

Monitoring falls in gastric cancer mortality in Europe

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We have considered trends in age-standardized mortality from gastric cancer in 25 individual European countries, as well as in the European Union (EU) as a whole, in six selected central-eastern European countries and in the Russian Federation over the period 1950–1999. Steady and persisting falls in rates were observed, and the fall between 1980 and 1999 was ~50% in the EU, 45% in eastern Europe and 40% in Russia. However, the declines were greater in Russia and eastern Europe, since rates were much higher, in absolute terms. Joinpoint regression analysis indicated that the falls were proportionally greater in the last decade for men (–3.83% per year in the EU) and in the last 25 years for women (–3.67% per year in the EU) than in previous calendar years. Moreover, steady declines in gastric cancer mortality were observed in the middle-aged and the young population as well, suggesting that they are likely to persist in the near future. In terms of number of deaths avoided, however, the impact of the decline in gastric cancer mortality will be smaller, particularly in the EU.

Key words: Europe, gastric cancer, mortality, time, trends

Introduction

Across Europe, major differences in gastric cancer rates are evident. Thus, gastric cancer rates in Russia are over five-fold higher than those in Scandinavia or France, and, in general, higher gastric cancer rates have been registered in central and eastern Europe, Portugal, Italy and Spain. Consequently, gastric cancer remains a major public health issue in several European areas [1–4]. Over the last few decades, however, substantial declines in gastric cancer mortality rates have been observed throughout Europe. Of 80 000 fewer cancer deaths observed in the European Union (EU) in 1997 as compared with 1988, 24 000 were due to the fall in gastric cancer rates [5]. We have therefore systematically reviewed trends in gastric cancer mortality across Europe over the last two decades. We have also considered long-term trends (1950–1999) for 18 countries providing data, and the EU, using joinpoint regression analysis [6].

Materials and methods

Official death certification data from gastric cancer were abstracted from the WHO database over the period 1950–1999, whenever available (<http://www3.who.int/whosis/menu.cfm>). Estimates of the resident population, generally based on official censuses, were based on the same WHO database.

For the present analysis we considered recent trends in mortality from gastric cancer for 25 individual European countries and the Russian Federation. Data for the Russian Federation, and for other Republics included in the former

Soviet Union, have been made available in the WHO database from 1980 onwards. Data for Croatia and Slovenia have been made available since 1985, those for the Czech Republic since 1986 and those for Slovakia since 1992. These were subsequently subdivided into the EU, and six central-eastern European countries providing uniform data across the calendar period considered (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia).

In the 1980s, most countries utilized the Ninth Revision of the International Classification of Diseases (ICD-9), but some still used ICD-8, and some adopted the ICD-10 from 1995 onwards. Since differences between various

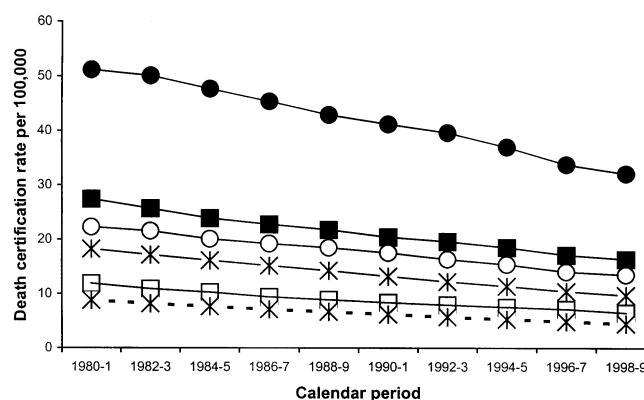


Figure 1. Trends in overall age-standardized (world population) death certification rates (per 100 000) from gastric cancer in men and women in the European Union (EU), eastern European countries and the Russian Federation in 1980–1999. Key: filled circles, Russian Federation, male; open circles, Russian Federation, female; filled squares, eastern European countries, male; open squares, eastern European countries, female; crosses on solid line, EU, male; crosses on dashed line, EU, female.

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Table 1. Overall age-adjusted (world population) mortality rates from gastric cancer per 100 000 men and women in separate European countries in 1980, 1989 and 1999 (unless otherwise stated in parentheses^a), and corresponding changes in rates

	Men					Women				
	1980	1989	1999	% Change 1989/80	% Change 1999/89	1980	1989	1999	% Change 1989/80	% Change 1999/89
Austria	25.80	16.77	9.89	-35.00	-41.03	12.06	8.55	5.35	-29.10	-37.43
Belarus (1981)	40.43	38.69	32.97	-4.30	-14.78	17.62	15.98	13.02	-9.31	-18.52
Bulgaria	23.07	20.16	14.91	-12.16	-26.04	13.11	10.49	7.49	-19.98	-28.60
Croatia (1985)	26.92	24.83	22.79	-7.76	-8.22	11.01	9.80	7.49	-10.99	-23.57
Czech Rep. (1986)		19.89	11.73		-41.03		9.07	5.88		-35.17
Denmark (1998)	12.17	7.52	5.18	-38.21	-31.12	6.32	4.29	2.69	-32.12	-37.30
Estonia (1981)	34.25	31.18	22.84	-8.96	-26.75	15.38	15.20	11.79	-1.17	-22.43
Finland	18.78	13.06	7.89	-30.46	-39.59	10.64	7.90	3.64	-25.75	-53.92
France (1998)	12.42	8.92	6.78	-28.18	-23.99	5.42	3.54	2.52	-34.69	-28.81
Germany	21.32	15.20	9.94	-28.71	-34.61	10.87	7.81	5.19	-28.15	-33.55
Greece (1998)	11.66	9.15	8.48	-21.53	-7.32	6.37	4.98	3.92	-21.82	-21.29
Hungary	31.01	23.57	18.51	-23.99	-21.47	13.59	10.50	7.76	-22.74	-26.10
Ireland (1998)	17.45	11.58	8.29	-33.64	-28.41	8.23	5.82	3.93	-29.28	-32.47
Italy (1998)	22.47	17.64	12.56	-21.50	-28.80	10.53	8.33	5.87	-20.89	-29.53
The Netherlands	17.42	13.12	8.47	-24.68	-35.44	7.11	5.04	3.55	-29.11	-29.56
Norway (1998)	13.57	11.29	7.57	-16.80	-32.95	7.59	5.16	3.72	-32.02	-27.91
Poland	30.79	23.13	16.52	-24.88	-28.58	11.75	8.47	5.70	-27.91	-32.70
Portugal	31.43	25.07	20.19	-20.24	-19.47	15.13	12.11	9.43	-19.96	-22.13
Romania	25.58	18.70	16.67	-26.90	-10.86	11.11	7.01	6.08	-36.90	-13.27
Russian Federation (1998)	51.61	42.04	32.04	-18.54	-23.79	22.60	18.20	13.45	-19.47	-26.10
Slovakia (1992)		17.56	16.69		-4.95		7.33	5.84		-20.33
Slovenia (1985)	26.89	24.44	17.82	-9.11	-27.09	11.81	9.51	7.67	-19.48	-19.35
Spain (1998)	19.39	14.71	11.17	-24.14	-24.07	9.19	6.82	4.67	-25.79	-31.52
Sweden (1998)	12.40	8.85	6.14	-28.63	-30.62	6.91	4.19	2.78	-39.36	-33.65
UK	16.92	12.93	8.09	-23.58	-37.43	7.52	5.28	3.26	-29.79	-38.26
Ukraine (1981)	33.47	32.30	24.86	-3.50	-23.03	14.02	12.98	9.58	-7.42	-26.19
EU	18.61	13.85	9.80	-34.37	-29.24	8.94	6.50	4.57	-27.29	-29.69
Eastern European countries	27.90	21.27	16.06	-31.17	-24.49	12.19	8.73	6.26	-28.38	-28.29

^aThe first and last year available are given in parentheses.

EU, European Union.

revisions were minor, gastric cancer deaths were re-coded for all countries according to the ICD-9 (code no. 151) [3, 7].

From the matrices of certified deaths and resident populations, age-standardized rates at all ages, at age 35–64 years and at age 20–44 years were computed on the basis of the world standard population.

The joinpoint regression model was used to describe changes in trends. This type of non-linear regression model has also been called ‘piecewise regression’, ‘segmented regression’, ‘broken line regression’ and/or ‘multi-phase regression with the continuity constraint’ in the literature [6]. In joinpoint analysis, the best fitting points (the ‘joinpoints’) are chosen where the rate changes significantly (increase or decrease) [6, 8]. The analysis starts with the minimum number of joinpoint (e.g. zero joinpoints, which is a straight line) and tests whether one or more joinpoints are significant and must be added to the model (up to four joinpoints). The tests of significance use a Monte Carlo permutation method. In the final model each joinpoint (if any) informs of a

significant change in trend, and an annual percentage change is computed by each of those trends by means of generalized linear models, assuming a Poisson distribution. Significant changes include changes in direction or in the rate of increase or decrease. The annual percentage change is tested to determine whether it is different from the null hypothesis of no change [8]. The joinpoint analyses were performed using the ‘Joinpoint’ software from the Surveillance Research Program of the US National Cancer Institute (available at <http://www.dccps.ims.nci.nih.gov/SRAB>).

Results

Figure 1 gives trends in overall age-standardized gastric cancer mortality in the EU, selected central-eastern European countries and the Russian Federation between 1980 and 1999. The fall in the

Table 2. Age-adjusted (world population) mortality rates from gastric cancer per 100 000 men and women aged 35–64 years in separate European countries in 1980, 1989 and 1999 (unless otherwise stated in parentheses^a), and corresponding changes in rates

	Men					Women				
	1980	1989	1999	% Change 1989/80	% Change 1999/89	1980	1989	1999	% Change 1989/80	% Change 1999/89
Austria	28.39	17.59	9.14	-38.04	-48.04	13.05	9.21	5.34	-29.43	-42.02
Belarus (1981)	72.21	66.98	52.48	-7.24	-21.65	28.71	24.23	19.35	-15.60	-20.14
Bulgaria	31.66	27.89	21.03	-11.91	-24.60	16.39	12.62	9.90	-23.00	-21.55
Croatia (1985)	36.52	31.54	25.60	-13.64	-18.83	13.48	11.32	7.04	-16.02	-37.81
Czech Rep. (1986)		23.17	14.66		-36.73		8.65	6.97		-19.42
Denmark (1998)	12.52	10.71	7.51	-14.46	-29.88	7.51	6.36	2.72	-15.31	-57.23
Estonia (1981)	53.89	46.46	33.65	-13.79	-27.57	21.42	23.38	17.64	+9.15	-24.55
Finland	20.04	13.56	9.58	-32.34	-29.35	12.38	8.62	3.87	-30.37	-55.10
France (1998)	13.73	9.89	7.75	-27.97	-21.64	5.05	3.30	2.67	-34.65	-19.09
Germany	22.79	16.59	10.84	-27.20	-34.66	11.05	8.61	5.93	-22.08	-31.13
Greece (1998)	16.19	12.26	11.24	-24.27	-8.32	7.06	5.45	4.39	-22.80	-19.45
Hungary	37.05	28.65	22.39	-22.67	-21.85	14.05	12.49	8.70	-11.10	-30.34
Ireland (1998)	20.89	14.31	7.70	-31.50	-46.19	8.19	5.33	3.38	-34.92	-36.59
Italy (1998)	27.43	19.11	14.04	-30.33	-26.53	11.07	8.43	6.88	-23.85	-18.39
The Netherlands	18.62	13.29	8.66	-28.63	-34.84	6.70	4.81	3.91	-28.21	-18.71
Norway (1998)	13.40	11.53	6.80	-13.96	-41.02	8.12	6.21	4.51	-23.52	-27.38
Poland	42.73	31.65	21.44	-25.93	-32.26	14.76	10.32	6.74	-30.08	-34.69
Portugal	47.61	33.12	25.42	-30.43	-23.25	19.59	15.26	12.31	-22.10	-19.33
Romania	36.74	29.84	26.02	-18.78	-12.80	14.46	9.82	7.90	-32.09	-19.55
Russian Federation (1998)	87.03	69.13	50.18	-20.57	-27.41	34.25	26.74	19.05	-21.93	-28.76
Slovakia (1992)		23.80	22.74		-4.45		8.32	6.48		-22.12
Slovenia (1985)	31.94	31.01	18.33	-2.91	-40.89	12.25	10.87	9.68	-11.27	-10.95
Spain (1998)	24.95	17.56	13.97	-29.62	-20.44	9.37	7.37	5.57	-21.34	-24.42
Sweden (1998)	11.46	8.75	6.21	-23.65	-29.03	8.28	4.56	3.70	-44.93	-18.86
UK	18.95	13.54	7.67	-28.55	-43.35	7.43	5.19	3.14	-30.15	-39.50
Ukraine (1981)	59.64	55.16	42.95	-7.51	-22.14	23.31	20.50	15.86	-12.05	-22.63
EU	21.56	15.47	10.74	-28.25	-30.58	9.31	6.92	4.98	-25.67	-28.03
Eastern European countries	36.96	29.32	21.81	-20.67	-25.61	14.48	10.45	7.55	-27.83	-27.75

^aThe first and last year available are given in parentheses.

EU, European Union.

EU was ~50% in both sexes, from 18.6 to 9.8/100000 males, and from 8.9 to 4.6/100000 females. In selected central European countries, the fall was 49% in men and 48% in women. In absolute terms, however, the decline was larger in central Europe (from 27.9 to 16.1/100000 men, and from 12.2 to 6.3/100000 women). Thus, for both sexes the rates registered in central Europe in the late 1990s are similar to those of the EU in the mid-1980s. In the Russian Federation, the fall during the last 20 years was 38% in men (from 51.6 to 32/100000) and 40% in women (from 22.6 to 13.5/100000), and the rates of the late 1990s were comparable to those registered in the EU as a whole three decades earlier.

Table 1 gives overall age-adjusted gastric cancer rates for men and women in separate European countries in 1980, 1989 and

1999, and the corresponding fall in rates. For men, some countries (e.g. Denmark, France, Greece, Hungary or Ireland) but not others (e.g. Finland, Germany, Italy, The Netherlands or the UK) showed greater proportional falls in the 1980s than in the 1990s. Overall, the fall in men was 34% in the 1980s and 29% in the 1990s in the EU, 31% and 24% in eastern Europe, and 19% and 24% in Russia. For women, the fall was similar in the two decades in most of Europe, approaching 30%.

Corresponding figures at age 35–64 years are given in Table 2. Although there was some variation across countries, the pattern of trends was similar to that registered at all ages, with a 25–30% fall for both sexes in all major areas of the continent over the last decade.

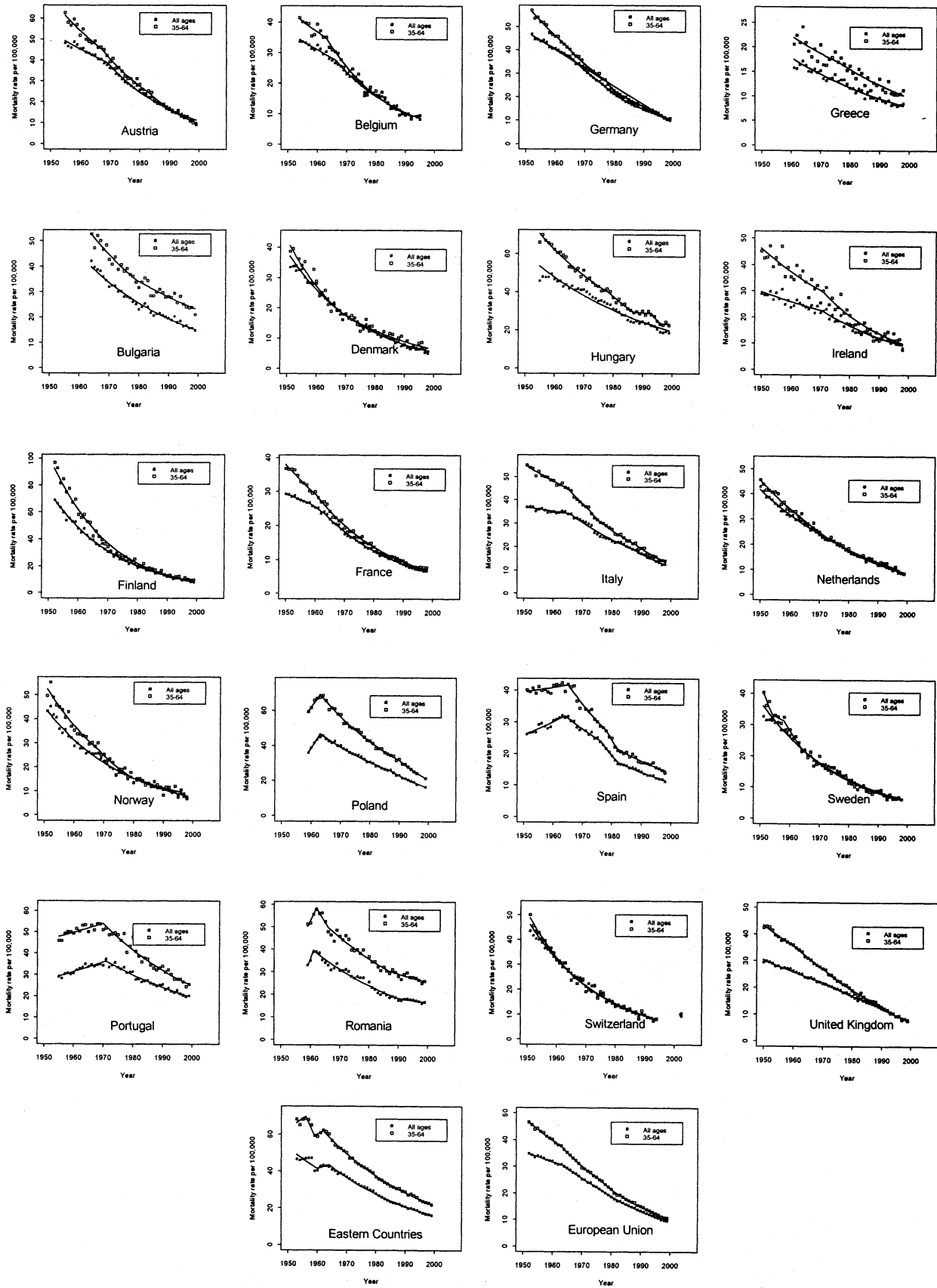


Figure 2. Joinpoint analysis (1950–1999) for gastric cancer mortality in selected European countries. Males, all ages and 35–64 years old.

Table 3. Joinpoint analysis (1950–1999) for gastric cancer (males, all ages)

	Trend 1		Trend 2		Trend 3		Trend 4		Trend 5	
	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC
Austria	1955–67	-1.45*	1967–93	-3.77*	1993–99	-6.39				
Belgium	1954–63	-1.39*	1963–82	-3.55	1982–95	-4.71*				
Bulgaria	1964–75	-3.41*	1975–99	-2.49*						
Former Czech Rep.	1953–66	-0.82*	1966–91	-3.43*						
Denmark	1951–55	-0.85	1955–98	-3.96*						
Finland	1952–91	-4.40*								
France	1950–61	-1.38*	1961–98	-3.61*						
Germany	1955–65	-1.66*	1965–75	-3.34*	1975–85	-4.13*	1985–95	-3.29*	1995–99	-5.69*
Greece	1961–76	-2.24*	1976–98	-2.87*						
Hungary	1955–59	0.71	1959–78	-1.76*	1978–86	-4.03*	1986–92	-1.00	1992–99	-3.63*
Ireland	1950–71	-1.36*	1971–98	-3.17*						
Italy	1951–65	-0.54*	1965–72	-1.88*	1972–76	-5.03*	1976–84	-1.59*	1984–98	-3.76*
The Netherlands	1950–74	-2.68*	1974–92	-3.32*	1992–99	-4.77*				
Norway	1951–62	-4.36*	1962–68	-1.52	1968–74	-5.45*	1974–98	-3.17*		
Poland	1959–63	6.47*	1963–87	-2.47*	1987–99	-3.70*				
Portugal	1955–71	1.35*	1971–99	-2.14*						
Romania	1959–61	7.56	1961–80	-2.10*	1980–83	-6.90	1983–99	-1.40*		
Spain	1951–64	1.53*	1964–76	-2.33*	1976–82	-5.34*	1982–98	-2.52*		
Sweden	1951–62	-2.32	1962–68	-5.14*	1968–74	-1.90*	1974–98	-4.20*		
Switzerland	1951–71	-3.44*	1971–94	-4.41*						
UK	1950–60	-1.25*	1960–75	-1.97*	1975–88	-2.81*	1988–99	-4.60*		
Eastern countries	1953–60	-2.45*	1960–63	1.57	1963–72	-2.29*	1972–98	-2.87*		
European Union	1952–64	-1.20*	1964–73	-2.67*	1973–91	-3.29*	1991–98	-3.83*		

*The APC is statistically significantly different from 0 ($P < 0.05$).

APC, annual percentage change.

To further understand cohort patterns in gastric cancer mortality, we also considered trends in young adults (20–44 years) only. Persisting falls were observed in the EU (~27% in the 1980s, and 20% in the 1990s in both sexes combined), in eastern Europe (~20% in both decades) and in Russia (30% in the 1980s, 25% in the 1990s). Only France and Greece, two countries with low rates, did not show consistent declines in both sexes over the last decade.

The main findings from joinpoint regression over the period 1950–1999 in 20 European countries providing long-term data, the EU, and selected central and eastern European countries are given in Figure 2 and Table 3 for men. Apart from some central (Hungary, Poland) and southern (Spain, Portugal) European countries, whose downward trends started in the 1960s, most countries showed falls in gastric cancer mortality throughout the five decades considered. These were, if anything, larger after the 1960s and 1970s, and showed no evidence of levelling off, in proportional terms. Indeed, in the whole EU, the largest proportional decline (-3.83% per year) was observed in the 1990s. As shown in Figure 2, the pattern was similar at age 35–64 years.

Comparable figures for women are given in Figure 3 and Table 4. As for men, trends were downward in all countries over recent decades, and the proportional decline was, if anything, larger since the mid-1970s, as indicated by the figure for the EU as a whole (-3.67% after 1974).

Discussion

The major finding from this update analysis of trends in gastric cancer mortality in Europe is the steady and persistent fall in rates across various major geographical areas of the continent. There was little systematic indication of a levelling of slopes over the most recent calendar years, indicating that the fall is likely to continue in the near future. With respect to this, the decline was observed in the young and middle-aged population as well, and hence the fall in gastric cancer across Europe has mainly been on a cohort of birth basis [1, 9]. The lowest gastric cancer rates in the late 1990s were registered in Denmark (5.2/100000 men; 2.7/100000 women); nonetheless, the fall over the last decade was over

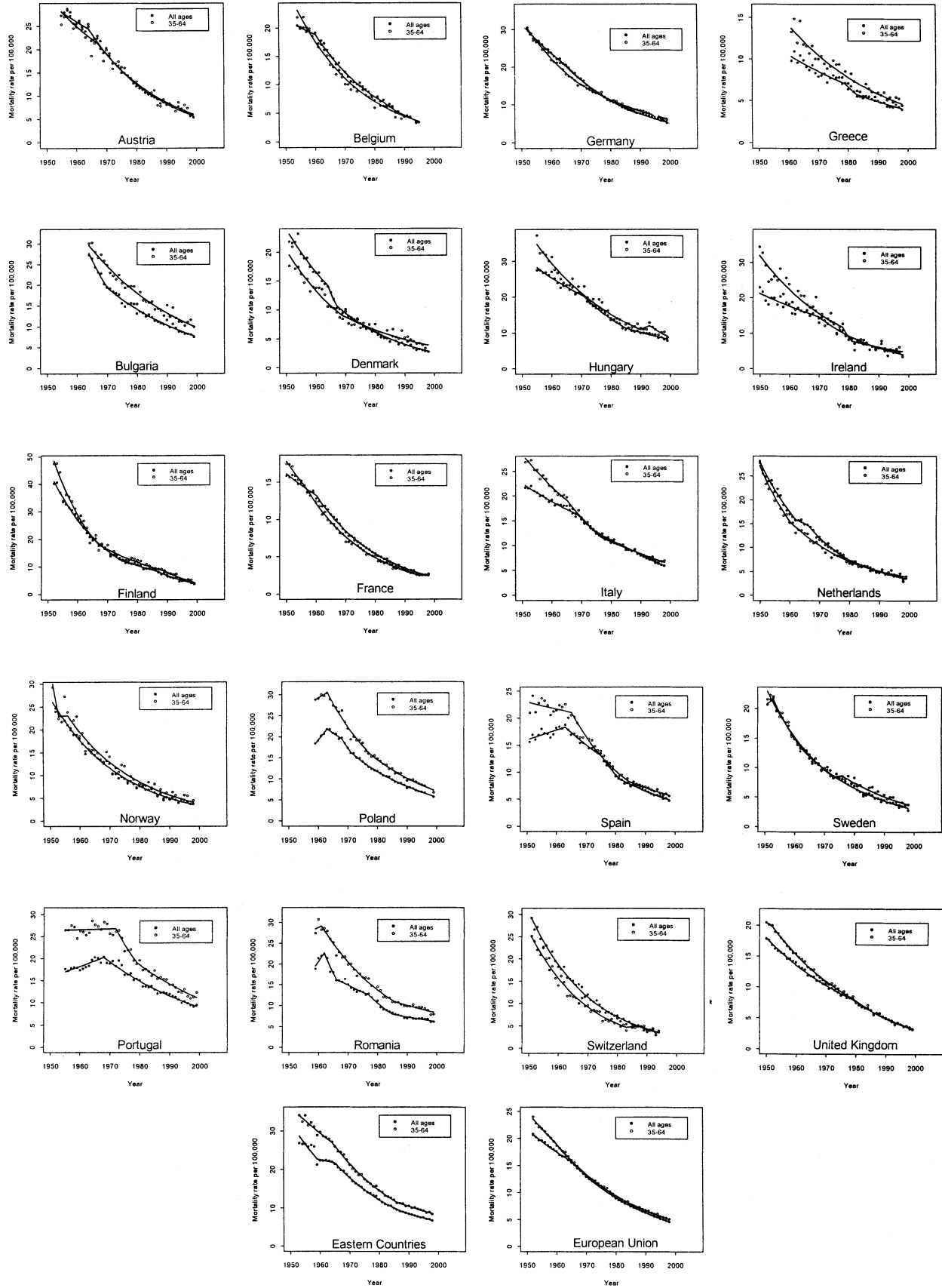


Figure 3. Joinpoint analysis (1950–1999) for gastric cancer mortality in selected European countries. Females, all ages and 35–64 years old.

Table 4. Joinpoint analysis (1950–1999) for gastric cancer (females, all ages)

	Trend 1		Trend 2		Trend 3		Trend 4		Trend 5	
	Years	APC	Years	APC	Years	APC	Years	APC	Years	APC
Austria	1955–64	-1.51*	1964–99	-4.10*						
Belgium	1954–60	-1.27	1960–83	-4.26*	1983–95	-5.68*				
Bulgaria	1964–70	-5.71*	1970–99	-3.10*						
Former Czech Rep.	1953–66	-1.60*	1966–91	-3.98*						
Denmark	1951–64	-3.71*	1964–67	-8.86	1967–98	-4.21*				
Finland	1952–75	-5.15*	1975–86	-3.00*	1986–91	-5.98*				
France	1950–60	-1.98*	1960–98	-4.38*						
Germany	1959–65	-2.78*	1965–84	-4.11*	1984–96	-3.20*	1996–99	-5.93*		
Greece	1961–79	-2.11*	1979–83	-4.92	1983–98	-2.31*				
Hungary	1955–71	-2.09*	1971–85	-4.00*	1985–99	-2.23*				
Ireland	1950–70	-1.82*	1970–98	-4.45*						
Italy	1951–69	-1.75*	1969–77	-4.00*	1977–88	-2.48*	1988–98	-3.99*		
The Netherlands	1950–62	-4.63*	1962–66	-1.74	1966–80	-4.82*	1980–99	-3.88*		
Norway	1951–98	-4.13*								
Poland	1959–63	4.47*	1963–68	-2.23*	1968–71	-5.89*	1971–99	-3.59*		
Portugal	1955–68	1.37*	1968–99	-2.53*						
Romania	1959–62	5.05*	1962–66	-7.91*	1966–77	-2.34	1977–85	-5.57*	1985–99	-1.74*
Spain	1951–63	1.05*	1963–75	-2.74*	1975–81	-6.36*	1981–98	-3.45*		
Sweden	1951–53	1.56	1953–62	-5.10*	1962–98	-3.93*				
Switzerland	1951–94	-4.81*								
UK	1950–79	-2.77*	1979–99	-4.24*						
Eastern Countries	1953–59	-3.79*	1959–65	-0.78*	1965–87	-3.79*	1987–98	-2.75*		
European Union	1952–64	-2.08*	1964–74	-3.43*	1974–98	-3.67*				

*The APC is statistically significantly different from 0 ($P < 0.005$).

APC, annual percentage change.

30% in both sexes for Denmark. At age 20–44 years, Danish gastric cancer rates declined by 16% in males and 37% in females over the last decade.

For gastric cancer, death certification has long been sufficiently reliable to permit meaningful inference on trends for most European countries, particularly those from western Europe, as well as for major central and eastern European countries, mostly in population aged <65 years [3]. In any case, it is unlikely that any possible change in diagnostic practices of gastric cancer can explain such widespread and important downward trends as those observed across Europe [10, 11].

The use of joinpoint analysis has allowed an innovative approach to the description of the trends in gastric cancer mortality over the last five decades. Although any modelling technique has inherent problems of interpretation, the key message from joinpoint regression is that, in most of Europe, the fall in gastric cancer mortality is continuing, if anything with a steeper slope, over the most recent calendar period. The estimate of the annual percentage change, however, is a measure of the proportional fall

in gastric cancer death rates, and, on a public health level, has to be translated in absolute figures.

During the 1990s, gastric cancer was the main determinant of the fall observed in cancer mortality in the EU [5]. Even assuming, as suggested by the present analysis, a persisting fall in gastric cancer mortality over the next decade, the number of deaths avoided in the first decade of the current century will probably not be greater than 15000. These figures will remain appreciably larger in central and eastern European countries, and most of all in the Russian Federation, where gastric cancer remains a public health priority [12].

The reasons for the generalized declines in gastric cancer rates throughout Europe are complex and not completely understood. Almost certainly, these include a more varied and affluent diet and better food conservation, including refrigeration, as well as the control of *Helicobacter pylori* infection [4, 13–15] and reduced tobacco smoking, at least in males [16]. Whether improved diagnosis and treatment has also played some role on the favorable trends in gastric cancer throughout Europe, particularly over most

recent calendar periods, however, remains open to question [17, 18].

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