ORIGINAL ARTICLES

Trends in Lung Cancer Mortality Rates in the Provinces of Andalusia, Spain, 1975-2002

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OBJECTIVE: To describe trends in lung cancer mortality rates in the different provinces of Andalusia, Spain, from 1975 through 2002.

MATERIAL AND METHODS: Deaths from lung cancer during the period 1975 through 2002 were obtained from the Spanish national institute of statistics. Crude rates and age-adjusted rates (overall and truncated 35-64 year rates) were calculated.

RESULTS: In Andalusia in 2002 there were 2802 deaths from lung cancer in men and 254 in women, representing 28.4% and 4.5%, respectively, of the mortality rate from tumors. Joinpoint regression analysis distinguished 3 recent trends in truncated (range, 35-64 years) lung cancer mortality rates in men: decrease in Sevilla, increase in Huelva and Jaen, and stability in the other provinces. For women there was a marked increase (5.2% annually) during the period 1988 through 2002 in Malaga.

CONCLUSIONS: From a strategic point of view, antismoking strategies should target women in the province of Malaga in particular, with the aim of detaining their increasing risk for this type of cancer and of preventing avoidable and premature deaths among future generations of women.

Key words: *Lung cancer. Mortality. Trends. Epidemiology. Smoking.*

Evolución de la mortalidad por cáncer de pulmón en las provincias de Andalucía (1975-2002)

OBJETIVO: Describir la evolución de la mortalidad por cáncer de pulmón en Andalucía durante el período 1975-2002 a nivel provincial.

MATERIAL Y MÉTODOS: Las defunciones por cáncer de pulmón durante el período 1975-2002 se obtuvieron del Instituto Nacional de Estadística. Se han calculado los siguientes indicadores: tasas brutas y tasas ajustadas por edad (globales y truncadas 35-64 años).

RESULTADOS: En 2002 se produjeron en Andalucía 2.802 defunciones por cáncer de pulmón en varones y 254 en mujeres, lo que representó el 28,4 y el 4,5% de la mortalidad por tumores, respectivamente. El análisis *joinpoint* permitió delimitar 3 tendencias diferenciadas en los últimos años (descenso en Sevilla, incremento en Huelva y Jaén, y estabilización en el resto de provincias) en las tasas truncadas (35-64 años) de mortalidad por cáncer de pulmón en varones. En las mujeres destacó el fuerte incremento (un 5,2% anual) observado en el período 1988-2002 en Málaga.

CONCLUSIONES: Desde el punto de vista estratégico es recomendable que las medidas antitabaco se dirijan especialmente a las mujeres de la provincia de Málaga, con el fin de detener el creciente incremento del riesgo de padecer este tipo de cáncer e impedir muertes evitables y prematuras entre las generaciones futuras de mujeres.

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

Introduction

Lung cancer is the most common cause of death from cancer in the European Union and continues to have an enormous impact on the health of Europeans.[1] Since the end of the 1980s, rates have been decreasing for men in most countries, while the much-lower rates for women have been increasing.[2] In Andalusia, lung cancer is the main cause of death from cancer in men and the fifth cause in women. In earlier studies we analyzed trends in lung cancer mortality in Andalusia as a whole[3] and in the provinces of Sevilla[4] and Huelva.[5] These early analyses were based on the pattern of mortality rates within a single period (1975-2000), giving the mean annual percent change supposing that rates increased or decreased at a constant rate but without examining the validity of this assumption.[6]

The recently developed joinpoint regression model is useful for identifying and describing the appearance of changes at several periods of time throughout a data trend.[7,8] The objective of this study was to provide

updated information and analyze the recent changes in lung cancer mortality in the 8 Andalusian provinces in the period 1975-2002, using joinpoint regression models.

Material and Methods

Population data and lung cancer mortality rates according to geographical regions from 1975 through 2002 were obtained from the official publications of the Spanish National Institute of Statistics. Populations were estimated from official census figures on July 1 of each year.

For each sex, the standardized cumulative rates and the truncated rate for the age range 35-64 years were calculated by the direct method (using the European population as reference) and expressed as rates per 100 000 person-years.

Statistical Analysis

We carried out a joinpoint regression analysis to identify points in time when statistically significant changes occurred in the trend curve. In this kind of analysis, best fit points are chosen when the rate changes significantly (increases or decreases). The analysis starts with the smallest number of joinpoints on which permutation tests are performed if one or more are statistically significant and should be included in the model (up to 4). In the final model, each joinpoint indicates a significant change in trend and the annual percent change is calculated for each trend using generalized linear models assuming a Poisson distribution. Significant changes include modifications in direction or in the rate of increase or decrease. Mortality rates and their standard errors were calculated on a

Microsoft Excel spreadsheet. Joinpoint analyses were performed using the software program Joinpoint of the Surveillance Research Program of the US National Cancer Institute.[9]

Results

In Andalusia in 2002 there were 2802 deaths from lung cancer in men and 254 in women, respectively accounting for 28.4% and 4.5% of the mortality rates from tumors. Table 1 shows the adjusted cumulative and truncated (35-64 years) lung cancer mortality rates, comparing the initial 5 years (1975-1979), the final 5 years (1998-2002), geographical regions, and sexes, using the European population as a reference. The annual percent change estimated over the whole study period (1975-2002) is also shown in this table.

Tables 2 and 3 show the results of the joinpoint regression analysis, indicating the points at which the rates significantly changed and the annual percent change of each trend by geographical region and sex.

In Andalusia, the lung cancer mortality rate adjusted by age (for all ages) in men during the study period increased from 50.1 per 100 000 in 1975 to 74.5 per 100 000 in 2002, for a mean annual increase of 1.7% ($P<.05$) (Table 1). Joinpoint analysis (Table 3), however, distinguished 2 periods of increase: 1975 through 1982 (4.9%) and 1982 through 1994 (2.0%) ($P<.05$), after which the rates decrease (−1.6% annually, $P<.05$). Analysis by provinces shows that over the

TABLE 1
Adjusted (European Population of Reference) Cumulative, and Truncated (34-64 Years) Mortality Rates for Lung Cancer According to Period of Time, Geographical Regions, and Sex[*]

	Men			Women		
	Adjusted Cumulative Rates per 100 000		APC	Adjusted Cumulative Rates per 100 000		APC
	1975-1979	1998-2002	1975-2002	1975-1979	1998-2002	1975-2002
Almeria	36.0	72.3	3.20†	5.4	5.3	−0.31
Cadiz	74.1	95.5	1.09†	6.1	5.9	−0.25
Cordoba	39.6	69.7	2.31†	4.4	4.4	−0.08
Granada	40.4	65.2	2.10†	5.4	5.2	−0.16
Huelva	57.9	86.4	1.62†	5.7	5.3	−0.99
Jaen	33.5	62.4	2.94†	5.0	3.5	−1.77†
Malaga	60.1	80.8	1.31†	6.5	7.4	0.56
Sevilla	63.3	88.0	1.62†	6.4	5.7	−0.57
Andalusia	52.0	76.0	1.70†	5.7	5.5	−0.26
Spain	44.7	71.0	2.08†	5.6	6.8	0.69†
	Truncated Rates per 100 000		APC	Truncated Rates per 100 000		APC
Almeria	39.9	72.1	3.01†	6.2	6.5	−1.27
Cadiz	76.3	89.6	0.65†	6.7	7.4	0.22
Cordoba	38.7	67.3	2.23†	3.7	4.2	−0.18
Granada	38.3	54.7	1.80†	5.8	4.6	−1.83
Huelva	59.5	82.4	1.51†	4.5	6.0	−0.25
Jaen	28.6	62.4	3.61†	4.9	3.0	−2.54
Malaga	60.0	73.5	1.14†	6.1	9.2	1.51
Sevilla	63.4	80.0	1.45†	6.5	6.5	0.31
Andalusia	55.7	76.8	1.76†	5.9	6.5	−0.10
Spain	46.1	70.8	1.97†	5.9	8.5	1.47†

[*]APC indicates annual percent change.
†APC is significantly different from 0 ($P<.05$).

TABLE 2
Joinpoint Analysis of the Adjusted (European Population of Reference) Cumulative and Truncated (34-64 Years) Mortality Rates for Lung Cancer in Men According to Geographical Regions[*]

	Adjusted Cumulative Rates per 100 000							
	Trend 1		Trend 2		Trend 3		Trend 4	
	Years	APC	Years	APC	Years	APC	Years	APC
Almeria	1975-1990	6.29†	1990-2002	−0.92				
Cadiz	1975-1983	3.70†	1983-1990	−0.57	1990-1993	5.90	1993-2002	−1.44†
Cordoba	1975-1989	4.94†	1989-2002	−0.54				
Granada	1975-1982	6.72†	1982-2002	1.13†				
Huelva	1975-1983	4.74†	1983-2002	0.76†				
Jaen	1975-1987	4.62†	1987-2002	1.74†				
Malaga	1975-1981	5.25†	1981-2002	0.71†				
Sevilla	1975-1994	2.64†	1994-2002	−1.93†				
Andalusia	1975-1982	4.86†	1982-1994	2.01†	1994-2002	−1.57†		
Spain	1975-1988	3.56†	1988-1994	1.45†	1994-2002	−0.18		

	Truncated Rates per 100 000							
	Trend 1		Trend2					
	Years	APC	Years	PCA				
Almeria	1975-1991	5.91†	1991-2002	−1.79				
Cadiz	1975-1983	4.18†	1983-2002	−0.32				
Cordoba	1975-1986	6.45†	1986-2002	−0.14				
Granada	1975-1996	3.12†	1996-2002	−6.19				
Huelva	1975-2002	1.51†						
Jaen	1975-2002	3.61†						
Malaga	1975-1994	2.07†	1994-2002	−2.09				
Sevilla	1975-1993	3.14†	1993-2002	−3.07†				
Andalusia	1975-1993	3.01†	1993-2002	−2.21†				
Spain	1975-1990	3.35†	1990-2002	0.09				

[*]APC indicates annual percent change.
†APC is significantly different from 0 ($P<.05$).

whole study period the standardized cumulative rates significantly increased in all provinces. Joinpoint regression analysis, however, distinguished 3 recent trends: a decrease in Cadiz and Sevilla, stability in Almeria and Cordoba, and an increase in Granada, Huelva, Jaen, and Malaga.

For women, standard mortality rates (for all ages) were considerably lower than for men and the only trend apparent during the study period was seen in Jaen, which showed a significant decrease (Table 3).

In Andalusia, the lung cancer mortality rate adjusted by age bracket (35-64 years) in men during the study period increased from 47.4 per 100 000 in 1975 to 74.6 per 100 000 in 2002 with a mean annual increase of 1.7% ($P<.05$). Table 2 shows a period of increase from 1975 through 1993 (3.0% annually, $P<.05$) after which the rates start to decrease (−2.2% annually, $P<.05$). Joinpoint regression analysis distinguished 3 recent trends in truncated rates: a decrease in Seville, an increase in Huelva and Jaen, and stability in the other provinces.

In women, although truncated rates decreased from 6.6 per 100 000 in 1975 to 5.4 per 100 000 in 2002 in the whole of Andalusia, that decrease was not significant (Table 3). Joinpoint analysis nevertheless distinguished 2 periods: an initial one (1975-1990)

when rates decreased significantly (−1.5% annually, $P<.05$) followed by another period of significant increase (2.4% annually, $P<.05$). Analysis by provinces showed that over the whole study period the truncated rates remained stable in all of them. Joinpoint analysis, however, showed a different pattern in the province of Malaga, where rates started to rise sharply (5.2% annually, $P<.05$) after a significant fall in rates from 1975 through 1988 (−2.5%, $P<.05$).

Discussion

Information on time trends in lung cancer is essential for the development of an effective policy of control. In Andalusia there is little information available on morbidity so we have had to use mortality data (an information source that fulfills the criteria of continuity and comprehensiveness,[10] reliability as an indicator of lung cancer frequency given the low patient survival rates,[11-13] and accuracy based on death certificates declaring lung cancer as cause of death[14]). A recent study[15] has shown that during the period 1975 through 2000 in certain Spanish autonomous communities, such as Aragon, Castile and Leon, Murcia, Navarre, and Rioja, there was an uninterrupted increase in mortality from lung cancer in men while in the Basque Country

TABLE 3
Joinpoint Analysis of the Adjusted (European Population of Reference) Cumulative and Truncated (34-64 Years) Mortality Rates for Lung Cancer in Women According to Geographical Region*

	Adjusted Cumulative Rates per 100 000			
	Trend 1		Trend 2	
	Years	APC	Years	APC
Almeria	1975-2002	–0.31		
Cadiz	1975-2002	–0.25		
Cordoba	1975-2002	–0.08		
Granada	1975-2002	–0.16		
Huelva	1975-2002	–0.99		
Jaen	1975-2002	–1.77†		
Malaga	1975-2002	0.56		
Sevilla	1975-2002	–0.57		
Andalusia	1975-2002	–0.26		
Spain	1975-1992	–0.49†	1992-2002	3.30†

	Truncated Rates per 100 000			
	Trend 1		Trend 2	
	Years	APC	Years	APC
Almeria	1975-2002	–1.27		
Cadiz	1975-2002	0.22		
Cordoba	1975-2002	–0.18		
Granada	1975-2002	–1.83		
Huelva	1975-2002	–0.25		
Jaen	1975-2002	–2.54		
Malaga	1975-1988	–2.47†	1988-2002	5.24†
Sevilla	1975-2002	0.31		
Andalucia	1975-1990	–1.54†	1990-2002	2,43†
Spain	1975-1990	–1.48†	1990-2002	5,68†

*APC indicates annual percent change.
†APC is significantly different from 0 (*P*<.05).

there was a sharp decrease of 2% annually from 1995. Mortality from lung cancer in women has increased at a rate of 2.4% annually since 1990 in Spain, and that trend has particularly affected women from the autonomous communities of Aragon, Castile and Leon, the Basque Country, and Valencia.

Despite lung cancer rates that are worse in Andalusia than in the rest of Spain as a whole (Table 1), our results show that our region has managed to reverse the trend in mortality from lung cancer in men since the beginning of the 1990s, with reductions of –1.6% and –2.2% annually for cumulative and truncated rates respectively. That development has not been observed at a national level, as Spanish rates have stabilized but not yet started to descend (Table 3). Mortality rates have nevertheless increased significantly (2.4% annually) for women in the age bracket of 35 through 64 years since 1990. That rising trend is similar to the pattern seen at the national level (5.7% annually) although the Andalusian rate is rising more slowly (Table 3).

Trends in mortality rates from lung cancer in Andalusia are consistent with changes in the prevalence of smoking and are similar to rates observed elsewhere.[16] In 2003, 32.7% of the population of Andalusia over the age of 16 years smoked (41.9% of men and 24.2% of women). Those data reflect a 10% decrease in male smokers and a 4% increase in female smokers since 1993.[17] The decrease in smoking among men is due to a higher percentage quitting at relatively young ages; 38.5% of smokers tried to give smoking in 2003, nearly 8 percentage points more than in 1999; this was observed mainly at ages between 25 and 64 years.[17]

The situation in Andalusia corresponds to the so-called phase 3 of the smoking epidemic characterized by a considerable reduction in smoking in men and an increase in women. This phase is common in southern and central European countries while the northern European countries are approaching the last phase (phase 4) in which smoking decreases among women too.[1,2]

The marked variability over time and region of lung cancer reflects the distribution of its risk factors, particularly smoking, the main etiologic agent.[18] This can help us interpret the recent and future trends of lung cancer mortality in our community. Thus, in 2003 the highest prevalence of smoking was found in Jaen (39.3%),[17] the province which also presents the greatest significant increases in lung cancer mortality rates in men.

The lung cancer epidemic in women aged 35 to 64 years would appear to be just starting in Andalusia, with a focus in the province of Malaga.

We must carry specific smoking prevention policies to the community in an efficient way if we want to control the lung cancer epidemic. Antismoking strategies should target women in general and women in the province of Malaga in particular in order to detain their increasing risk for this type of cancer and to prevent avoidable and premature deaths in future generations.

In conclusion, our results show that decrease in smoking prevalence among men in Andalusia is being followed by a decrease in lung cancer mortality. In contrast, a marked increase in lung cancer mortality among young women was observed, particularly in the province of Malaga, although rates are much lower than those of men. These data confirm that the impact of lung cancer can be reduced in our society by interventions aimed at reducing smoking.

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