The impact of cigarette smoking on life expectancy between 1980 and 2010: a global perspective[a]

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Abstract

Almost 6 million people died from smoking in 2010, and 8.3 million are expected to die from smoking in 2030, 80% of them in low- and middle-income countries (LMIC). Among the methods proposed to estimate smoking-related mortality, none seems adequate to analyze data from developing countries. This paper aims to estimate the time trends of the impact of smoking on life expectancy from 1980 to 2010 in 63 countries with data of moderate or high quality, in Africa (2), the Americas (15), Asia (12), Europe (32), and Oceania (2). We propose a revision of Peto-Lopez method taking into account national accumulated exposure to tobacco smoke and smoking-related risk of death, anchored to the country's level and position within the smoking epidemic spectrum. The impact of tobacco-smoking on life expectancy has decreased for men in high-income countries and some Latin American countries, but is still increasing in East Asia and southern-eastern Europe. Women from high-income countries observe the larger increases in the impact of tobacco on life expectancy.

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Introduction

The toll of cigarette smoking on mortality continues to rise worldwide. In 2010 almost 6 million people died from smoking, and more people are expected to die from smoking in the future, i.e. 8.3 million in 2030[1]; 80% of these deaths are projected to be in low- and middle-income countries[2]. More than 71% of lung cancer cases, 37% of chronic obstructive pulmonary disease (COPD) cases, and 34% of upper respiratory tract cancers can be attributed to tobacco smoking. Although only 11% of deaths from cardiovascular diseases are due to smoking, in terms of numbers, they contributed to 37% and 35% of total smoking-related deaths in 1985 and 2000, respectively[3, 4].

Several methods have been proposed to estimate smoking-related mortality[3, 5, 6], but none seems adequate to analyze data from less-developed countries. The evolving relative risks for smokers, depending on the maturity of the smoking epidemic[7, 8], and cross-country variation in the distribution of cause-specific deaths[5] are some of the challenges in the application of these methods to data from low- and middle-income countries. An adjustment of Peto-Lopez method was applied[4] to control for the fact that a high percentage of lung cancer mortality in non-smokers in China and other Asian countries may also be due to air pollution, but did not control for the two challenges mentioned earlier.

This paper aims to estimate the time trends of the impact of smoking on life expectancy from 1980 to 2010 in 65 countries worldwide, including 2 countries in Africa, 15 in America, 14 in Asia, 32 in Europe, and 2 in Oceania. To investigate the impact in low- and middle-income countries, we propose a revision of Peto-Lopez method that takes into account national accumulated exposure to smoking and smoking-related risk of dying, anchored to the country's level and position within the smoking epidemic continuum[7]. We validated the robustness of the results with a sensitivity analysis comparing the results with estimates obtained with another model for developed countries[5].

Methods

Data sources: cause-specific mortality

Data on age- and sex-specific mortality by cause of death were extracted from the WHO Mortality Database for 153 countries between 1980 and 2010. Only those countries with data of high or moderate quality[9] were included in the analysis, with the exception of South Africa. Countries included in the analysis are summarized in Table 1. Among the 63 countries, there are 2 in Africa, 15 in the Americas, 12 in Asia (although 13 regions, with Hong Kong Special Administrative Region considered separately from China), 32 in Europe, and 2 in Oceania. Annual national age- and sex-specific population estimates were obtained from the United Nations Population Division. We excluded those countries with a population of <1 million people, to avoid problems of reliability. Only 58 countries had data available for all three decades, but almost all countries had data available for the most recent decade (2000–2010), with the exception of China, which had data only until 2000. To avoid statistical problems caused by random variations, we included data only for adults aged 35 years and older.

Statistical analysis

Mortality from lung cancer has been used as a population indicator of lifelong exposure to smoking as mortality data are available for many countries worldwide and are relatively easy to measure. Using lung cancer mortality rates avoids the need to estimate the prevalence of smoking while takes into account the duration of exposure to smoke, the smoking intensity, or the type of tobacco used. Lung cancer mortality can therefore be converted into the smoking impact ratio (SIR) as a proxy for the prevalence of lifelong smokers in a population[10], as follows:

$$SIR = \frac{C_{\mathrm{LC}} - N_{\mathrm{LC}}}{S^{*}_{\mathrm{LC}} - N^{*}_{\mathrm{LC}}}$$

where C_{LC} and N_{LC} are the total lung cancer mortality rate and the lung cancer mortality rate of never-smokers, respectively, in the population under study, and S_{LC}^{*} and N_{LC}^{*} are the lung cancer mortality rates of smokers and never-smokers, respectively, from the Cancer Prevention Study Phase II (CPS-II). When N_{LC} is not available, N_{LC}^{*} is used instead.

Lung cancer mortality rates in never-smokers can be particularly high due to the level of indoor air pollution caused by the use of coal as a home cooking fuel in some countries like China[11]. Assuming that lung cancer cases are caused mainly by high tobacco smoking prevalence would thus lead to overestimation of the proportion of smoking-related deaths. In such instances, we used the correction factor presented by Ezzati and Lopez[10] that consists in normalize the SIR ratio with lung cancer mortality rates for never smokers from China weighted by the level of prevalence of coal use as home fuel in each country[12]:

$$SIR = \frac{C_{\mathrm{LC}} - N_{\mathrm{LC}}}{S^{*}_{\mathrm{LC}} - N^{*}_{\mathrm{LC}}} \cdot \frac{N^{*}_{\mathrm{LC}}}{N_{\mathrm{LC}}}$$

The relative risk (RR) of dying for smokers compared with non-smokers according to cause of death, sex, and age group were derived from CPS-I, CPS-II, and CPS-Contemporary Cohort. The RR of dying for smokers compared with non-smokers has evolved in parallel with the smoking epidemic, especially in the case of those causes highly related to smoking, such as lung cancer and upper aerodigestive tract cancers or COPD[6, 8]. For male smokers, RR has increased only slightly since the smoking-attributable mortality started to decline, with the exception of COPD RR, which has continued to increase greatly with time. For female smokers, the RR of dying has markedly increased. Therefore, using RR as reported by the CPS-II study group in the 1980s would lead to overestimation of the percentage of smoking-related deaths for countries with low smoking prevalence but would underestimate this proportion for countries with higher smoking prevalence. To correct for these changes, we applied a different RR depending on which stage of the smoking epidemic the country was in, using the RR of the smoking epidemic in the USA – the three different CPS waves – as a reference[8].

There is increasing evidence that tuberculosis is a smoking-related cause of death[11, 13, 14]. Tuberculosis has not been considered in previous analyses of the impact of smoking on mortality because of the very low tuberculosis mortality rates in developed countries. However, the importance of tuberculosis in developing countries is undeniable[15] and it has already been included as a separate cause of mortality due to smoking in several studies[11, 16]. The RR of dying for smokers compared with non-smokers used for tuberculosis as a cause of death was extracted from Lin et al.[17]

The proportion of deaths attributable to accumulated exposure to tobacco smoke was estimated using the population attributable fraction (PAF), which is calculated as follows:

$$PAF = \frac{p \cdot (RR - 1)}{\left[1 + p \cdot (RR - 1)\right]}$$

where p is the prevalence of lifelong smokers in the population (the SIR in our case) and RR is from the CPS studies. We estimated the PAF due to smoking separately by sex and 5-year age group and for each cause of death (lung cancer, upper aerodigestive tract cancers, other cancers, COPD, other respiratory diseases, CVDs, tuberculosis and other medical causes).

To avoid the effects of confounding from other risk factors, we applied a reduction of 50% to excess mortality related to tobacco smoking for all causes except for lung cancer, which includes all other cancers, CVDs, COPD, other respiratory diseases, and other medical causes. Some of the medical causes (rest if infectious and parasitic diseases, maternal and perinatal conditions, neuropsychiatric conditions, cirrhosis of the liver, and congenital anomalies) and non-medical causes (injuries and accidents) were assumed not to be affected by tobacco smoking.

The impact of tobacco-smoking on life expectancy at age 40 was estimated using a cause-deleted life table, applying the smoking-related PAF for each cause of death and excluding the total number of smoking-related deaths by age and sex from the observed mortality. The proportions were applied to UN life tables of 5-year period for each country. Time trends of the impact of smoking on life expectancy (measured as years of life expectancy gained after deleting smoking deaths) by country and sex were quantified for the most recent 10 years of each country using the estimated annual percent change (EAPC) estimated using a log-linear regression.

Preliminary results

Impact of smoking on life expectancy

We assessed the impact of smoking on life expectancy at age 35 years by estimating the difference between the life expectancy with and without smoking-related deaths. Among men, the impact of smoking on life expectancy has been particularly high (Table 1); the impact was highest in Singapore and the Netherlands in 1991 and 1988, respectively, with >6.5 years of life expectancy gained when smoking-related deaths were excluded. In the latest year (2010), Hungary had the largest difference between life expectancy with and without smoking-related deaths (5.9 years). Finland was the country showing the most absolute improvement in reducing the impact of smoking on life expectancy, with a change from an impact of 5.8 years in 1981 to 2.9 years in 2009. Although the majority of countries experienced a reduction in the number of years of life expectancy lost by smoking-related deaths, some of them, concentrated in southern and eastern Europe, Asia, and Latin America, showed a growing impact of smoking on life expectancy, as the number of years of life expectancy lost due to smoking increased from 1980 to 2010.

Tobacco smoking has taken fewer life years in women than in men, as the largest impact of smoking on life expectancy among women is of 2.6 years in the USA in 2010. However, the majority of countries have had an increase in the impact of smoking on life expectancy in women where the Netherlands showed the highest absolute increase, from only 1.2 years in 1980 to 2.4 years in 2010. Among the countries that showed a decreasing impact of smoking on life expectancy, Singapore diverged from the rest of the group with 1.4 years of life expectancy lost caused by smoking-related deaths in 1980 that decreased in 0.35 in 2010. The rest of countries that also experienced reductions in the impact of smoking on life expectancy showed very low levels of smoking burden in their mortality and the decrease is not significant.

Figure 1 compares the trend over the most recent 10 years analysed for each country after estimating the annual percentage change (EAPC) of the number of years of life expectancy lost due to smoking to the maximum number of years of life expectancy lost during the period for each country. In both sexes, there is a quadratic relationship between the EAPC and the number of years of life expectancy lost in accordance with the stages of the smoking epidemic. In stage 1, countries are concentrated in small impacts of smoking on life expectancy and/or negative EAPC of the number of years of life expectancy lost during the most recent 10 years. In stage 2, the correlation between EAPC and years lost is positive, and all countries show an increasing trend for the 10 most recent years under study. Finally, in stages 3 and 4 the relationship between the recent trend (EAPC) and years lost changes to a negative correlation, where those countries with higher impacts of tobacco smoking on life expectancy also seem to have the larger negative EAPC values.

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