intervention measures against smoking should be taken without delay to reduce the health and financial losses caused by smoking. Therefore, the Iranian government should raise tobacco taxes on the cigarettes without delay.

Conflict of Interests

The Authors have no conflict of interest.

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برآورد هزینه‌های بیماری‌های منتسب به مصرف سیگار (پنج بیماری منتخب) در شهر کرمان در سال ۱۳۹۳

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مقاله پژوهشی

چکیده

مقدمه: سیگار در بین مواد اعتیادآور، به ظاهر کم‌ارزش‌ترین ماده محسوب می‌گردد که به راحتی در دسترس عموم قرار دارد و توجه کمتری به عوارض زیانبار آن در سطوح فردی و اجتماعی می‌شود. شیوع مصرف سیگار در کشورمان از میانگین جهانی پایین‌تر است، اما کاهش سن شروع مصرف آن در دو دهه اخیر قابل تأمل می‌باشد. مصرف سیگار باعث گسترش مشکلات سلامت عمومی و در نهایت، مرگ و میر می‌شود. بنابراین، پژوهش حاضر با هدف برآورد هزینه بیماری‌های منتسب به سیگار در افراد سیگاری سنین ۳۵ سال به بالاتر در شهر کرمان و در سال ۱۳۹۳ انجام شد.

روش‌ها: با استفاده از رویکرد شیوع، هزینه‌های مستقیم و غیر مستقیم بیماری‌های منتسب به سیگار (سرطان ریه، سرطان معده، سکت قلبی، سکت مغزی و ناراحتی انسدادی مزمن ریه) برآورد گردید. هزینه‌های مستقیم پزشکی با محاسبه قیمت خدمات و مراقبت‌های لازم در مدت زمان بستری (ویزیت پزشک، خدمات بستری، دارو، بستری و...) و هزینه‌های غیر مستقیم با محاسبه روزهای از دست رفته عمر به علت ناتوانی، ناتوانی و ازکارافتادگی و مرگ زودهنگام تخمین زده شد. داده‌های اولیه با استفاده از اطلاعات موجود در مدارک و اسناد واحدهای مدارک پزشکی و درآمد بیمارستان‌های آموزشی دانشگاه علوم پزشکی کرمان در سال ۱۳۹۳ به دست آمد.

یافته‌ها: میزان کل هزینه‌های اقتصادی بیماری‌های منتسب به سیگار در شهر کرمان در سال ۱۳۹۳، ۵۰ میلیون دلار برآورد گردید که بر اساس محاسبات انجام شده، ۰/۰۲ درصد از تولید ناخالص داخلی ایران را به خود اختصاص می‌دهد. کل هزینه‌های مستقیم بیماری‌های ناشی از مصرف سیگار شهر کرمان بالغ بر ۱۷ میلیون دلار به دست آمد. هزینه‌های غیر مستقیم برآورد شده بیماری‌های ناشی از مصرف سیگار نیز ۳۳ میلیون دلار بود. هزینه به ازای یک فرد سیگاری مبتلا به یکی از پنج بیماری منتخب، سالانه ۲۷۰ دلار محاسبه گردید. هزینه‌های مستقیم سیگار زنان، ۵۲ درصد در مجموع پنج گروه بیماری را به خود اختصاص داد. هزینه‌های غیر مستقیم در مردان بیشتر از زنان بود. ۷۳ درصد از هزینه‌های غیر مستقیم بیماری‌های ناشی از مصرف سیگار نیز مربوط به گروه سنی ۶۰ سال به بالا بود.

نتیجه‌گیری: سیگار عاملی است که بهداشت عمومی را تهدید می‌کند و نیازمند توجه است. مصرف سیگار هزینه سنگینی بر جامعه و خانواده‌ها تحمیل می‌کند. این هزینه‌ها به دلیل بهره‌برداری بیش از حد مراقبت‌های بهداشتی - درمانی و کاهش عرضه نیروی کار می‌باشد. تعداد سال‌های بالقوه از دست رفته ناشی از مصرف سیگار، دلیل مناسبی جهت اقدام برای مبارزه با مصرف سیگار می‌باشد.

واژگان کلیدی: هزینه بیماری، مصرف سیگار، خطر نسبی، سرطان، ناراحتی انسدادی مزمن ریه، سکت قلبی

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