

SMOKING ATTRIBUTABLE HOSPITAL TREATMENT, TREATMENT COSTS AND SMOKING ATTRIBUTABLE MORTALITY IN THE CZECH REPUBLIC IN 2002

Hana Sovinová, Ladislav Csémy, Bohumír Procházka, Stanislava Kottbauerová

National Institute of Public Health, Prague, Czech Republic

SUMMARY

Objectives: The main objective of this work is to quantify the number of hospitalizations caused by smoking, estimate the costs of hospital treatment and to estimate contribution of smoking to mortality in the Czech Republic (CR) in 2002.

Methods: The estimate of the proportion by which smoking contributed to hospitalizations and to mortality in the CR was computed using the method of smoking-attributable fractions (SAF). The SAF was computed from relative risks established in the American study *Cancer Prevention Study II* and from estimates of the prevalence of smoking in the CR from a nationwide study conducted in 2002.

Results: In 2002, based on data provided by the General Health Insurance Company, there were 145,336 hospitalizations, and the total cost of hospital treatment was estimated as 4,727,612 (in thousands) CZK. The total number of deaths caused by smoking was 20,550 (95% CI: 18,851–22,262), 14,525 in men and 6,025 in women. Deaths caused by smoking represented 19% of the total nationwide mortality for 2002. Earlier estimates were published by Peto and Lopez for 1995 (22,300 deaths caused by smoking) and 2000 (17,746 deaths). The estimate arrived by authors using the SAF method for 2002 corresponds quite well with that by Peto and Lopez for 2000.

Conclusions: The high morbidity and mortality rate related to smoking is directly connected to high prevalence of smoking in the Czech Republic. An effective tobacco control policy, including restrictive measures on availability of tobacco products combined with preventive programmes and smoking cessation programmes, could contribute to the reduction of smoking and save lives and treatment costs caused by smoking.

Key words: hospitalizations, smoking, mortality, costs of treatment, Czech Republic

Address for correspondence: H. Sovinová, National Institute of Public Health, Šrobárova 48, 100 42 Praha 10, Czech Republic.
E-mail: sovinova@szu.cz

INTRODUCTION

In developed countries, cigarette smoking is the leading risk factor endangering health (health hazard). According to a report by the World Health Organization (2) smoking contributes 12.2% to the total morbidity rate in developed countries (as recorded in the DALY index). Research has shown that the differences in morbidity and mortality rates and life expectancy among regions and states are the result of life-style factors, particularly cigarette smoking (3, 4, 5). It is true, as far as the Czech Republic (CR) is concerned, that there have been positive changes in the morbidity that has significantly decreased after year 1989. According to the WHO data (WHO European Health for All database) the standardized mortality rate in the Czech Republic in 1993 was 1,052 per 100,000 inhabitants, while it was only 899.6/100,000 ten years later. Compared to the mortality in the EU 15 countries (before 2004), where the mortality rate was only 639/100,000 in 2002, these values are still rather high. Compared to the EU 15 countries, the CR has significantly higher mortality, particularly in the groups of cardiovascular disease (more than 80%) and neoplasms (more than 30%) (6). These are diseases, the origin and course of which is significantly influenced by smoking (among other factors).

Research concerned with the impact of smoking on the population's morbidity and mortality has furthered our knowledge about environmental factors posing a danger to health, and has decidedly determined the policies towards the issue of tobacco in developed countries. In this field, an important role has been and continues to be played by work concerned with the estimation of the proportion of morbidity and mortality that is attributable to smoking. In the Czech Republic, the estimation of the proportion (or fraction) of mortality attributable to cigarette smoking has thus far been almost exclusively based on the results of the work published by Peto et al. (1). The authors used the so-called indirect method to obtain their estimate, i.e. an estimate based on a coefficient derived from the number of deaths due to lung cancer. The advantage of the indirect method assumes that the computation of mortality does not presuppose knowledge of the prevalence of smoking in the population that is not available in many countries. According to these authors, smoking contributed to 14,098 male deaths and 3,648 female deaths in the CR in 2000.

Another, rather widespread estimation method employs the smoking attributable fractions for specific diagnoses, or diagnostic groups. This method has been applied in the USA (7, 8) and a number of other countries (see the Method section for more detail). This second method has been used in the present work. The

Table 1. Smoking attributable number of hospitalizations and respective costs of treatment in Czech Crowns by gender and groups of diseases

Groups of diseases		Males	Females	Males and females
Neoplasms	Number of hospitalizations	19,089	5,568	24,657
	Costs of treatment in CZK(000)	502,433	163,503	665,936
Cardiovascular diseases	Number of hospitalizations	64,807	33,154	97,961
	Costs of treatment in CZK(000)	2,461,924	948,571	3,410,495
Respiratory diseases	Number of hospitalizations	12,868	7,943	20,811
	Costs of treatment in CZK(000)	317,431	176,488	493,919
Diseases among infants (<1 year of age)	Number of hospitalizations	1,236	671	1,907
	Costs of treatment in CZK(000)	10,087	51,175	157,262
Total	Number of hospitalizations	98,000	47,336	145,336
	Costs of treatment in CZK(000)	3,387,875	1,339,737	4,727,612

reason for using this method consisted in the apparent lack of domestic expert work concerned with determining the contribution of smoking to the overall morbidity and mortality rates that would, at the same time, employ good-quality medical statistics.

The main objective of the present work is to quantify the number of smoking related hospitalizations and estimate respective costs of treatment for this hospital care. The second major objective is to quantify the contribution of smoking to the overall mortality in the Czech Republic in 2002. In addition, we want to compare our estimate to previous estimates published by Peto and Lopez and discuss the mortality caused by smoking in the CR as related to other countries.

METHOD

We have based our quantification of the contribution of smoking to morbidity and mortality on a method that employs fractions that can be attributed to smoking in individual diagnoses or diagnostic groups. In scientific literature, this method is most commonly referred to using the term *smoking attributable fractions* (SAFs). It is a method that has been developing for many years and has become rather widespread. In the US, this procedure is used by the CDC to estimate mortality and morbidity associated with smoking, and to obtain estimates of economic losses accruing to society as a result of smoking (8). The method has also been applied in some European countries, e.g. Spain (9), Italy and Germany (11). The method is based on the application of SAF to the population's mortality data. To compute smoking attributable fractions, it is necessary to know the values of the relative risks [RR] and prevalence of smoking in a population. We have used the prevalence values for smoking obtained in the frame of Czech section of the GENACIS project for 2002 (for information on methodology and sample see (12). Based on the results of this study, the values of prevalence of smoking were as follows: men – current smokers 37.2%, former smokers 22.9%, non-smokers 39.9% – for women: 20.4% current smokers, 14.4% former smokers, and 65.2% non-smokers. The values of the relative risk of diseases and death associated with smoking are not available for the Czech population. We have therefore used the RR values from the American Cancer Prevention Study II (8, 13). The takeover of RR values from this study is a common

procedure in those countries where these data are not available from domestic epidemiological studies.

The relationship for SAF is as follows:

$$\text{SAF} = \frac{[(p_0 + p_1(\text{RR1}) + p_2(\text{RR2})) - 1]}{[p_0 + p_1(\text{RR1}) + p_2(\text{RR2})]}$$

where p_0 is the percentage of never smokers in the population; p_1 – percentage of current smokers in the population; p_2 – percentage of former smokers in the population; RR1 – value of relative risk of death for current smokers *versus* non-smokers; RR2 – value of relative risk of former smokers *versus* non-smokers.

To quantify the number of hospitalizations and costs of treatment we asked the General Health Insurance Company to provide us primary data needed for this part of analyses.

To obtain the numerical values of deaths, we have used data on deaths by specific detailed causes of death that are published by the Czech Statistical Office in the publication *Population Mobility* (14).

RESULTS

Information on smoking attributable hospital admissions and costs of treatment is summarised in Table 1. Clearly, the highest number of smoking attributable diseases is in category of cardiovascular diseases – 64,807 for males and 33,154 for females. The high proportion is associated with the structure of morbidity of the Czech population. It is important to mention here, that this “disease profile” is caused partly by biological and genetic factors and partly by environmental and behavioural factors, including tobacco smoking and elevated alcohol consumption. Among hospitalizations for neoplasms the lung cancer was the most frequent cause of hospitalization (12,465 of 24,657). The male to female ratio for hospitalizations for lung cancer was 3,6:1. In the group of respiratory diseases the most frequently emerging disease was the chronic obstructive pulmonary disease. The relatively small but anyway important group of diseases are diseases of infants up to 1 year of age. These diseases are supposed to be partly influenced by smoking of mother during the pregnancy. The respective costs of treatment included in Table 1, document the share of smoking on hospital care. The total amount of 4,727,612 (in thousands) CZK represent 11% of the total costs for all hospital treatments in the Czech Republic, that is paid by the General

Health Insurance Company (GHIC). The GHIC is the largest health insurance company that covered the health care of 68.1% of Czech population in the year 2002. Therefore the estimate of the hospital treatment for smoking related diseases for the whole country is of course higher and may be approximated to about 6.145,000 (in thousands) CZK.

The number of deaths that can be attributed to smoking are summarized in Table 2. The diagnoses given in the Table are stated under the headings of disease groups (e.g. neoplasms, cardiovascular diseases). Absolute numbers of deaths are given in the columns by sex and limits of 95% confidence interval. It is obvious from the Table that the diagnosis accounting for the highest number of deaths attributable to smoking is lung (or bronchogenic) cancer with a total of 4,815 deaths, i.e. 3,879 for men and 936 for women. The numbers for atherosclerosis are also rather high (4,259), as are those for coronary artery disease, angina pectoris and myocardial infarction (1,622 in the group of individuals under 65 years of age, and 1,848 for older individuals); other rather high values are those for cerebrovascular disease (1,349 deaths for 65 years old and older). Regarding respiratory disease, we have recorded a high number of deaths due to chronic obstructive pulmonary disorder (993). The smoking attributable fraction was markedly higher in men for all diagnoses of interest, with the exception of atherosclerosis.

We have summarized the data on mortality for 2002, where smoking played a role, that were obtained using SAF, together with the data for 2000 that were obtained using the indirect *SIR* method (1) into Table 3. The Table gives, in addition to the total numbers of deaths due to all causes of death, the numbers of deaths for four groups of diseases and categories (neoplasms, cardiovascular, respiratory, and neonatal/infant diseases). The overall estimate of the contribution of smoking to the total annual mortality in the CR in 2002 can be obtained using the number of 20,550 deaths (95% CI: 18,851 – 22,262) corresponding to 19% of all deaths in the given year. Of the total number of deaths that can be attributed (are attributable) to smoking, most deaths are deaths from cardiovascular disease (a total of 11,364). There were 7,203 cases of deaths from neoplasms. These two groups of diseases represent approx. 90% of the overall mortality caused by smoking. The overall estimate of mortality for 2002 is slightly higher compared to the estimate for 2000, though the value for 2000 comes rather close to the lower bound of the 95% confidence interval for 2002. The difference between these two estimates is most pronounced in the case of female mortality, and especially for deaths from cardiovascular diseases.

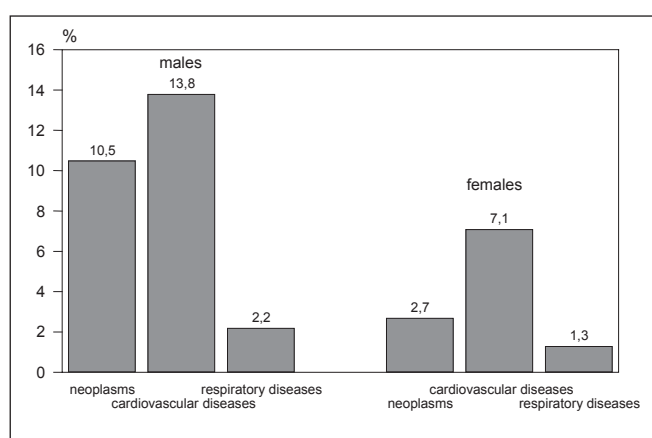
The share of smoking attributable mortality on total yearly mortality in the year 2002 in the Czech Republic is shown in Fig. 1. The data suggest especially serious impact of smoking to

Table 2. Smoking attributable death by causes of death and gender in the Czech Republic in 2002

Disease category	Males (95% CI)	Females (95% CI)	Total M+F (95% CI)
Neoplasms			
Lip, oral cavity, pharynx	496 (493-499)	54 (51-57)	550 (544-556)
Oesophagus	266 (263-269)	41 (39-42)	307 (302-311)
Pancreas	250 (235-265)	214 (198 -229)	464 (433-494)
Larynx	195 (192-197)	15 (15-15)	210 (207-212)
Trachea, lung, bronchus	3,879 (3,853-3,900)	936 (906-962)	4,815 (4,759-4,862)
Cervix uteri	-	100 (93-108)	100 (93-108)
Kidney, other urinary passways	264 (255-274)	62 (58-66)	326 (313-340)
Urinary bladder	384 (371-396)	47 (42-51)	431 (413-447)
Cardiovascular diseases			
Hypertensive diseases	149 (142-157)	102 (92-112)	251 (234-269)
Ischaemic heart diseases – 35–64 yrs	1,364 (1,315-1,413)	258 (236-279)	1,622 (1,551-1,692)
Ischaemic heart diseases – ≥ 65 yrs	1,357 (1,093-1,598)	491 (278-730)	1,848 (1,371-2,328)
Other heart diseases	687 (655-724)	373 (336-410)	1,060 (991-1,134)
Cerebrovascular diseases – 35–64 yrs	477 (459-495)	221 (205-236)	698 (664-731)
Cerebrovascular diseases – ≥ 65 yrs	1,071 (843-1,281)	278 (124-459)	1,349 (967-1,740)
Atherosclerosis	2,218 (1,965-2,493)	2,041 (1,857-2,212)	4,259 (3,822-4,705)
Aortic aneurysm	162 (158-166)	42 (39-46)	204 (197-212)
Other arterial diseases	49 (48-50)	24 (22-26)	73 (70-76)
Respiratory diseases			
Pneumonia and influenza	374 (359-390)	290 (265-315)	664 (624-705)
Bronchitis and emphysema	190 (188-192)	112 (109-115)	302 (297-307)
Chronic airways obstruction	678 (671-685)	315 (306-323)	993 (977-1,008)
Diseases among infants			
Short gestation, low birth weight	0 (0-0)	2 (1-2)	2 (1-2)
Respiratory distress syndrome	7 (7-7)	3 (3-3)	10 (10-10)
Other respiratory conditions of newborn	6 (6-6)	4 (4-5)	10 (10-11)
Sudden infant death syndrome	2 (2-2)	0 (0-0)	2 (2-2)

Table 3. Estimates of smoking attributable deaths in the Czech Republic in 2000 and 2002

Groups of diseases	Year of estimate	Males	Females	All
Neoplasms	2002	5,734	1,469	7,203
	2000	6,612	1,135	7,747
Cardiovascular diseases	2002	7,534	3,830	11,364
	2000	5,369	1,740	7,109
Respiratory diseases	2002	1,242	717	1,959
	2000	1,205	471	1,676
Diseases among infants (<1 year of age)	2002	15	9	24
	2000	-	-	-
Other medical condition	2002	-	-	-
	2000	912	302	1,214
Total	2002	14,525	6,025	20,550
	2000	14,098	3,648	17,746

**Fig. 1.** Relative share of smoking attributable death from the total number of deaths by gender in the Czech Republic in the year 2002.

mortality for neoplasms and cardiovascular diseases in males. The respective data for females are lower and correspond to lower prevalence of tobacco smoking among females.

DISCUSSION

The results described above provide an overview of the impact of smoking on hospital treatment and on mortality by individual diagnoses and disease groups. In the discussion, we will focus on the diagnosis that represents the absolutely highest number of deaths as related to smoking (lung cancer) and on the group of diseases that are most influenced (cardiovascular diseases). Mortality from lung and bronchial cancer is the most studied and discussed issue related to smoking. Our results are in close agreement with the international findings. Ezzati et al. (15) report that deaths from lung cancer represent 60% of the overall mortality from tumours attributable to smoking worldwide. Our estimate is comparable (66% for mortality and 51 % for hospitalizations). Reports concerned with the development of mortality from lung cancer are consistent in regarding smoking as the most serious risk factor (16, 17, 18). Kubik et al. (19) report that the risk of lung cancer is 10.3 times higher in women smokers compared

to non-smokers. Compared to non-smokers, an increased risk of lung cancer was also found in former women smokers who quit smoking ten years ago or more (OR = 3.79). It is obvious that the differences in lung cancer prevalence among countries cannot be explained only by differences in smoking as other factors such as environmental pollution, occupational noxae, ionising radiation, etc. may play a role as well.

In the group of cardiovascular disease where the impact of smoking on mortality is greatest (see Fig. 1) the contribution of smoking is usually discussed in the context of other risk factors (20). Unal et al. (21) studied factors that influenced the decline in mortality from cardiovascular diseases in England and Wales over the period from 1981 to 2000. They found that therapeutic interventions accounted for 42% of the reduction of mortality, and the remaining 58% were due to the reduction of prevalence of risk factors in the population, with smoking explaining 48% of the reduction of mortality. According to Banegas et al. (22), tobacco smoking is the most serious risk factor for myocardial infarction and coronary artery disease. It is likely, in the context of the present result that reduced smoking in the CR would result in a reduced mortality rate from cardiovascular disease.

The estimate of mortality attributable to tobacco smoking obtained with the SAF method makes it possible to compare results obtained with two different estimation methods. It is seen that the results concur to a large degree. Peto et al. (1) estimate that the total number of deaths due to smoking in the CR in 2000 was 17,746 cases. Our estimate for 2002 is 20,550 cases. Taking the 95% confidence interval into account, the estimate obtained using the indirect methods comes close to the lower bound of our estimate (18,851 cases). The degree of coincidence is rather high for men, where the indirect method gives 14,098 cases as the number of deaths in 2000, and the SAF method, 14,525 cases for 2002. Contrary to this, the estimates differ significantly for women. Our estimate for 2002 is 6,025 cases, while the indirect-method estimate gives 3,648 cases of death. Technically, this difference can be accounted for by the fact that the indirect method does not consider the prevalence of smoking by sex, and depends on a ratio derived from numbers of deaths from lung cancer in men and women. It is likely that the SAF estimate is somewhat more accurate in this respect as it accounts for the relative risks for individual diagnoses specifically, i.e. for sex, and

the prevalence of smoking is also considered by sex. We must admit, however, that the accuracy of the SAF estimate is limited by the fact that the relative risks were derived from an extensive American study, i.e. from a population that can hardly be regarded as representative for the Czech population as there are undeniable social, economic, and demographic difference between these two populations. Though the RR values from this study have been applied in other countries as well it is not possible to verify whether this application is warranted. In this respect, researches depend on clinical experience that underlies the epidemiological conclusions resulting from CPS II.

Regardless of partial differences resulting from the use of different methods there are no doubts when comparing findings of both methods that smoking contributes rather significantly to the overall morbidity and mortality of the Czech population. Research work concerned with the trends of smoking in the population suggests that the prevalence of smoking during the last ten years stagnates in adults (slight decline in men and increase in women), but is on the increase among adolescents (6, 23, 24). These findings speak in favour of more intense and effective steps that would lead to the reduction of smoking in society, both through the restriction of access to tobacco products and more effective programmes in area of health promotion and prevention and of smoking cessation.

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