ORIGINAL RESEARCH

Mortality and economic burden of Krasnoyarsk region, Russia, caused by regular tobacco usage

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Background: This study assesses mortality and economic burden due to the regular tobacco usage among the population of the Krasnoyarsk region of the Russian Federation. This territory was chosen for the analysis because of two factors: high smoking prevalence in the Krasnoyarsk region (46% among the adult population) and premature mortality of the working-age population, which leads to a significant burden to the federal budget of the Russian Federation.
Data sources: In our work, three main causes of smoking-related deaths were considered: cardiovascular disease, lung cancer, and COPD. The working-age population was investigated (20–72 years old). The databases of mortality and population size of the territorial body of state statistics of the Krasnoyarsk region (data for 2013) were used as the information sources.
Methods: Joint application of population-attributable risk and disability-adjusted life years method allowed us to estimate medico-demographic and economic burden due to the tobacco-attributable premature mortality in the investigated population.
Results: We found that tobacco use-related economic burden is at least equal to 2% of the gross regional product of the Krasnoyarsk region in 2013.
Conclusion: An assessment of economic tobacco use-related burden is important for determining the volume of necessary funding for development of smoking prevention programs, proper estimation of tobacco companies' taxation, and other measures for controlling tobacco use. Smoking cessation is a priority for prevention of the tobacco-related diseases and reduction of their burden on local economy.
Keywords: lung cancer, COPD, cardiovascular disease, disability-adjusted life years, population-attributable risk, smoking-related mortality

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Introduction

Tobacco smoking is a medical, social, and economic problem worldwide. Cigarette usage leads to development of many diseases, loss of health, and premature mortality.[1–4] Regular tobacco smoking is responsible for approximately five million deaths in the world each year. According to studies done in Russia, smoking reduces life expectancy by 10–12 years.[5,6]

According to the World Health Organization (WHO), there are over one billion smokers worldwide, and 44 million in Russia alone.[7]

Regular tobacco use enhances risks of many diseases such as malignant neoplasms, cardiovascular diseases (CVDs), respiratory diseases, tuberculosis, stroke, diabetes, and gastrointestinal diseases. The three leading causes of smoking-related deaths are lung cancer, ischemic heart disease, and COPD.[1,5,8–14]

Tobacco kills people of working age – the most skilled workers. Therefore, regular tobacco use leads to additional economic burden.[8–10] Economic costs associated with cigarette smoking, calculated in several different ways, were obtained at a rate

of 1%–3% of the gross domestic product of the Russian Federation.[5,15,16]

The present study focuses on assessing the Krasnoyarsk region budget costs caused by tobacco smoking-related premature mortality in the working population. This territory was chosen for specific reasons. Krasnoyarsk region is one of the major districts of the Russian Federation with a population of approximately three million people covering the territory, equal to ~14% of the entire country. Krasnoyarsk region is one of the ten regions, responsible for >50% of the gross domestic product of the Russian Federation and the federal budget. It is the absolute leader among other regions of the country in the development of industrial products per capita. The population of the region heavily contributes to the industrial work force (such as in the chemical and metallurgical industries). Thus, premature mortality in this population leads to a significant financial burden to the federal budget of the Russian Federation. Therefore, health preservation is not only social but also an important economic problem.

According to the Global Adult Tobacco Survey 2009, 39.1% of the adult population of the Russian Federation are regular smokers: 60.2% men and 21.7% women.[17] Notably, the prevalence of smoking in the Krasnoyarsk region is higher than the average rates of smoking in Russia: ~46% of the adult population in the Krasnoyarsk region are active smokers, 65% men and 30% women.[18]

Therefore, the investigation and prevention of tobacco-related mortality and economic costs of the Krasnoyarsk region are important for the Russian Federation.

Methods

In our work, the three main smoking-related causes of deaths were considered (International Classification of Diseases-10 codes): CVD (I20–I25), lung cancer (C34), and COPD (J44). The adult population over 20 years old was investigated.

Data sources

The databases of mortality and population size of the territorial body of state statistics of the Krasnoyarsk region (data for 2013) were used as data sources. These databases contain information about the number of deaths by sex, age, and nosology. The data were collected by the 5-year age groups (20–24, 25–29, 30–34 years of age, etc).

We used the data of L Schwartz (personal communication, October 2013) for estimation of cause-specific mortality relative risks (RRs) for the different age groups (stratified mortality RRs).[19] The difference in tobacco

smoking prevalence in the USA and the Russian Federation was taken into account.

Ethical approval

As the databases used for this study are depersonalized and the data are not identifiable, patient consent was not required and ethical approval was not sought as per the Declaration of Helsinki.

Statistical analysis

Medical–demographic burden due to premature mortality in the investigated population caused by tobacco-related diseases was estimated using the disability-adjusted life years (DALY) method.[20]

The DALY index provides an assessment of health loss (in years). It measures the difference between the current situation and an ideal situation where everyone lives up to the age of standard life expectancy in perfect health.[20]

The DALY index consists of two components: years lived with a disability (YLD) and years lost due to premature mortality (YLL).[20–24]

$$DALY = YLL + YLD \qquad (1)$$

In Russia, there are some obstacles to calculating demographic health loss due to disability using the DALY method (YLD component). This method requires information about the disease prevalence, average disease duration, and cause-specific disability weight. The required information is absent in the databases of the Russian official statistics.[25] With regard to this, we used the DALY method only on the premature mortality data to estimate medical and demographic health loss.

The estimation of life years lost due to premature mortality was made using the formula given by Prüss-Üstün et al.[20] This formula has been programmed into calculation spreadsheet templates for DALY that are available at the WHO website. The age-weighting modulation constant $K=0$ was used for our calculations.

To estimate the smoking-attributable mortality, the following approach was used: to calculate the number of deaths directly caused by smoking, the total number of deaths was multiplied by the smoking population-attributable risk (PAR). PAR is a measure of the number of deaths caused exclusively by the presence of a specific risk factor in the population. Its value depends on the risk factor prevalence (fraction of smokers) and its influence strength (cause-specific mortality

Table 1 Cause-specific stratified mortality population-attributable risks

Cause (ICD-10 code)	Age group, years									
	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84
Men										
Cardiovascular diseases (I20–I25)	0.49	0.69	0.70	0.62	0.51	0.44	0.34	0.27	0.17	0.16
Lung cancer (C34)	0.10	0.64	0.77	0.92	0.96	0.95	0.94	0.94	0.92	0.88
COPD (J44)	0.80	0.80	0.80	0.80	0.84	0.88	0.91	0.84	0.89	0.85
Women										
Cardiovascular diseases (I20–I25)	0.13	0.25	0.63	0.54	0.41	0.29	0.27	0.20	0.14	0.03
Lung cancer (C34)	0.19	0.75	0.85	0.73	0.81	0.78	0.81	0.71	0.75	0.62
COPD (J44)	0.76	0.76	0.76	0.76	0.69	0.73	0.79	0.75	0.74	0.76

Abbreviation: ICD, International Classification of Diseases.

RR) and may be estimated using the standard attributable risk formula[26]:

$$PAR = \frac{p_s \cdot (RR-1)}{1 + p_s \cdot (RR-1)} = \frac{p_n + p_s \cdot (RR-1)}{p_n + p_s \cdot RR} \quad (2)$$

where p_n is the fraction of nonsmokers, p_s is the fraction of current smokers, and RR is the relative risk of mortality for smokers compared to nonsmokers.

We estimated the years of potential life lost related to tobacco smoking by multiplying years lost due to premature mortality (YLL) by the appropriate PAR for each age group, nosology, and sex.

Results

Table 1 shows cause-specific PARs by age group and sex obtained using the standard attributable risk formula, stratified mortality RR data (the data of L Schwartz),[19] and smoking prevalence data for the Russian Federation. The stratified mortality RR data are available only for the 35- to 84-year age group. Tobacco smoking consequences for health have a cumulative effect. To prevent overestimation of health loss, we set the PAR to zero for the 20- to 24-year age group, for the age group 25–29 – one-third of the risk value of the group 35–39, and for the age group 30–34 – two-thirds of 35–39 group risk value.

Table 2 shows the results from the main analysis of the tobacco-related cause-specific mortality, years of potential life lost, and economic burden by nosology and sex for the adult population under the age of 72. According to the "Methodology of economic cost of population mortality, morbidity and disability calculations" confirmed in 2012 by the Order No 323n of the Ministry of Public Health of the Russian Federation, 72 years is an age of expiry of the economic human activity. So, in our assessments, we assume that the working-age population is the population aged between 20 and 72 years.

Smoking-related mortality was obtained as the total number of deaths in a particular age group and nosology multiplied by the appropriate PAR. Smoking-related medical–demographic index DALY was estimated using the population size and smoking-related mortality data. Taking into account that the DALY unit represents lost years of healthy life, smoking-related economic burden is a multiplication of smoking-related DALY by gross regional product (GRP) per capita. GRP of the Krasnoyarsk region in 2013 amounts to 1,188.78 billion rubles according to the territorial body of state statistics of the Krasnoyarsk region. It is equal to 419.5 thousand rubles per capita.

The value of the regional budget burden due to the smoking-related premature mortality in the population in 2013 is 22.12 billion rubles. According to the Central Bank of the Russian Federation, 1€ =42.60 rubles and 1 US\$ =32.62 rubles (the data on July 16, 2013). Thus, the total budget loss

Table 2 Tobacco-related cause-specific mortality, years of potential life lost, and economic burden by nosology and sex for the adult population aged 20–72 years

Cause (ICD-10 code)	SAM	SA DALY	SA economic burden		
			Rubles (million)	Euros (million)	USD (million)
Total	3,959	52,730	22,119	519.3	678.1
Men					
Cardiovascular diseases (I20–I25)	2,217	29,519	12,383	290.7	379.6
Lung cancer (C34)	678	7,891	3,310	77.7	101.5
COPD (J44)	119	1,338	561	13.2	17.2
Total	3,014	38,748	16,254	381.6	498.3
Women					
Cardiovascular diseases (I20–I25)	801	11,944	5,010	117.6	153.6
Lung cancer (C34)	108	1,562	655	15.4	20.1
COPD (J44)	36	476	200	4.7	6.1
Total	945	13,982	5,865	137.7	179.8

Abbreviations: SAM, smoking-attributable mortality; SA, smoking-attributable; DALY, disability-adjusted life years; ICD, International Classification of Diseases.

corresponds to 519.3 million euros or 678.1 million dollars. The amount of the damage has resulted in a loss of 2% of the GRP of the Krasnoyarsk region in 2013. These costs could be avoided if the people of the region did not smoke.

Conclusion

Our study investigates mortality and economic burden assessments due to the regular tobacco usage in the population of the Krasnoyarsk region. This territory was chosen for the analysis because of the two factors: higher smoking prevalence compared to the average rates of smoking in Russia and tobacco use-related high premature mortality rates in the population. These factors collectively lead to a significant financial burden to the federal budget of the Russian Federation, as premature mortality in the working-age population results in significant GRP loss. We found that tobacco-related economic burden is at least equal to 2% of the GRP of the Krasnoyarsk region in 2013. These estimates, however, reflect only some of the economic costs of tobacco smoking.

We analyzed three main causes of smoking-related deaths: CVD, COPD, and lung cancer. It should be noted that regular tobacco smoking enhances risk for many other diseases. Therefore, additional consideration of these diseases will raise the value of the economic burden. Here, we estimated economic burden based only on assessment of tobacco use-related deaths, as smoking is associated with a high morbidity. In addition to the loss of GRP, smoking-related economic burden includes hospitalization expenses and disability payments. We did not consider the impact of secondhand smoke in our analysis.

WHO Framework Convention on Tobacco Control summarizes the world effort to effectively control tobacco use.[27] Presently, there is a worldwide emphasis on reducing the prevalence and intensity of tobacco smoking.[28,29]

The Federal Law No 15-FZ, "On the protection of public health from exposure to environmental tobacco smoke and effects of tobacco exposure" was adopted by the Russian Federation on February 23, 2013. One of the expected results is a reduction of smoking prevalence in the country.

Reduction in tobacco usage will lead to an increase in life expectancy in the population of working age people, reduce medical fees and disability payments, and decrease tax losses from regional businesses. Collectively, these will significantly reduce the economic burden to the federal budget of the Russian Federation. Therefore, development of programs and incentives for smoking cessation is a priority for prevention of the tobacco use-related diseases and reduction of their impact on the economy of the Russian Federation.

Disclosure

The authors report no conflicts of interest in this work.

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