

Lung cancer mortality in European regions (1955–1997)

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Background: The different spread of tobacco smoking across European countries has caused a substantial variability in lung cancer mortality. The objective of this investigation was to analyse the trends in lung cancer mortality rates in three broad European regions (Northern and Western countries, Eastern countries, and Mediterranean countries) during the second half of the 20th century.

Patients and methods: Mortality data were obtained from the World Health Organisation database. Lung cancer mortality rates were age-standardised by the direct method to the world standard population. Trends from 1955 to 1997 were assessed by means of joinpoint regression analysis.

Results: In men, rates in Eastern Europe increased to reach in the 1990s the highest values ever registered, while downward trends were observed in Northern and Western Europe since 1979, and in Mediterranean countries since the 1990s. In women, upward trends were observed in the three regions considered for the whole period.

Conclusions: Different smoking prevalences over time explain the shift of almost one decade in the trends in Mediterranean men as compared with Northern and other Western European men. The persisting upward trends in women in the three regions are of concern.

Key words: epidemiology, Europe, lung cancer, mortality, time trends, smoking

Introduction

Lung cancer is the leading cause of cancer mortality in Europe in men and the third in women [1]. Smoking has been consistently established as the main aetiologic factor for lung cancer, and accounts for about 85–90% of cases [2]. The different spread of tobacco smoking across European countries has caused a substantial variability in lung cancer mortality [3]. An analysis of lung cancer mortality trends by different geographical areas offers an interesting picture from an epidemiological and public health perspective. Thus, we analysed the trends in lung cancer mortality rates in three broad European regions (Northern and Western countries, Eastern countries and Mediterranean countries, see Table 1) during the second half of the 20th century.

Data and methods

Mortality data were obtained from the World Health Organisation database [1]. Mortality rates were computed by the direct method, and standardised by quinquennia of age using the world standard population, for comparative purposes of other areas of the world. The pattern of trends described was in any case similar using the European standard population. Joinpoint regression analysis was used to identify points where a statistically significant change in

the linear slope of the trend occurred [4]. In joinpoint analysis, the best-fitting points (the 'joinpoints') where the rate changes significantly (increase or decrease) are chosen. The analysis starts with the minimum number of joinpoints (e.g. no joinpoints, which is a straight line) and tests whether one or more joinpoints are statistically significant and must be added to the model (up to four joinpoints). In the final model each joinpoint (if any) indicates a statistically significant change in trend, and an annual per cent change (APC) is computed by each of those trends by means of generalised linear models assuming a Poisson distribution. Significant changes include changes in direction or in the rate of increase or decrease. The computation of mortality rates and their standard errors was implemented in S-PLUS (S-PLUS 2000; MathSoft, Inc., 1999). The joinpoint analyses were performed using the 'Joinpoint' software from the Surveillance Research Program of the US National Cancer Institute (available at <http://www-dceps.ims.nci.nih.gov/SRAB>).

Results

Lung cancer mortality trends showed different patterns in various European regions (Figure 1). In Northern and other Western European countries, lung cancer mortality rates increased from 1955 to 1962 by 4.0% per year and to a lesser degree up to 1979, and declined thereafter (Table 1). Thus, these countries had the highest lung cancer rates in the first three decades, but the lowest ones since the mid-1990s. A different pattern was observed in Eastern Europe. Rates increased up to 1987, more sharply in the early 1960s (APC 7.0%), and levelled off in more recent periods (APC –0.3%). Consequently, male lung cancer mortality in the 1990s in Eastern Europe was the highest ever registered, being

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Table 1. Annual per cent change (APC) in the mortality rates of lung cancer in different time periods, as derived from joinpoint analysis

European regions ^a	Periods and APC									
	Trend 1		Trend 2		Trend 3		Trend 4		Trend 5	
	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC
Males										
Northern and Western	1955–62	4.03 ^b	1962–69	2.08 ^b	1969–79	0.67 ^b	1979–88	-0.80	1988–97	-2.29 ^b
Eastern	1960–64	6.97 ^b	1964–87	2.33 ^b	1987–97	0.34	–	–	–	–
Mediterranean	1955–64	6.18 ^b	1964–79	3.59 ^b	1979–88	1.72 ^b	1989–95	-0.30	1995–97	-3.27 ^b
Females										
Northern and Western	1955–67	3.02 ^b	1967–73	1.91 ^b	1973–87	3.06 ^b	1987–97	1.66 ^b	–	–
Eastern	1960–76	1.33 ^b	1976–96	2.87 ^b	–	–	–	–	–	–
Mediterranean	1955–82	1.38 ^b	1982–97	1.86 ^b	–	–	–	–	–	–

^aNorthern and other Western: Austria, Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland and UK.

Eastern: Bulgaria, Czechoslovakia, Hungary, Poland and Romania (period 1960–1996). Mediterranean: France, Greece, Italy, Portugal and Spain.

^bThe APC is significantly different from 0 ($P < 0.05$).

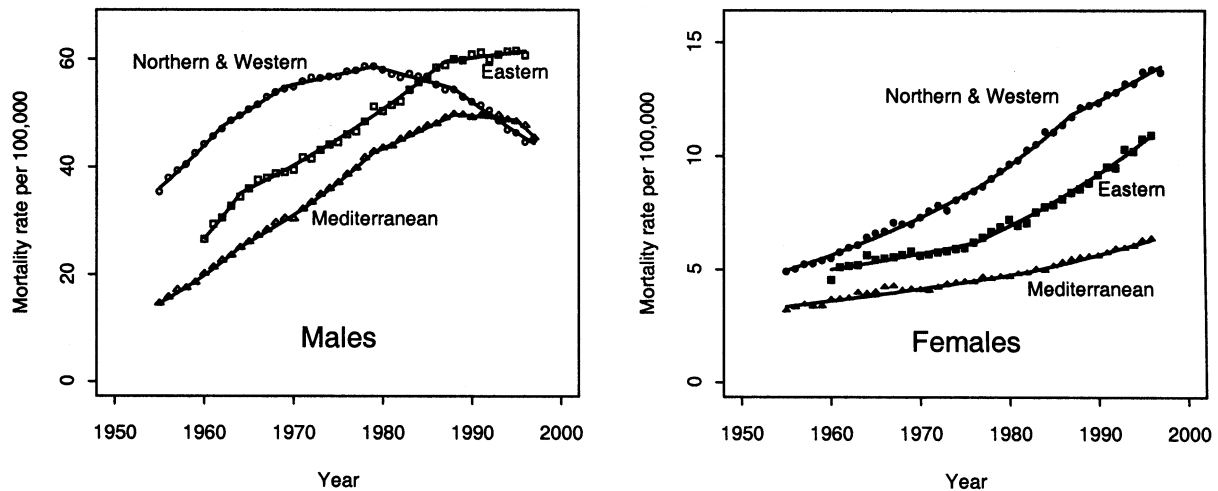


Figure 1. Joinpoint analysis for lung cancer in Europe, 1955–1997. Northern and other Western countries: Austria, Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland and UK. Eastern countries: Bulgaria, Czechoslovakia, Hungary, Poland and Romania (period 1960–1996). Mediterranean countries: France, Greece, Italy, Portugal and Spain.

higher than that reported in Western countries in the 1970s. The Mediterranean region had the lowest lung cancer mortality rate at the beginning of the study period (Figure 1), but trends monotonically increased until a peak was reached in 1988. Lung cancer mortality was stable between 1988 and 1995, and significantly decreased thereafter (APC -3.3%).

In women, lung cancer mortality rates were considerably lower than in men (Figure 1). Upwards trends were observed in the three regions considered for the whole period, although some differences in the slopes emerged. The sharpest increases were in Western and Northern Europe in 1955–1967 (APC 3.0%) and in 1973–1987 (APC 3.1%), and trends were still upwards in recent years, although with a flatter slope (APC 1.7% in 1987–1997). Conversely, increases were steeper in more recent years in Eastern Europe (APC 2.9% in 1976–1996) and in the Mediterranean region (APC 1.9%, 1982–1997). For the whole period, the

highest rates were registered in Northern and Western Europe, and the lowest ones in Mediterranean countries.

Discussion

The changes in the prevalence of smoking in men may explain the decrease in lung cancer rates in Northern and Western countries after 1970 [5], since the effects on lung cancer mortality of changes in smoking pattern become evident after a few decades. No major improvements in lung cancer treatment and survival have occurred that could have influenced mortality trends during the past years [6]. In women a different pattern emerged. In the Northern and Western region, the smoking epidemic in women reached a peak around the 1960s (smoking prevalence about 40–50%), followed by a recent decline [5, 7]. Thus, a levelling off of lung cancer mortality rates in this region

can be expected in the future, as already observed in the UK [8] (although at one of the highest rates registered worldwide).

The mortality rates among men in Eastern Europe increased less steeply in recent years, after remarkable previous upward trends. Nonetheless, as a consequence of the marked increase in smoking prevalence, the mortality rates in this region are now the highest in Europe. In spite of a steady increase in rates during the whole period, rates in women were five to six times lower than in men. As the prevalence of smoking women is still increasing [7, 9], further upward trends in lung cancer mortality rates are expected in women in the coming years.

During the last years of the study period, lung cancer mortality rates decreased among males in the Mediterranean region as a consequence of the changes in smoking pattern which occurred since the 1970s [5, 10, 11]. The pattern of trends in the Mediterranean region appears similar to that of the Northern and Western countries, although shifted by almost one decade [12]. To support the recent favourable tendency, anti-smoking activities should be maintained and increased.

Problems of data comparability, diagnostic improvement or certification reliability, although potentially present, can hardly explain the magnitude of the changes observed. The use of the joinpoint method of analysis has allowed a new approach to the description of the pattern of cancer mortality over the last 50 years, since it identifies the calendar years in which statistically significant changes in the trends occurred.

In conclusion, different patterns in lung cancer mortality—consistent with the corresponding smoking experience—were observed among European regions. While downward trends in Mediterranean and in Northern and other Western countries are apparent in men, the persistently high rates in men in Eastern countries and the increasing trends in women in various areas of the continent are of major concern.

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