

Lung Cancer Mortality Trends in Spain Between 1980 and 2005

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OBJECTIVE: To describe trends in lung cancer mortality in Spain between 1980 and 2005.

MATERIAL AND METHODS: Data on deaths from lung cancer during the study period were obtained from the Spanish National Institute of Statistics. Global and truncated (35 to 64 years) age-specific and gender-specific mortality rates were calculated and expressed as rates per 100 000 person-years. Trends were analyzed using joinpoint regression models.

RESULTS: In 2005 in Spain, 16 647 men and 2471 women died from lung cancer, accounting for 26.6% and 6.6%, respectively, of all cancer deaths. In men, truncated mortality rates initially increased in the 1980-1992 period (3.1% per year, $P < .05$) but began to decrease in the 1992-2005 period (-0.8% per year, $P < .05$). Starting in the 1990s, age-specific mortality rates showed a statistically significant decrease in patients aged less than 85 years. For women, after an initial stable period, truncated mortality rates increased significantly from 1992 onward by 6.3% per year. The analysis by age groups showed that the rates increased in all age groups, except for patients aged 25 to 34 years and patients aged 75 to 84 years, in whom they remained stable.

CONCLUSIONS: While lung cancer mortality began to decrease slightly among Spanish men 15 years ago, it increased significantly among women during the same period.

Mortalidad por cáncer de pulmón en España. Evolución en 25 años (1980-2005)

OBJETIVO: Describir la evolución de la mortalidad por cáncer de pulmón en España durante el período 1980-2005.

MATERIAL Y MÉTODOS: Las defunciones por cáncer de pulmón durante el período de estudio se obtuvieron del Instituto Nacional de Estadística. Se calcularon las tasas específicas globales y truncadas (35-64 años) por grupos de edad y sexo, que se expresan como tasas por 100.000 personas-año. Para el análisis de tendencias de las tasas se utilizaron modelos de regresión *joinpoint*.

RESULTADOS: En 2005 se produjeron en España 16.647 defunciones por cáncer de pulmón en varones y 2.471 en mujeres, lo que representó el 26,6 y el 6,6% de la mortalidad por tumores, respectivamente. En los varones las tasas truncadas, tras un período de incremento (1980-1992, un 3,1% anual; $p < 0,05$), comienzan a descender (1992-2005, un -0,8% anual; $p < 0,05$). Las tasas específicas por grupos de edad muestran un descenso estadísticamente significativo por debajo de los 85 años que comienza en la década de los noventa. En las mujeres las tasas truncadas, tras un período inicial en que permanecen estables, se incrementan significativamente a partir de 1992 un 6,3% anual. El análisis por grupos de edad muestra que las tasas se han incrementado en todos ellos, excepto en los grupos de 25-34 y 75-84 años, donde permanecen estables.

CONCLUSIONES: Mientras que la tendencia de mortalidad por cáncer de pulmón en los varones españoles comenzó a descender ligeramente hace 15 años, en las mujeres se observa un aumento llamativo durante el mismo período.

Key words: Lung cancer. Mortality. Trend. Epidemiology. Smoking.

Palabras clave: Cáncer de pulmón. Mortalidad. Tendencia. Epidemiología. Tabaco.

Introduction

Lung cancer mortality has varied considerably in recent years. In the European Union, lung cancer is currently responsible for most cancer-related deaths in men and is

the third most common cancer-related cause in women: 171 990 men and 64 100 women were estimated to have died from lung cancer in 2006, that is, 26.3% and 12.5% of all cancer deaths, respectively,¹ even though data from the period 1997 to 2002 show that standardized mortality rates fell by 1.9% annually in men, whereas in women they increased by 1.6%.²

While lung cancer mortality among women continues to increase in many EU countries, more favorable trends have been observed in recent years, especially in younger age groups.^{3,4} In fact, after growing by 2.8% between 1970 and 1991, lung cancer mortality rates among EU women

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aged 20 to 44 years began to fall by 3.6% per year.⁵ This means that if we can take effective measures to reduce the number of women who smoke, the lung cancer epidemic in the European Union could be brought under control and would not reach the levels observed in the United States.⁵

In the Spanish autonomous community of Andalusia, after 2 periods with significant increases (1975-1988 and 1988-1994) and annual increases of 3.6% and 1.4% for men and women, respectively, standardized lung cancer mortality rates for men stabilized during the period 1994 to 2002. By contrast, after an initial decrease of 0.5% ($P<.05$) between 1975 and 1992, the number of women who died from lung cancer increased significantly by 3.3% per year.⁶

In Spain, studies reporting trends in cancer mortality were carried out during the late 1980s and early 1990s,⁷⁻⁹ just when the changes in mortality rates reported in other countries were first observed. However, there are no recent studies on lung cancer mortality in Spain that allow us to ascertain whether the changes observed in Andalusia and the rest of Europe can also be observed in the Spanish population as a whole at this time. Therefore, we decided to use joinpoint regression analysis to provide updated information on lung cancer mortality in Spain and to analyze recent changes in the mortality trends for 1980 through 2005.

Materials and Methods

Data on population and deaths from lung cancer according to age group and sex were obtained from the database of the Spanish National Institute of Statistics.¹⁰ Specific rates by age group, standardized rates (all ages), and truncated rates (35-64 years) were calculated for men and women using the direct method with the European population as a reference. Rates were expressed per 100 000 person-years.

Joinpoint regression models were used to analyze rate trends. These models make it possible to identify when significant changes in the trend occur and to estimate the magnitude of the increase or decrease observed during each interval. Thus, the results obtained show the years that make up each trend and the annual percentage change for each trend.

These models were calculated using standardized mortality rates and their standard errors. For the models based on age

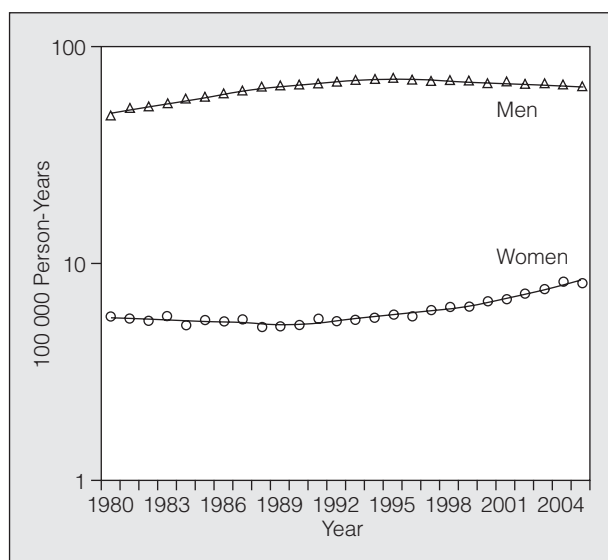


Figure 1. Lung cancer mortality in Spain (1980-2005). Standardized rates per 100 000 person-years (European standard population).

group, deaths and populations were calculated using a Poisson distribution. A maximum of 2 inflection points were sought in each regression. To do this, the program uses the weighted minimum squares method to look for the simplest model that fits the data and then calculates the statistical significance of changes identified by means of Monte Carlo simulations.¹¹ Statistical significance was set at .05.

Mortality rates and their standard errors were calculated using a spreadsheet (Microsoft Excel). Joinpoint regression analyses were carried out using the software package Joinpoint version 3.0 from the Surveillance Research Program of the US National Cancer Institute.¹²

Results

During 2005, a total of 16 647 men and 2471 women died from lung cancer in Spain, representing 26.6% and 6.6% of all deaths from cancer, respectively. Figure 1 shows the standardized lung cancer mortality rates for both sexes. Tables 1 and 2 set out the specific rates by age group. These rates are gross and standardized for the years

**TABLE 1
Lung Cancer Mortality Rates (Spain, 1980-2005) and Joinpoint Regression Analysis for Men**

Age Group, y	1980 Rate	2005 Rate	APC 1980-2005	Trend 1		Trend 2		Trend 3	
				Period	APC	Period	APC	Period	APC
25-34	1.6	0.6	-3.4 ^a	1980-1990	1.4	1990-2005	-6.2 ^a		
35-44	7.3	8.4	0.0	1980-1992	6.2 ^a	1992-2005	-4.4 ^a		
45-54	38.3	57.1	1.5 ^a	1980-1988	4.1 ^a	1988-1999	1.6 ^a	1999-2005	-2.0 ^a
55-64	119.3	156.8	0.7 ^a	1980-1992	2.6 ^a	1992-2005	-0.8 ^a		
65-74	252.6	303.7	0.5 ^a	1980-1993	2.3 ^a	1993-2005	-1.1 ^a		
75-84	292.3	455.7	1.4 ^a	1980-1994	2.9 ^a	1994-2005	0.2 ^a		
≥85	226.7	433.6	2.3 ^a	1980-1994	4.1 ^a	1994-2005	0.7		
Gross rate ^b	41.2	78.3	2.4 ^a	1980-1989	5.0 ^a	1989-1995	3.0 ^a	1995-2005	0.3
Standardized rate ^b	48.5	65.8	0.93 ^a	1980-1988	3.4 ^a	1988-1994	1.7 ^a	1994-2005	-0.7 ^a
Truncated rate ^b	50.0	67.8	0.90 ^a	1980-1992	3.1 ^a	1992-2005	-0.8 ^a		

Abbreviation: APC, annual percentage change.

^aAPC significantly different from 0 ($P<.05$).

^bRates per 100 000 person-years (European standard population).

TABLE 2
Lung Cancer Mortality Rates (Spain, 1980-2005) and Joinpoint Regression Analysis for Women

Age Group, y	1980 Rate	2005 Rate	APC 1980-2005	Trend 1		Trend 2		Trend 3	
				Period	APC	Period	APC	Period	APC
25-34	0.6	0.4	-1.2	1980-2005	-1.2				
35-44	1.8	4.0	5.2 ^a	1980-2005	5.2 ^a				
45-54	5.0	13.4	5.1 ^a	1980-1994	0.5	1994-2005	10.1 ^a		
55-64	11.2	17.8	1.9 ^a	1980-1989	-1.9	1989-1999	2.2 ^a	1999-2005	6.6 ^a
65-74	25.1	27.2	0.4 ^a	1980-1989	-1.8 ^a	1989-2001	0.9 ^a	2001-2005	4.0 ^a
75-84	41.4	42.2	-0.05	1980-2005	-0.05				
≥85	38.5	53.1	0.8 ^a	1980-2005	0.8 ^a				
Gross rate ^b	6.1	11.2	2.7 ^a	1980-1992	1.1 ^a	1992-2005	3.9 ^a		
Standardized rate ^b	5.7	8.2	1.7 ^a	1980-1990	-0.8 ^a	1990-1999	2.2 ^a	1999-2005	4.8 ^a
Truncated rate ^b	5.6	11.3	3.5 ^a	1980-1992	-0.3	1992-2005	6.3 ^a		

Abbreviation: APC, annual percentage change.

^aAPC significantly different from 0 ($P < .05$).

^bRates per 100 000 person-years (European standard population).

TABLE 3.
Percentage of Smokers in the General Population by Age and Sex. Population Aged 16 Years or Over. Spain, 1987-2003²⁵

	1987	1993	1995	1997	2001	2003	APC 1987-2003
Men							
16-24 years	54.6	38.6	39	35.9	36.5	38.5	-1.00%
25-44 years	63.6	57.7	54.3	55.4	49.9	45.7	-2.00%
45-64 years	53.7	42.8	42.9	41.5	39.9	37.9	-1.70%
≥65 years	35.5	20.1	24.2	19.9	17.2	16.8	-2.10%
Total	54.7	48	47.2	44.8	42.1	37.5	-2.50%
Women							
16-24 years	48.7	33.8	40.5	34.5	36.9	35.3	-0.60%
25-44 years	33.4	35.1	40.4	43.4	39.9	38.2	1.60%
45-64 years	5.2	8.4	10.7	11.6	16.1	19.4	9.60%
≥65 years	1.9	1.6	1.6	1.4	1.8	1.7	-0.90%
Total	22.9	25	27.2	27.2	27.2	24.7	0.30%

Abbreviation: APC, annual percentage change.

1980 and 2005. Similarly, the results of the joinpoint regression analysis (that is, the points at which the rates change significantly) and the annual percentage change for each trend in men and women are shown.

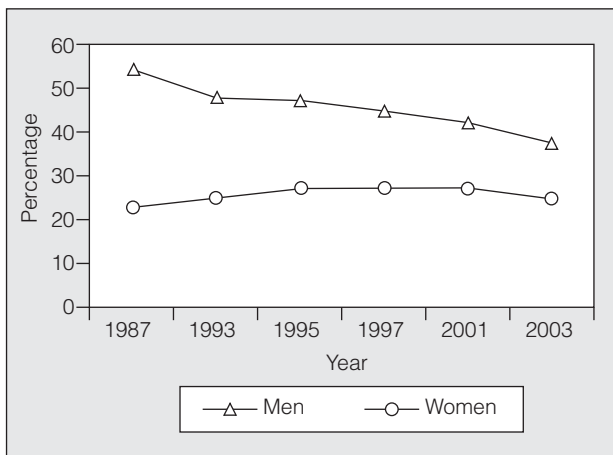


Figure 2. Percentage of the adult population (≥16 years) who were smokers.

The age-adjusted lung cancer mortality rate in men rose from 48.5 per 100 000 men in 1980 to 65.8 per 100 000 men in 2005, for a mean annual increase of 0.9% ($P < .05$). The joinpoint regression analysis identified 1 period with a statistically significant decrease (-0.7% from 1994 onward), preceded by 2 periods with significant increases (1980-1988 and 1988-1994, with increases of 3.4% and 1.7%, respectively). A similar situation was observed in the truncated rates (35-64 years), that is, after an increase between 1980 and 1992 (3.1% per year; $P < .05$), the rates began to decrease by 0.8% per year ($P < .05$) until 2005. When age group was analyzed, a statistically significant decrease beginning in the 1990s was observed in almost all groups (although not in individuals aged more than 85 years).

The mortality rates for women are considerably lower than those recorded for men. During the study period, the standardized rates increased by 1.7% per year (from 5.7% in 1980 to 8.2% in 2005). The joinpoint regression analysis identified 3 periods: in 1 period (1980-1990) a decrease (0.8% per year) was identified and in the remaining 2 periods (1990-1999 and 1999-2005) increases (2.2% per year and 4.8% per year, respectively) were identified (all comparisons, $P < .05$). After a period of stabilization, the truncated rates increased significantly by 6.3% per year from 1992 onward. The analysis by age group showed that rates increased in all age groups, except in patients aged 25 to 34 years and patients aged 75 to 84 years, in whom they remained stable throughout the study period (1980-2005).

Discussion

In this study, we analyzed lung cancer mortality in Spain between 1980 and 2005. To our knowledge, this is the first analysis of trends with national data and a long follow-up period (25 years). Joinpoint regression studies are a new tool that can help us to determine changes in the trends of mortality rates and to identify exactly when these changes occur and measure them. This in turn makes it possible to provide a more exhaustive description of changes in the rates and to establish hypotheses on trends over time.¹¹

Studies based on death certificates may be limited by the quality of the data. Fortunately, in Spain, the quality of the death certificates is acceptable,^{13,14} and they can therefore be used in mortality studies. Our study also includes an analysis of the truncated rates (35-64 years), in which the quality of the information on cause of death is higher. For these reasons and because of the poor survival associated with lung cancer, mortality figures are considered a reliable indicator of incidence.¹⁵⁻¹⁷

The fall observed in lung cancer mortality rates in Spanish men (Figure 1 and Table 1) is similar to that recorded in other Mediterranean countries¹⁸ and in the north of Europe,^{19,20} although in the latter this decrease occurred a decade earlier. Similarly, the increase in the number of women who died of lung cancer is consistent with reports from previous studies carried out in Spain, such as the Spanish national multicenter study EpicliCP-2003,²¹ which showed an increase in the incidence of lung cancer in women compared with previous studies by the same group.²²

The main risk factor for lung cancer is smoking, which is responsible for 85% to 90% of all related deaths.²³ Therefore, it would be interesting to comment on changes in mortality rates and the prevalence of smoking. In Spain, the first representative estimate of the prevalence of smoking was made in 1978 (53.9% of men and 16.5% of women aged over 8 years smoked regularly).²⁴ The Ministry of Health carried out a further 2 studies in 1982 and 1989, as well as a series of standardized National Health Surveys that included a section on smoking.²⁵ With the exception of the series of national surveys, the information from other studies is not strictly comparable due to changes in the definition of smoker and the age range of the target population. The 6 National Health Surveys carried out between 1987 and 2003 (Table 3) show the number of smokers in the adult population. The effect observed is that the difference in prevalence between men and women aged over 16 years becomes smaller (Figure 2). In 2003, 31.1% of the Spanish population aged 16 years or older (37.6% of men and 24.7% of women) smoked (occasional smokers plus active smokers). This percentage has been falling since 1987 both in the population as a whole (prevalence fell by 19.8%) and in men (prevalence fell by 31.4%). Women began smoking later than men as a result of sociocultural factors related to the equal rights movement and their joining the workforce, factors that have been widely and skillfully used by the tobacco industry.²⁶ Between 1987 and 2003, the number of women smokers increased by 7.9%.²⁷

The National Health Surveys were used to estimate the prevalence for the period between 1945 and 1995,²⁸ revealing a progressive increase in the percentage of men who smoke until a peak prevalence (of approximately 60%) was reached around 1975. This figure remained stable for a decade before beginning to decline. The increase in smoking prevalence among women began around 1970 and continued until it peaked at 27.2% in 1995.²⁹ Taking these data into consideration, and given that the latency period before the effects of smoking on mortality can be observed is 30 years,^{30,31} the change in lung cancer mortality trends in men and women in Spain could be attributed to

changes in smoking pattern during the 1970s. In fact, in the EpicliCP-2003 study, 37.6% of patients diagnosed with cancer had been abstinent for longer than 10 years, thus indicating a long latency period.²¹

In the European Union, after an increase of 2.8% between 1970 and 1991, lung cancer mortality rates in women aged 20 to 44 years began to decrease by 3.6% per year.⁵ Our data (Table 2) show that lung cancer mortality rates in women aged 25 to 34 years fell by 1.2% per year between 1980 and 2005, although this decrease was not statistically significant. Similarly, the number of smokers decreased between 1997 and 2003 (Table 3) in women aged 25 to 44 years (from 47.1% to 38.2%).²⁷ This decrease shows that if we can continue to reduce the number of young women who smoke, the lung cancer epidemic in Spain could be brought under control and would not reach the levels observed in the United States.⁵

To conclude, the trends observed in lung cancer mortality in Spain between 1980 and 2005 agree with the changes observed in the prevalence of smoking and are similar to those recorded in neighboring countries.

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