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Lung cancer mortality in European women: recent trends and perspectives

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Background: Lung cancer mortality in men has been declining since the late 1980s in most European countries. In women, although rates are still appreciably lower than those for men, steady upward trends have been observed in most countries. To quantify the current and future lung cancer epidemic in European women, trends in lung cancer mortality in women over the last four decades were analyzed, with specific focus on the young.

Patients and methods: Age-standardized (world standard) lung cancer mortality rates per 100 000 women—at all ages, and truncated 35–64 and 20–44 years—were derived from the WHO for the European Union (EU) as a whole and for 33 separate European countries. Joinpoint regression analysis was used to identify points where a significant change in trends occurred.

Results: In the EU overall, female lung cancer mortality rates rose by 23.8% between 1980–1981 and 1990–1991 (from 7.8 to 9.6/100 000), and by 16.1% thereafter, to reach the value of 11.2/100 000 in 2000–2001. Increases were smaller in the last decade in several countries. Only in England and Wales, Latvia, Lithuania, Russia and Ukraine did female lung cancer mortality show a decrease over the last decade. In several European countries, a decline in lung cancer mortality in young women (20–44 years) was observed over the last decade.

Conclusions: Although female lung cancer mortality is still increasing in most European countries, the more favorable trends in young women over recent calendar years suggest that if effective interventions to control tobacco smoking in women are implemented, the lung cancer epidemic in European women will not reach the levels observed in the USA.

Key words: Europe, lung cancer, mortality, trends, women

Introduction

Lung cancer mortality in men has been declining since the late 1980s in most European countries. The overall fall was over 13% (from 55.4 to 46.7/100 000 men, world standard) between 1988 and 2000 in the 25 countries of the European Union (EU) [1]. Downward trends were observed also in the Russian Federation, and central and eastern European countries, characterized by exceedingly high rates in the early 1990s [2–4]. The only exceptions were Portugal and Romania, where male lung cancer mortality was still increasing.

In women, lung cancer mortality rates in most Europe are still appreciably lower than those for men, but the pattern of trends is largely different, since steady upward trends have been observed in most countries, reaching extremely high levels (20 to 25/100 000 at all ages) in Denmark, Iceland, Ireland and the UK [3–7]. In most other European countries, female lung cancer mortality rates are still below 10/100 000, substantially lower than in North America [8, 9]. A clearer understanding of the ongoing lung cancer epidemic among European women requires detailed analysis of trends in separate age groups.

We present therefore a comprehensive analysis of trends in lung cancer mortality in European women over the last four decades, with specific focus on the young, who are of specific interest to shed light on the most likely future trends [10, 11].

Patients and methods

Official death certification numbers for lung cancer for 33 European countries (including the Russian Federation, but excluding a few small countries such as Andorra and Liechtenstein) for the period 1965–2001 were derived from the WHO database as available on electronic support [12]. As well as the UK as a whole, data are also presented separately for England and Wales, Scotland and Northern Ireland. Data for the Russian Federation and other Republics included in the former Soviet Union have been available in

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the WHO database from the early 1980s onwards. For Albania, data are available only since 1989, for Belgium up to 1997, and for Denmark, France and The Netherlands up to 2000.

The EU was defined as the 25 member states as in May 2004 (i.e. Austria, Belgium, the Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, The Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, UK). Data for Cyprus were not available. During the calendar period considered (1965–2001) three different revisions of the International Classification of Diseases (ICD) were used [13–15]. Classification of cancer deaths was recoded, for all calendar periods and countries, according to the Ninth Revision of the ICD [14].

Estimates of the resident population, generally based on official censuses, were obtained from the same WHO database [12]. From the matrices of certified deaths and resident populations, age-specific rates for each 5-year age group and calendar year were computed. Age-standardized rates per 100 000 women—at all ages, and truncated 35–64 years and 20–44 years—were computed using the direct method, and based on the world standard population [16].

Joinpoint regression analysis was performed using the joinpoint software from the Surveillance Research Program of the US National Cancer Institute [17]. This analysis allows us to identify points where a significant change in the linear slope of the trend occurred [18]. In joinpoint analysis, the best fitting points (the 'joinpoints') are chosen where the rate changes significantly. The analysis starts with the minimum number of joinpoints (e.g. zero joinpoints, which is a straight line), and tests whether one or more joinpoints (up to three) are significant and must be added to the model. In the final model, each joinpoint (if any) indicates a significant change in the slope. The estimated annual percent change (EAPC) is then computed for each of those trends by fitting a regression line to the natural logarithm of the rates using calendar year as a regressor variable [i.e. given $y = a + bx$, where $y = ln(rate)$ and x = calendar year, the EAPC is estimated as: $100 * (e^b - 1)$].

Results

Table 1 gives the age-adjusted mortality rates from lung cancer in women (at all ages, and truncated 35–64 and 20–44 years) for 33 European countries in 1980–1981, 1990–1991 and 2000–2001, and the corresponding percentage changes between the three periods. In the EU as a whole, female lung cancer mortality rose by 23.8% between 1980–1981 and 1990–1991 (from 7.8 to 9.6/100 000). A further increase, though smaller (16.1%), was observed afterward, to reach the rate of 11.2/100 000 in 2000–01. Steady upward rates between 1980–1981 and 1990–1991 were observed in most European countries, with the highest rises found in some countries of northern, central and eastern Europe, including Denmark, Germany, Hungary, Norway and Poland. Smaller increases were found in several countries, with the exception of France and Switzerland, which showed larger increases between 1980–1981 and 1990–1991. Only in Latvia, Lithuania, England and Wales, the Russian Federation, and Ukraine did female lung cancer mortality show a decrease between 1990 and 2001. In England and Wales, however, lung cancer rates in 2001 were still ~20/100 000.

Lung cancer mortality in EU middle-aged women increased by 17.2% between 1980–1981 and 1990–1991 (from 7.8 to 9.6/100 000), and by a further 21.1% thereafter, to reach a value of 17.9/100 000 in 2000–01. In most European countries, the changes in truncated rates between 1980–1981 and the 1990s were similar to those for the overall ones, the only exceptions being Ireland, the Russian Federation, Ukraine, and England and Wales, which already showed declines in rates. Between 1990–1991 and 2000–2001 rates in middle-aged women showed a decline in a few European countries, including Britain, Denmark, Ireland, the Russian Federation and Ukraine. In France and Spain, however, steady upward trends were observed in this period.

We also considered trends in young women (20–44 years) from various European countries in 1980–1981, 1990–1991 and 2000–2001 (Table 1). In the EU, lung cancer mortality rates per 100 000 in young women were 1.1 in 1980–1981, 1.5 in 1990–1991 and 1.7 in 2000–2001, corresponding to percentage increases of 35.5 and 11.4% in the two periods, respectively. In various European countries, however, a decline in lung cancer mortality in young women was observed over the last decade.

Figure 1 shows trends in female lung cancer mortality at all ages and truncated at 35–64 years for selected European countries between 1965 and 2001. A steady upward trend in overall rates was observed in several European countries over the four decades considered. A levelling of lung cancer mortality was observed in Denmark, Iceland (since the late 1990s), Ireland and the UK (since the late 1980s). In these countries, however, rates had steeply increased in the previous decades, when they reached the highest values on a European scale. Trends in middle-aged women follow similar, though more pronounced, patterns than those for all women. Thus, the rises were stronger than those in overall rates in most countries with increasing mortality from lung cancer. In countries where overall lung cancer mortality tended to level off in more recent years (i.e. Denmark, Iceland, Ireland and the UK), truncated rates showed declining trends.

Lung cancer mortality trends in young women (20–44 years) over the period 1965–2001 in selected European countries are shown in Figure 2. Although less clear than overall and 35–64 years trends due to smaller numbers of deaths, the trends over recent calendar periods appeared to be more favorable than those in all-age and middle-aged women in most European countries. Thus, in several European countries (including Austria, Hungary, Italy, The Netherlands, Poland, Sweden and Switzerland), rates tended to decline in young women in the last few years. Steady long-term declines in rates were observed in Ireland and the UK since the late 1960s. Lung cancer mortality rates in young women were still consistently increasing in France and Spain up to more recent calendar years.

The main findings from jointpoint regression analysis for female lung cancer mortality (at all ages, and truncated at 35–64 and 20–44 years) over the period 1965–2001 in the EU overall are given in Table 2 and Figure 3. At all ages, female lung cancer rates rose by 1.5% per year between 1965 and 1971, by 2.6% between 1972 and 1987, and by 1.4% thereafter. In middle-aged women, the rise was 2.1% per year until 1983, 1.4% between 1984 and 1997, and 2.9% thereafter. In young women, after a decrease between 1965 and 1969 (−0.8% per year), rates rose by 2.8% per year between 1970 and 1997, and subsequently declined by −3.6% over the last 4 years.

Table 1. Age-adjusted (world population) death certification rates per 100 000 for lung cancer in women (all ages, truncated 35–64 years and 20–44 years) in selected European countries and in the European Union, in the years 1980–81, 1990–91 and 2000–01

Country	All ages					Age 35–64 years					Age 20–44 years				
	Death rate/100 000			Percent change		Death rate/100 000			Percent change		Death rate/100 000			Percent change	
	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91
Albania	–	5.07[a]	6.72	–	32.50	–	7.39[a]	8.15	–	10.3	–	1.31[a]	1.39	–	6.1
Austria	7.31	9.19	11.11	25.7	20.90	10.19	14.21	19.22	39.5	35.3	0.75	2.09	1.71	178.7	−18.2
Belgium	6.48	8.48	10.02[b]	30.9	18.20	10.47	15.09	16.64[b]	44.1	10.3	1.14	1.89	1.87[b]	65.8	−1.1
Bulgaria	5.69	6.36	6.38	11.8	0.30	8.88	10.15	11.3	14.3	11.3	1.32	1.74	1.61	31.8	−7.5
Croatia	–	8.19	10.76	–	31.40	–	13.92	16.97	–	21.9	–	2.02	1.91	–	−5.4
Czech Republic	–	9.91	12.75	–	28.70	–	16.88	20.58	–	21.9	–	1.57	1.15	–	−26.8
Denmark	15.35	24.88	27.44[c]	62.1	10.3	29.31	44.14	38.96[c]	50.6	−11.7	2.27	2.13	2.48[c]	−6.3	16.4
Estonia	7.53[d]	7.57	7.49	0.5	−1.1	9.23[d]	11.73	10.64	27.1	−9.3	0.72[d]	1.11	1.05	54.2	−5.4
Finland	5.99	6.85	7.86	14.4	14.7	8.49	8.70	10.52	2.5	20.9	0.66	0.75	0.71	13.6	−5.3
France	3.84	5.19	7.31[c]	35.2	40.9	6.07	8.41	13.43[c]	38.6	59.7	0.61	1.08	2.12[c]	77.1	96.3
Germany	5.65	8.10	10.75	43.4	32.7	8.62	12.94	18.21	50.1	40.7	0.82	1.41	1.64	72.0	16.3
Greece	6.03	7.22	7.56	19.7	4.7	9.33	11.51	10.99	23.4	−4.5	1.54	1.43	1.16	−7.1	−18.9
Hungary	10.07	15.73	21.25	56.2	35.1	16.23	28.15	42.06	73.4	49.4	1.90	4.89	4.96	157.4	1.4
Iceland	23.46	23.44	26.68	−0.1	13.8	32.93	39.21	39.32	19.1	0.3					
Ireland	15.70	17.74	17.80	13.0	0.3	26.30	25.60	19.33	−2.7	−24.5	2.41	0.94	1.34	−61.0	42.6
Italy	6.05	7.32	8.38	21.0	14.5	9.50	10.62	12.17	11.8	14.6	0.92	1.11	1.24	20.7	11.7
Latvia	5.7[d]	6.73	6.06	18.1	−10.0	9.85[d]	9.63	8.65	−2.2	−10.2	0.72[d]	0.69	0.73	−4.2	5.8
Lithuania	4.99[d]	6.09	5.34	22.0	−12.3	8.99[d]	9.33	6.94	3.8	−25.6	0.33[d]	0.96	0.75	190.9	−21.9
Luxembourg	6.69	9.13	10.94	36.5	19.8	10.42	15.51	19.99	48.9	28.9					
Malta	5.54	2.82	7.13	−49.1	152.8	5.88	3.38	9.85	−42.5	191.4					
The Netherlands	6.29	10.53	16.87[c]	67.4	60.2	11.11	20.16	30.72[c]	81.5	52.4	1.28	2.04	2.63[c]	59.4	28.9
Norway	5.81	10.81	16.32	86.1	51.0	10.35	19.03	25.53	83.7	34.2	0.86	1.34	1.67	55.8	24.6
Poland	7.05	10.05	12.69	42.6	26.3	12.46	17.6	22.75	41.3	29.3	1.20	1.89	1.81	57.5	−4.2
Portugal	3.73	4.53	4.79	21.5	5.70	5.91	6.72	7.43	13.7	10.6	1.13	1.3	1.18	15.0	−9.2
Romania	6.22	6.49	7.89	4.34	21.3	11.38	11.79	13.53	3.6	14.8	1.76	1.64	1.77	−6.8	7.9
Russian Federation	6.53	7.30	5.95	11.8	−18.5	11.08	10.99	8.86	−0.8	−19.4	1.31	1.2	1.10	−8.4	−8.3
Slovakia	–	7.33[e]	7.61	–	3.8	–	11.99[e]	12.02	–	0.3	–	1.42[e]	1.43	–	0.7
Slovenia	–	8.31	10.83	–	30.3	–	14.36	18.42	28.3	28.3	–	0.73	2.20	–	201.4
Spain	3.83	3.61	4.71	−5.7	30.5	5.53	5.3	8.77	−4.2	65.5	0.91	1.15	1.67	26.4	45.2
Sweden	7.67	10.35	13.84	34.9	33.7	13.05	17.91	22.30	37.2	24.5	1.32	1.67	1.06	26.5	−36.5

Table 1. (*Continued*)

Country	All ages					Age 35–64 years					Age 20–44 years				
	Death rate/100 000			Percent change		Death rate/100 000			Percent change		Death rate/100 000			Percent change	
	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91	1980–81	1990–91	2000–01	1990–91/ 1980–81	2000–01/ 1990–91
Switzerland	5.43	7.50	10.70	38.1	42.7	9.15	12.84	18.33	40.3	42.8	1.23	1.62	1.25	31.7	−22.8
Ukraine	6.55[d]	7.35	5.51	12.2	−25.0	11.7[d]	11.23	8.97	−4.0	−20.1	1.61[d]	1.42	1.31	−11.8	−7.8
UK	17.82	21.06	19.75	18.2	−6.2	30.24	29.39	24.74	−2.8	−15.8	1.78	1.56	1.19	−12.4	−23.7
UK, England/Wales	17.40	20.37	18.83	17.1	−7.6	29.27	28.27	23.67	−3.4	−16.3	1.71	1.48	1.13	−13.5	−23.7
UK, Northern Ireland	14.16	17.14	19.66	21.1	14.7	25.70	24.86	24.08	−3.3	−3.1	1.04	1.42	0.87	36.5	−38.7
UK, Scotland	22.80	28.84	28.92	26.5	0.3	40.86	41.2	35.6	0.8	−13.6	2.62	2.40	1.84	−8.4	−23.3
European Union	7.76	9.61	11.16	23.8	16.1	12.61	14.78	17.9	17.2	21.1	1.10	1.49	1.66	35.5	11.4

[a]Data refer to the years 1988–1989.
[b]Data refer to the years 1996–1997.
[c]Data refer to the year 2000.
[d]Data refer to the year 1981.
[e]Data refer to the years 1992–1993.

Discussion

The present comprehensive analysis of female lung cancer mortality in Europe indicates and quantifies a steady increase in rates in women from most European countries over the last few decades. In the EU overall, the rates increased from 5.53/100 000 in 1965 to 11.16 in 2001 at all ages, and from 9.15 to 17.88 in middle-aged women. However, as in the USA [19], a gradual slowing in the rate of increase has been observed over recent years. According to the jointpoint regression analysis, female lung cancer mortality in the EU increased by 2.6% per year between the early 1970s and the late 1980s, and by 1.4% thereafter.

Rises in female lung cancer rates were consistently observed in several European countries, although the degree of the increase varied between countries. Thus, particularly sharp increases were observed in some northern, central and eastern countries such as Denmark, Germany, Hungary and Poland. In England and Wales, Ireland and Iceland [5], where rises were earlier and mortality rates were higher, a levelling off in overall rates—and a decline in middle-aged and young women—was observed in more recent years.

The different patterns of female lung cancer mortality reflect the different prevalence of tobacco smoking in women from various European countries, which in turn can help in interpreting recent and future trends in lung cancer mortality. The lag in the temporal trend of lung cancer mortality rates in women compared with men also reflects historical differences in cigarette smoking between men and women. In some northern countries such as Belgium, Denmark, Sweden and The Netherlands, where the estimated smoking prevalence in women has fallen recently, a slowing of lung cancer mortality rates can be expected in the future, as already observed in the UK [20–22]. The female lung cancer epidemic seems to be still in its early phases in countries like Austria, Spain and France, where smoking prevalence in women has been rapidly increasing in the 1990s [21, 22]. Among countries of central and eastern Europe, Hungary is the only country where a steady increase in smoking prevalence has been observed since the 1960s [23]. Conversely, the prevalence of tobacco smoking among Russian, as well as Ukrainian, women has remained relatively low in the last decades (i.e. ∼10–15%) [24]. The declining trends observed in the Russian Federation should be taken with caution since they are also influenced by effects in earlier cohorts, owing to the limited availability of cigarettes in generations who were teenagers in the post-war period [25].

A major finding of the present analysis is the more favorable lung cancer mortality trends in young women, particularly in countries where a peak has already been reached, suggesting that overall trends are likely to be more favorable in the future. Trends for young adults are in fact an early indicator of the recent and potential future impact of changes in the prevalence of risk factors—notably tobacco smoking—on cancer rates [11, 26]. Also in the USA, the effect of decreasing the prevalence of smoking was seen first in young adults [27–29]. We chose to use the age-standardized rates at age 20–44 years as a measure of lung cancer trends in the young, as suggested by Doll in the

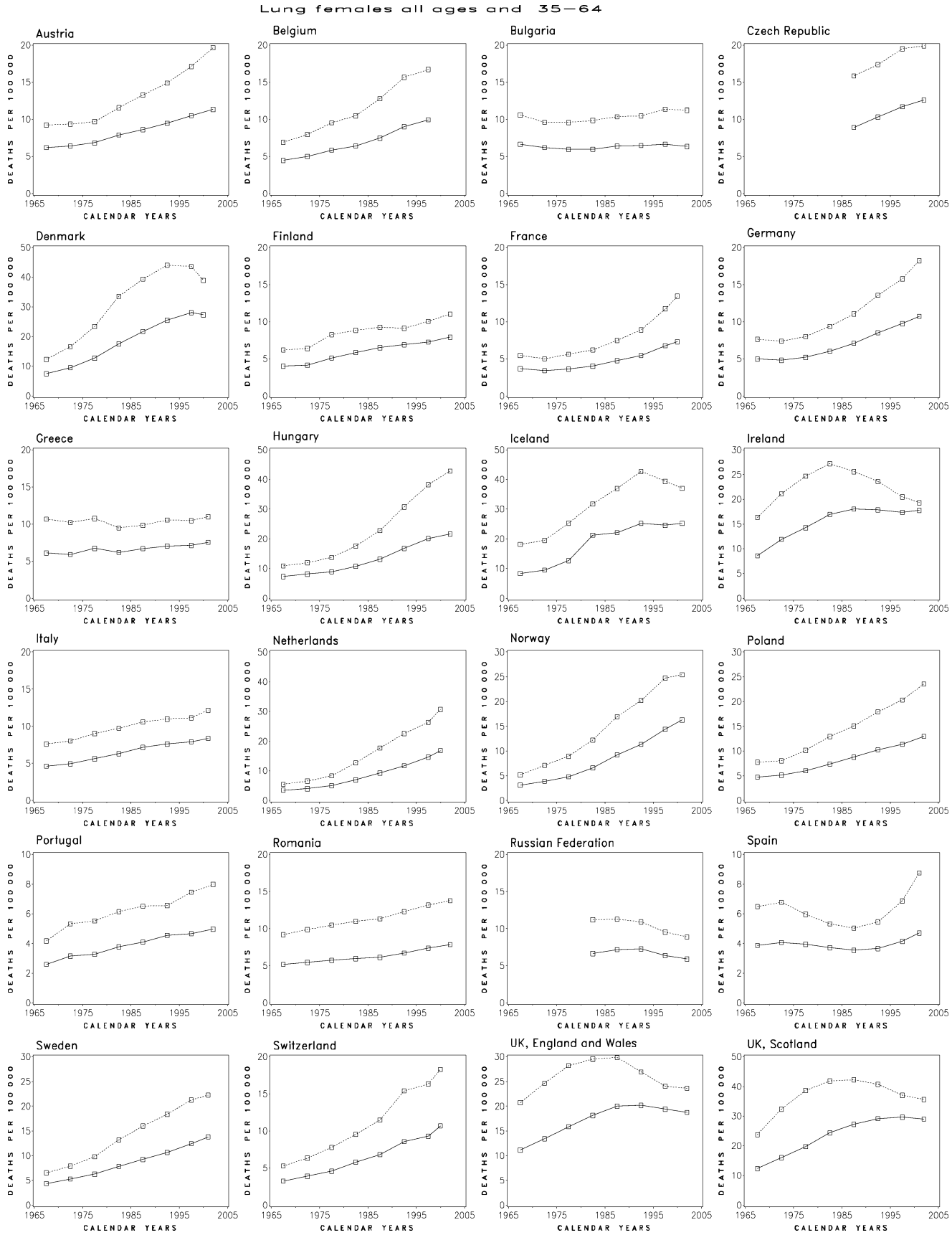

Figure 1. Trends in age-standardized (world population) death certification rates per 100 000 for lung cancer in women (all ages, and age 35 to 64 years) in selected European countries, 1965–2001. All ages, solid lines; truncated at 35–64 years, dotted line.

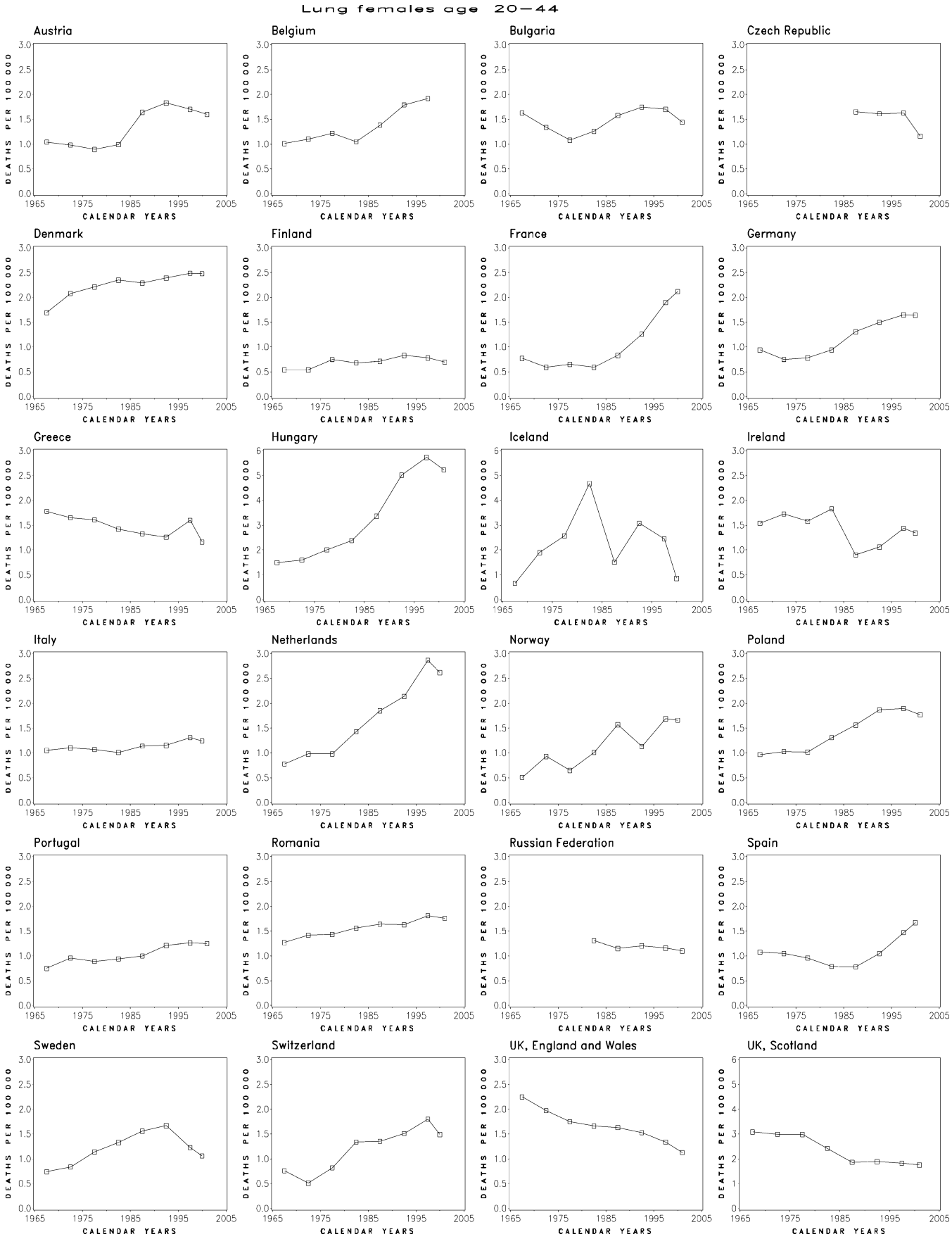

Figure 2. Trends in age-standardized (world population) death certification rates per 100 000 for lung cancer in women aged 20–44 years in selected European countries, 1965–2001.

Table 2. Age-standardised (world population) lung cancer mortality rates per 100 000 women and joinpoint analysis (1965–2001), at all ages, truncated at 35–64 years and at 20–44 years in the European Union

	Age-standardized mortality rates		Jointpoint analysis					
	1965	2001	Trend 1		Trend 2		Trend 3	
			Years	EAPC	Years	EAPC	Years	EAPC
All ages	5.53	11.16	1965–1971	1.51	1972–1987	2.59[a]	1988–2001	1.39[a]
35–64 years	9.15	17.88	1965–1983	2.08[a]	1984–1997	1.39[a]	1998–2001	2.93[a]
20–44 years	1.19	1.59	1965–1969	−0.84[a]	1970–1997	2.78[a]	1998–2001	−3.60[a]

[a]Significantly different from 0 (P <0.05).
EAPC, estimated annual percent of change.

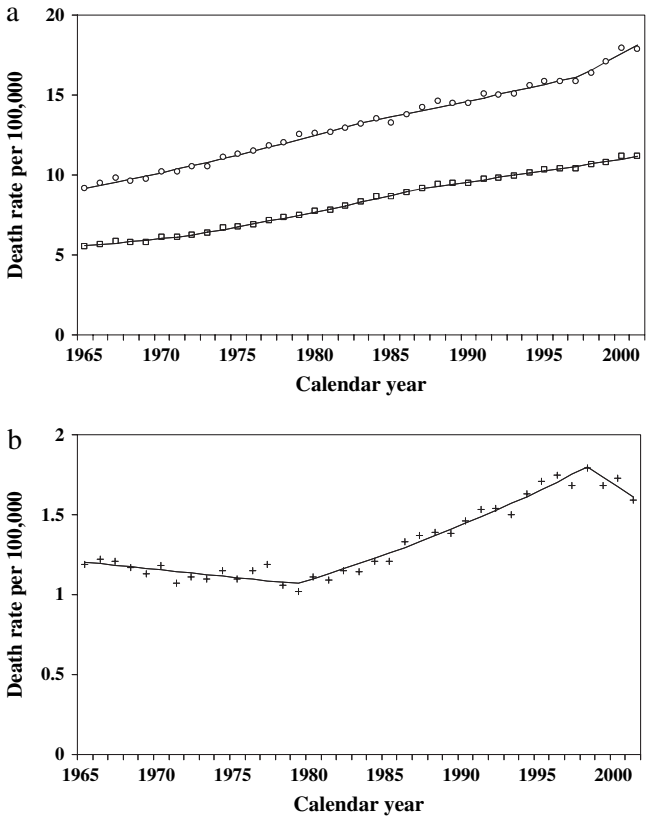

Figure 3. Jointpoint analysis for female lung cancer mortality in the European Union, 1965–2001. (**A**) All ages, squares; truncated at 35–64 years, circles. (**B**) Age 20–44 years.

1990s [11], and adopted for instance by Polednak [29] to analyze lung cancer incidence trends in black and white young adults in the USA. These rates are heavily influenced by the last quinquennia of age, since over 90% of all lung cancer deaths at age 20–44 years occur at 35–44 years, and over 70% at 40–44 years (median age at death 42 years). Other measures of lung cancer rates in the young have been suggested, such as using the age group 30–39 years [28]. These are, however, on average at a younger age (median age at death 38 years), and are based on smaller absolute numbers. Therefore, this would be a major problem for smaller countries.

Thus, since EU female lung cancer rates at age 20–44 years have leveled off in the late 1990s at values ∼50% lower than those of their male counterparts, it is likely that overall lung cancer rates in EU women will continue to increase for some years, to then stabilize at a value ∼15/100 000 between 2015 and 2020. Any more precise estimate is, however, hampered by major uncertainties in the prevalence of smoking in women over the next few years, and mostly by the role of stopping smoking over the next decades [30]. In the presence of effective intervention to reduce smoking among European women, the peak rate may be lower. Assuming a constant 1.4% rise per year between 2000 and 2015, the rate would approach 14/100 000. With a 1% rise, it would remain ∼13/100 000.

In the interpretation of the present results it is important to consider problems related to random variation, which are clearly greater in relation to smaller populations. Secondly, and more complex, there are problems of death certification reliability and validity in various countries [31, 32]. In general, for lung cancer, death certification is sufficiently reliable to permit meaningful inference on trends for most European countries. Furthermore, trends in the young are less likely to be affected by certification problems. Some under-recording of cancer deaths was reported for the Russian Federation in the late 1980s and 1990s, due to a fall in precision of coding of causes of death. This was, however, mainly restricted to the elderly living in rural areas [33], and should therefore not have materially influenced rates at younger ages. Moreover, no major changes in lung cancer treatments and survival have occurred in the last decades that could have materially influenced mortality trends [34].

Overall, age-standardized female lung cancer mortality across Europe is still much lower than in the USA, where lung cancer has become the leading cause of cancer death among women, with a rate of 24/100 000 in the year 2000 [8,9]. Only a few European countries have female lung cancer rates comparable to those of the USA, but there a peak seems to have been reached. In most other European countries, the lower extent of more recent increases compared with those of the past, and the more favorable trends in young women, suggest that female lung cancer mortality rates will probably not reach the high levels observed in the USA [5, 8]. Effective interventions to control and reduce tobacco smoking in women should be implemented to avoid a major lung cancer epidemic in European women in the near future.

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