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The net effect of smoking on healthcare and welfare costs. A cohort study

Jari Tiihonen,[1–3] Kimmo Ronkainen,[4] Aki Kangasharju,[5] Jussi Kauhanen[4]

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[1]Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden
[2]National Institute for Health and Welfare, Helsinki, Finland
[3]Departments of Psychiatry and Forensic Psychiatry, University of Eastern Finland, Niuvanniemi Hospital and Kuopio University Hospital, Kuopio, Finland
[4]Institute of Public Health and Clinical Nutrition, University of Eastern Finland, Kuopio, Finland
[5]Government Institute for Economic Research, Helsinki, Finland

Correspondence to
Dr Jari Tiihonen;
jari.tiihonen@niuva.fi or
jari.tiihonen@ki.se

ABSTRACT

Objective: To study the net economic effect of smoking on society.

Design: Prospective cohort study.

Setting: Eastern Finland.

Patients: We studied mortality, paid income and tobacco taxes, and the cumulative costs due to pensions and medical care among tobacco smoking and non-smoking individuals in a 27-year prospective cohort study of 1976 men from Eastern Finland. These individuals were 54–60 years old at the beginning of the follow-up.

Main outcome measures: The net contribution of smoking versus non-smoking individuals to public finance balance (euros).

Results: Smoking was associated with a greater mean annual healthcare cost of €1600 per living individual during follow-up. However, due to a shorter lifespan of 8.6 years, smokers' mean total healthcare costs during the entire study period were actually €4700 lower than for non-smokers. For the same reason, each smoker missed 7.3 years (€126 850) of pension. Overall, smokers' average net contribution to the public finance balance was €133 800 greater per individual compared with non-smokers. However, if each lost quality adjusted life year is considered to be worth €22 200, the net effect is reversed to be €70 200 (€71.600 when adjusted with propensity score) per individual in favour of non-smoking.

Conclusions: Smoking was associated with a moderate decrease in healthcare costs, and a marked decrease in pension costs due to increased mortality. However, when a monetary value for life years lost was taken into account, the beneficial net effect of non-smoking to society was about €70 000 per individual.

ARTICLE SUMMARY

Article focus

- No results have been obtained from prospective individual level data based on mortality, morbidity, pension and healthcare costs and, therefore, the net economic impact of smoking on society has remained unclear.

Key messages

- Healthcare and pension costs are lower for smokers than non-smokers, the overall difference being more than 100 000 euros per individual.
- However, when a monetary value for life years lost was taken into account, the beneficial net effect of non-smoking to society was about €70 000 per individual.

Strengths and limitations of this study

- This study provides the first evidence of the net economic effect of smoking versus non-smoking on costs related to health and social welfare, based on prospective data from individual subjects.
- Only men were included in the study.

INTRODUCTION

Smoking is the single most important preventable cause of premature death in industrialised countries,[1] and tobacco taxation is still the most cost-effective method for decreasing the prevalence of smoking. Increases in tobacco taxes have encouraged 9–17% of smokers to quite,[2 3] and in the long run the main effect of taxation is a reduction in the incidence of new young smokers.[4] Early smoking cessation increases lifespan by about 9–10 years,[5] and if the smoking rate diminished by 10 percentage points, life expectancy would increase by about 1 year. It has been estimated that a 10% increase in the price of smoked tobacco will result in about a 5% decrease in cigarette consumption,[4] yet tobacco taxes are still low in many countries. Thus, it would be interesting to know why so many governments in the world continue to increase spending on healthcare costs, while a substantial savings and advances in life expectancy are readably available by administratively increasing tobacco taxes. There are two plausible explanations: the governments do not know about the correlation between increasing tobacco taxes on increasing life expectancy, or they realise this effect, but do not want to increase life expectancy. One possible explanation is that governments are reacting to pressure from cigarette companies and smokers (either implicit or explicit) which prevents tax increases.

The net effect of smoking on healthcare costs has been investigated in several studies.[6–18] Some modelling studies have suggested that although smokers suffer more

from many kinds of diseases, non-smokers incur more healthcare costs because they live longer,[6–8 11 12] yet others have reached the opposite conclusion.[9 10 13–18] Only a few of these studies have included pension and insurance costs,[7 12 17 18] and paid tobacco taxes.[12 17 18] In 2001, Philip Morris provided a report to the Government of the Czech Republic, which indicated that the effect of smoking on the public finance balance in the Czech Republic in 1999 was positive and estimated to be 5815 million korunas (about 150 million USD).[12] Although this report generated outraged reactions worldwide, Milos Zeman, the Czech prime minister stated:

> As a smoker, I support the state budget, because in the Czech Republic, we pay tax on tobacco. Also, smokers die sooner, and the state does not need to look after them in their old age.[19 20]

This report was based on many assumptions that were obtained through theoretical modelling, and it did not give any monetary value for life years lost because of smoking, and it was claimed to have underestimated the costs of medical care for people suffering from smoking related diseases.[21] The overall net effect of smoking on private (personal) and external costs has also been studied by Sloan *et al*[17] and Viscusi,[18] who used US lifetable data to model the forthcoming lifelong net costs caused by smoking. As shown by van Baal *et al*,[22] slightly different models can give markedly different results on the net effect of smoking, depending on what assumptions are used. In any case, sophisticated incidence-based datasets are ultimately required to establish the true healthcare costs incurred by smoking.[23] Since no results have been obtained from prospective, individual level data based on mortality, morbidity, pension and healthcare costs, the net economic impact of smoking on society has remained unclear. The aim of this study was to investigate this net economic effect by using data from a prospective 27-year follow-up of a cohort of 1976 Finnish middle-aged men.

METHODS

Study population

The subjects of the Kuopio Ischemic Heart Disease study (KIHD) were obtained from a randomly selected sample of 3433 men, aged 42 to 60 years, who resided in the town of Kuopio or its surrounding rural communities. Of those invited, 2682 (83%) participated in the study. Of these, individuals from 54 to 60 years with complete data for smoking, income, healthcare costs, retirement and mortality (n=1976 men) were included in the final analyses. The baseline examinations were conducted between March 1984 and December 1989.[24] The mean follow-up time was 24.2 years (range 21.1±26.8 years). The KIHD study was approved by the Research Ethics Committee of the University of Kuopio, in Kuopio, Finland. Each participant gave written informed consent. The end of the follow-up period was 31 December 2010.

A subject was defined as a smoker if he had ever smoked on a regular basis, and had smoked cigarettes, cigars or a pipe within the past 30 days. The lifelong exposure to smoking ('cigarette pack-years') was estimated as the product of years smoked and the number of tobacco products smoked daily at the time of examination. 'Years smoked' were defined as the sum of years of smoking regardless of when smoking had started, whether the subject had stopped smoking, or whether it had occurred continuously or during several periods. Data on mortality were obtained from Statistics Finland, and data on healthcare costs from the Finnish Institute for Health and Welfare (THL). The healthcare costs did not include visits to general practitioners, home nursing, or medication and dental care costs in outpatient care, which have been estimated to be about 20–30% of total healthcare costs in this age group in Finland.[25] The amount of paid tobacco taxes was estimated on the basis of cigarette pack-years,[26] and the amount of paid income taxes was estimated by using the income tax rate for the year 1987. The amount of occupational productivity and income taxes lost was calculated as the difference of age at retirement (relative to the retirement age of matched non-smokers) multiplied by the annual income and income tax of each smoker. 'Income taxes paid' also included obligatory pension and healthcare insurance fees. All monetary values were expressed as Euros (€) and converted to the level for the year 2009.

In the UK, the monetary value of one quality adjusted life year (QALY) has been estimated to be 20 000–30 000 Pounds for an individual having perfect health.[27] In the present study, we used a value of 30 000 Euros (about 25 100 Pounds in February 2012). In a recent large study on the effect of smoking on life expectancy, the quality-of-life score among former smokers with a body mass index (BMI) of 25–30, who were older than 65-years was estimated to be 0.71–0.77.[28] Therefore, we used a quality-of-life score of 0.74 for smokers in the present study, thus equalling to 0.74×30 000 Euros=22 200 Euros for each life year lost due to smoking among former smokers aged over 65 years (deceased smokers who would be over 65 if they had lived).

Statistical analysis

Differences in baseline characteristics and costs were examined using the Student's t-test. Descriptive data are presented as means and percentages. A p value of less than 0.05 was considered statistically significant. These statistical analyses were performed using SPSS 17.0 for Windows. Life expectancy for those individuals still alive on 31st December 2009 was calculated by using life expectancy from the Life Table provided by Statistics Finland.[29]

Adjusted group difference in total cost was also assessed using bootstrap type analysis of covariance (ANCOVA) with adjustments for the propensity score.

Potential variables for inclusion in the propensity score (age at baseline, BMI, systolic blood pressure, low-density lipoprotein (LDL)-cholesterol and years of education) were explored in logistic regression with a backward selection procedure ($p<0.25$ as selection criterion). Patients were stratified based on quintiles of the propensity score. Furthermore, the fit of the propensity score model was assessed by the Hosmer–Lemeshow test.

RESULTS

The crude mortality rates were 351/493 (71.2%) among smokers, and 553/1483 (37.3%) among non-smokers, and the cause-specific mortality in each group is shown in table 1. The observed age at death was 67.8 years for smokers, and 71.4 years for non-smokers. The predicted mean age at death was 72.1 for smokers and 80.7 years for non-smokers, indicating 8.6 years difference between two groups. When the effect of birth year on life expectancy was taken into account, the amount of life years lost due to smoking was 9.2 years. The demographic variables and smoking-related outcomes are shown in table 2. Smokers had substantially lower mean BMI and educational level. Smokers also had a slightly lower mean systolic blood pressure and a slightly higher mean LDL cholesterol level. Smoking was associated with a moderate decrease in productive occupational career, income taxes paid and hospital care costs, and showed a marked decrease in pension costs. The net effect of smoking on public finance was plus €133 800 for these smokers during the follow-up when life years lost were not included, and minus €70 200 when a monetary value for life years lost was included in the calculation. When the propensity score method was applied, the result remained almost the same (€71.600, 95% CI €52.300 to €90.800).

Figure 1 demonstrates the average annual healthcare costs as a function of age among those individuals still alive, and figure 2 shows the corresponding results when all individuals (also deceased) are included. The higher mortality results in lower annual cost among smokers after 72 years from birth.

Table 1 Cause-specific mortality among smokers and non-smokers

Cause of death	Non-smokers (%)	Smokers (%)
Cardiovascular disease	267 (48%)	166 (47%)
Cancer (all)	146 (26%)	102 (29%)
Lung cancer	15 (3%)	47 (13%)
Respiratory disease	13 (2%)	20 (6%)
External causes of death	56 (10%)	28 (8%)
Other	71 (13%)	35 (10%)
Total	553 (100%)	351 (100%)

A total of 553 (37.3%) non-smokers and 351 (71.2%) smokers had died during the follow-up. Percentages indicate the proportions for cause of death from all deaths in each group. Cancer deaths include lung cancer deaths.

DISCUSSION

Hospital care costs were 1600 Euros greater per person year for living individuals among smokers during the follow-up, but due to a 8.6 year shorter lifespan, the total costs per individual were 4700 Euros lower among smokers than non-smokers during the entire study period. This study provides the first evidence of the net economic effect of smoking versus non-smoking on costs related to health and social welfare, based on prospective, individual level data.

Smoking resulted in a moderate decrease in the productive occupational career and income taxes and pension fees paid, a moderate decrease in healthcare costs and a marked decrease in the pension costs. The costs of smoking to society have been modelled by using estimates on increased mortality and morbidity.[6–18] However, none of these modelling studies investigated the overall net economic effect of smoking on public finance balance by using actual data from individuals, and only a few had taken into account all the following factors; lifetime productivity or income taxes and pension fees paid, pension costs, and a monetary value of life years lost.[17 18] Our results indicate that combined, these factors make a considerable contribution to the overall net effect than merely healthcare costs which is in line with the modelling studies by Sloan *et al*[17] and Viscosi.[18] If the potential increase in quality adjusted life years is taken into account, our results suggest that the life long net beneficial economic effect of early smoking cessation is more than €70 000 per individual, and this sum did not change substantially when propensity score was applied in the analysis. Our results also indicate that reducing the rate of smoking has a huge beneficial economic effect on society, mainly due to increased lifespan and continued pension costs. In Finland, the National Institute for Health and Welfare aims to make Finland free of smoking by the year 2040. Since there are currently about 900 000 smokers in Finland, the average net effect of €134 000 per individual on public finance balance (without taking into account the monetary value of life years lost) would correspond during the next decades to about 120 billion Euros total increase in costs (over 2.5-fold to annual state budget). However, this nominal deficit would be massively outweighed by about 2 years increase in life expectancy of the whole nation.

Our overall results on the net economic effect of smoking on public finance balance are contrary to the Philip Morris report. A major reason for this difference is that Little did not consider the inherent value of the quality adjusted life years lost. In other words, if we used an estimate of 0 Euros for each lost year of human life, then the positive economic effect of smoking in our study would have been even larger than the effect

Table 2 Smoking-related outcomes

	Non-smokers N=1483		Smokers N=493			
	Mean	SD	Mean	SD	Difference of means	p Value
Age at baseline, years	55.72	2.50	55.54	2.38	−0.2	0.17
Body mass index (BMI)	27.29	3.51	26.01	3.81	−1.3	<0.001
Mean systolic blood pressure (mm Hg)	135.93	17.43	133.43	18.18	−2.5	0.007
LDL-cholesterol (mmol/l)	4.07	1.01	4.21	1.09	0.1	0.013
Years of education	8.19	3.32	7.52	2.74	−0.7	<0.001
Age at death, years	80.71	8.40	72.13	8.89	−8.6	<0.001
Life years lost due to smoking	0	0	9.19	8.15	9,2	<0.001
Age at retirement, years	56.60	5.89	55.35	6.23	−1.3	<0.001
Years of receiving pension	23.69	9.11	16.42	9.39	−7.3	<0.001
Number of hospitalisations	10.74	12.34	10.84	10.89	0.1	0.88
Number of inpatient days	88.47	235.25	101.55	216.23	13.1	0.28
Years of smoking (at baseline)	2.69	8.96	31.81	9.72	29.1	<0.001
Annual income, €	34060	22180	27510	17.730	−6550	<0.001
Occupational productivity lost due to smoking, €	0	0	34370	27080	34370	<0.001
Income taxes lost due to smoking, €	0	0	11660	12550	11660	<0.001
Annual pension, €	20440	13330	16180	9730	−4260	<0.001
Reduced pension costs due to smoking,€	0	0	126850	148120	126850	<0.001
Reduced income taxes paid from pensions, €	0	0	34230	48650	34230	<0.001
Annual healthcare costs/living individuals, €	3420	9870	5040	10650	1620	0.003
Total healthcare costs, €	79290	173420	74570	154950	−4720	0.59
Tobacco tax paid, €	2190	8860	50300	32450	48110	<0.001
Life years lost due to smoking, €	0	0	203960	180890	203960	<0.001
Total costs, life years lost not included, €	77110	173840	−56680	195130	−133790	<0.001
Total costs, life years lost included, €	77110	173840	147280	195960	70170	<0.001

Total costs of smoking versus non-smoking were calculated by taking into account the life-long difference (€/person) of healthcare costs (€4720), tobacco taxes paid (€48110), income taxes lost (€11660), reduced pension costs (€126850) and reduced taxes paid from pensions (€34230). The smoking-related harms for the society were €11660+€34230=€45890, and the smoking-related benefits for the society were €4720+€48110+€126850=€179680, and thus the net effect on public finance balance was €133790 positive for each smoking individual. When the value of 9.19 life years lost due to smoking (€203960) was taken into account, the net effect became €70170 negative for each smoking individual. 'Income taxes lost due to smoking' indicate the loss due to earlier disability/retirement, and 'Pension costs' indicate the pensions paid by the state and pension companies. The value of one quality adjusted life year lost was estimated to be 0.74×€30 000= €22200.[10 25]

estimated by Little. However, when considering the implications of these results, the major question is whether or not humans are to be valued as commodities, like domesticated animals, or does human life maintain an inherent value even when the individual is no longer economically productive, as in retirement? In the field of healthcare, it is generally assumed that all human life—even that of the old and disabled—is

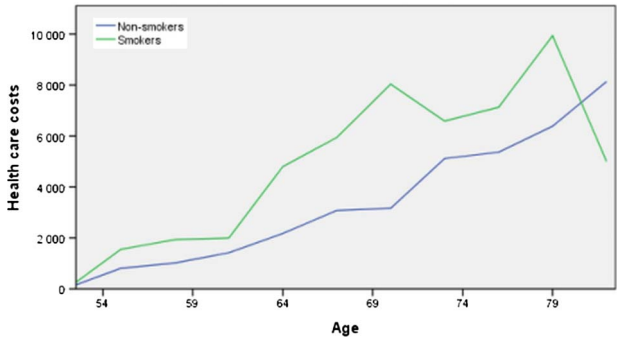

Figure 1 Average annual health care costs per living individual, in Euros, as a function of age.

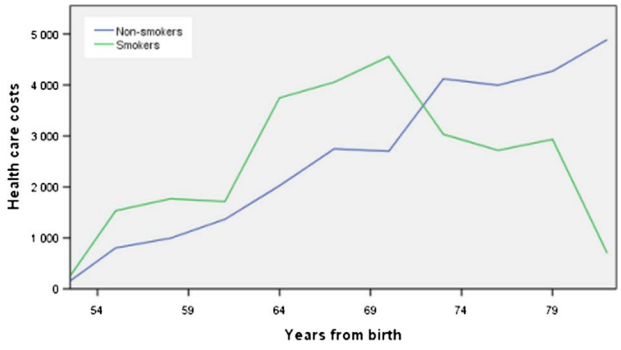

Figure 2 Average annual healthcare costs among all individuals in Euros (including deceased persons).

precious and has value. This view is also currently accepted by national authorities throughout most of the modern world. Already in 1999, 387 billion USD was used in the US for medical treatment and care of people older than 65 years.[30] Nowadays, it is generally agreed that the monetary value of one additional life year of a healthy human being is about 20 000–30 000 British Pounds when additional costs of medical care are considered.[27] One may ask why societies continue to invest even larger amounts of money and other social resources to achieve a longer mean lifespan for citizens, when a more drastic increase could be achieved administratively, without any further costs, by substantially raising tobacco taxes and otherwise restricting access to smoking? There are two likely answers: either governmental authorities have not realised this fact, or they have realised it, but do not want to increase life expectancy due to a subsequent increase in healthcare and pension costs.

While denying access to medical care for older people, in order to prevent a deficit in the national economy, would not be possible because of common ethical concerns and public opinion, preventing a decrease in smoking rates essentially has the same effect, and is apparently more acceptable to many societies. If this is the case, it would also explain the reluctance of governments to regulate eating and other consumption habits that negatively affect the general population by, for example, increasing the value added tax (VAT) on food products that are high in sugar and saturated fats, and decreasing VAT on fruits and vegetables, for example. The Czech prime minister stated in 2001 that smoking is beneficial for the state, because smokers die sooner.[17 18] Such comments have not been echoed by other state leaders; however, it is possible that this view still influences tobacco policies in many modern countries. Therefore, governments should be transparent concerning which kind of knowledge their tobacco and food taxation policy is based on. Our study cannot answer the question on why cigarette taxes are still low in many countries. Therefore, this remains open and a topic for further research.

The strength of this study is based on empirical data that were gathered from a 27-year prospective study. Thus, no assumptions on healthcare, pension costs or discount percentages of future costs were needed. One shortcoming is that this study did not include women, and it did not include visits to general practitioners, home nursing or medication and dental care costs in outpatient care, which contribute to about 20–30% of the total healthcare costs among elderly and middle-aged people in Finland.[25] In a previous 19-year follow-up study, it was observed that although the overall healthcare costs were higher among smokers aged 25–59 years, the costs of medication in outpatient care did not differ between smokers and non-smokers.[31] Thus, it can be further estimated that the total healthcare costs might have been at the most about 6000 to 7000 Euros higher per individual among non-smokers when compared with smokers, instead of our modest estimate of about 5000 Euros per individual. However, the magnitude of this difference (€ 1000–2000) is less than 2% of the pension costs, and does not have any substantial effect on these results. We also did not include the costs of fires or littering related to smoking, as this information was not available, yet the combined contribution of these factors is probably less than 1% of the total costs.[12] Since only 17% of the initiated subjects refused to participate, the generalisability of the results can be considered quite sufficient.

It was presumed that smokers' lower education level and lower income level were not caused by smoking, and that differences in these characteristics were associated with smoking due to the fact that less educated individuals are more likely to start smoking than individuals with a higher educational level. Therefore, it was assumed that smoking cessation would not substantially increase education level or income. It can be estimated that during a productive career of about 35 years, with an annual difference of € 2970 in paid income taxes, smokers in our study have paid an average of about 100 000 Euros less income taxes than non-smokers. If it were assumed that early smoking cessation would change these variables to the same levels as with non-smokers, the net difference between smokers versus non-smokers would shift from €134 000 to about €30 000 in favour of smoking, if the value of life years lost are not included, and from €70 000 to about €170 000 in favour of non-smoking if the value of life years lost are included in the analysis. Either way, the principal conclusions on the net costs would remain the same. It is questionable if tobacco taxes should be considered as beneficial increases in income to the state. For example, if an individual would not have been smoking, then he/she probably would have consumed more goods in the extra years of life and thus paid more taxes for those goods instead of the taxes paid for cigarettes. Overall, the estimate of a €70 000 beneficial effect of early smoking cessation per individual is probably an underestimate.

Contributors JT, JK and AK conceived the idea of the study and were responsible for design of the study. KR and JK were responsible for undertaking for data analysis and produced the tables and graphs. JT and AK provided input into data analysis. The initial draft of the manuscript was prepared by JT and then circulated repeatedly among all the authors for critical revision. KR was responsible for acquisition of the data and JT, JK, KR and AK contributed to interpretation of the results.

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Competing interests All the authors have completed the Unified Competing Interest form at http://www.icmj.org.coi_disclosure.pdf (available on request from the corresponding author) and declare: Dr Tiihonen is a member of the advisory board of AstraZeneca and Janssen-Cilag, and he reports as a consultant to Lundbeck, Organon, Janssen-Cilag, Eli Lilly, AstraZeneca, F. Hoffman-La Roche and Bristol-Myers Squibb. He has received fees for giving expert opinions to Bristol-Myers Squibb and GlaxoSmithKline, and lecture fees from Janssen-Cilag, Bristol Myers-Squibb, Eli Lilly, Pfizer,

Lundbeck, GlaxoSmithKline, Novartis and Astra Zeneca. No further disclosures were reported.

Ethics approval The KIHD study was approved by the Research Ethics Committee of the University of Kuopio, in Kuopio, Finland.

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