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Breast cancer incidence and mortality trends in 16 European countries

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Abstract

Trends in the incidence of and mortality from breast cancer result from a variety of influences including screening programmes, such as those introduced in several European countries in the late 1980s. Incidence and mortality rates for 16 European countries are analysed. Incidence increased in all countries. The estimated annual percent change (EAPC) varied from 0.8 to 2.8% in pre-screening years in 6 'screened' countries and from 1.2 to 3.0% in 10 'non-screened' countries. Screening related temporary increases were visible. Earlier mortality trends were maintained in the most recent decade in Estonia (EAPC +1.8%) and Sweden (−1.2%). In other countries, previously increasing trends changed. Trends flattened in Finland, Denmark, France, Italy and Norway (EAPC 0.0 to −0.3%), while they declined in England and Wales (−3.1%), Scotland (−2.0%), and The Netherlands (−1.0%), all of which have national screening programmes, and in Slovakia (−1.1%), Spain (−0.7%), and Switzerland (−1.1%). In some countries with screening programmes, declines in mortality started before screening was introduced, and declines also occurred in non-screened age groups and in some countries without national screening programmes. This suggests that the major determinants of the observed trends vary among the countries and may include earlier detection through screening in countries where this has been introduced, but also improvements in therapy, in countries with or without screening.

Keywords: Breast cancer; Europe; Incidence; Mortality; Trends; Age-period analysis

1. Introduction

Time trends in the incidence of breast cancer are the outcome of several influences: the changing profile of risk factors in the population (e.g. decreasing fertility, increasing height and weight), earlier diagnosis due to screening or simply to better health awareness. Time trends in mortality may reflect changes in incidence and/or improved outcome following diagnosis, because of earlier stage of presentation of breast cancers, or their more effective treatment. Large-scale reviews of international trends in the incidence and mortality from breast cancer [1,2] have shown, for the most part, that incidence was increasing with less marked, but similar, changes in the mortality rates. More recently, declines in mortality rates from breast cancer were noted in Canada and in some European countries, e.g. UK, The Netherlands, Denmark, and Norway [3], although it was first noted in the USA [4]. Furthermore, the recent decline in mortality rates coincided, more or less, with the introduction of screening programmes for breast cancer [5], accompanied by a brisk rise in incidence, as 'prevalent' (undetected and asymptomatic) cancers were diagnosed by screening [6–8]. There has been considerable debate concerning the relative contributions to the observed trends of screening and of improved therapy [9–11].

In this paper, we examine long-term trends in incidence of and mortality from breast cancer by age group in 16 European countries, and their relationship to the

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introduction of widespread mammographic screening programmes in six of them. This was made possible by the availability of recent incidence and mortality data in the EUROpean Cancer Incidence and Mortality (EUROCIM) database and software package, an initiative of the European Network of Cancer Registries (ENCR). Member registries regularly submit cancer incidence and mortality in their catchment area for inclusion in the EUROCIM package after being subjected to validity checks, thus providing members with a resource to compare their own incidence and mortality with data from other European cancer registries.

2. Patients and methods

Breast cancer incident cases and breast cancer deaths in women aged 35–74 years from the EUROCIM databases [12,13] used for this analysis are shown in Table 1, grouped into four areas according to the United Nations classification of European countries. Incidence data for England were obtained from the Office for National Statistics. Registries were excluded from the analysis if their data had not been accepted for publication in Cancer Incidence in Five Continents Volume VII [14] (a proxy for the quality of registration), or if they had contributed fewer than 10 consecutive years of data.

Details of screening programmes were taken from information published by the International Breast Screening Network and the European Network of Pilot Projects for Breast Cancer Screening [5]. Countries were taken to operate national screening when at least 75% population coverage was reported to have been achieved in 1995. These details are summarised in Table 2.

The EUROCIM analytical facilities were used to estimate directly age-standardised rates (ASRs), truncated for the ages 35–74 years, using the European standard population. Age-specific incidence and mortality data were exported into STATA [15] to produce graphs and to obtain country-specific estimated annual percent change (EAPC). The EAPC was estimated for each country via Poisson regression analyses. For age-specific

Table 1
Populations included in the analysis

European subgroup	Country	EUROCIM 'populations' for incident cases	Quality of registrations		Breast cancer incidence (35–74 years)			Breast cancer mortality (35–74 years)		
			MV%[a]	DCO%[b]	Period	Cases[c]	Population[d]	Period	Deaths[e]	Population[f]
Eastern	Czech Republic	National	81	2	1985–1997	39 095	2 543 468	1986–1997	15 587	2 543 468
	Slovakia	National	84	0	1968–1995	24 459	1 214 315	1968–1995	11 566	1 214 315
Northern	Denmark	National	96	0	1978–1995	39 527	1 238 834	1958–1996	31 006	1 246 799
	England and Wales	National	84	0–11	1971–1997	510 472	12 029 100	1958–1997	319 823	12 029 100
	Estonia	National	92	–	1968–1996	8840	386 028	1968–1998	4473	384 700
	Finland	National	99	0	1953–1997	57 275	1 292 941	1958–1996	16 410	1 283 830
	Iceland	National	99	0	1970–1996	1888	53 842	1958–1996	804	53 842
	Norway	National	98	0	1953–1996	48 796	976 337	1958–1996	16 276	976 337
	Scotland	National	86	3	1975–1996	44 837	1 218 753	1968–1997	24 111	1 226 345
	Sweden	National	99	–	1960–1996	117 583	2 059 780	1958–1996	36 194	2 059 780
Southern	Italy	Ferrara, Florence, Genoa, Latina, Macerata, Modena, Parma, Ragusa, Romagna, Trieste, Turin, Varese, Veneto	85–99	0–6	1983–1994	25 140	1 590 622	1958–1996	233 453	14 473 800
	Slovenia	National	94	2	1983–1996	7557	498 990	1985–1997	3244	502 071
	Spain	Albacete, Asturias, Basque, Granada, Mallorca, Murcia, Navarra, Tarragona, Zaragoza	81–96	2–9	1983–1994	18 471	1 644 236	1958–1997	103 331	9 229 300
Western	France	Bas-Rhin, Calvados, Doubs, Haut-Rhin, Hérault, Isère, Somme, Tarn	96–99	–	1978–1995	29 905	1 225 177	1958–1997	218 163	13 777 750
	The Netherlands	Eindhoven	98	–	1958–1997	9579	234 237	1958–1997	72 434	3 669 700
	Switzerland	Basel, Geneva, Graubunden, Neuchatel, St-Gall, Vaud, Zurich	95–99	0–3	1983–1994	17 084	827 045	1958–1994	30 602	1 668 600

[a] % of breast cancer cases microscopically-verified.
[b] % of breast cancer cases registered on the basis of death certificate information only.
[c] Occurring in full period listed.
[d] Population census or estimate for most recent year in which national registry or all regional registries contributed.
[e] Deaths occurring in national population in full period listed.
[f] Population census or estimate for most recent year.

Table 2
Organised breast cancer screening programmes in Europe (source: Ref. [5])

Country	Start	Coverage	Age group (years)	Screening interval (years)	% targeted population covered in 1995
Denmark	1992	Regional	50–69	2–3	<25
Finland	1989	National	50–59	2	100
Iceland	1987	National	40–69	2	100
The Netherlands	1988	National	50–69	2	76–100
Sweden	1986	National	40–74	11/2, 2	100
England and Wales	1988	National	50–64	3	100
Scotland	1988	National	50–64	3	100
France	1994	National	50–65/69	2–3	30–40
Italy	1990	Regional	50–69	2	<25
Spain	1989	Regional	45–64	2	<25

analyses, the model fitted contained an interaction term between age and year of diagnosis or death (of the form 'log rate = constant + age + year + age*year'). For overall estimates for ages 35–74 years, the model contained only the main period effect (of the form 'log rate = constant + year'). In screened countries, estimates were produced for the incidence trend in prescreening years and for the years following the initial prevalent screens, where that was possible. For mortality, trend estimates were produced for the last decade for which data were available.

3. Results

Time trends are displayed in Figs. 1–3. Information from countries is available for varying periods of time, but the same time span on the x-axis (1950 to 2000) is used on all the graphs, to facilitate visual comparison. The year in which screening started is shown for the relevant countries, although in most countries it took several years to achieve national coverage (see Table 2). Different age groups were screened in different countries, but to enable comparisons of age-specific rates across different years in different countries in Figs. 2 and 3, rates are shown in the same three age groups (35–49 years, 50–64 years, and 65–74 years) for all countries.

Tables 3 and 4 show the EAPC in the incidence and mortality rates shown in Figs. 1–3, based upon the fitted models for the periods shown, for countries with (Table 3) and without (Table 4) national screening programmes.

3.1. Geographical patterns

Incidence rates are lower in Estonia and Slovakia than in the other countries, with ASRs just reaching 100 per 100 000 person-years in the 1990s (Fig. 1). Mortality rates are low (consistently below 50 per 100 000 person-years) in Finland, Sweden, Czech Republic, Estonia, France, Italy, Norway, Slovakia, Slovenia and Spain. Both incidence and mortality rates are consistently higher in the 50–64 and 65–74 year age groups than in the 35–49 year age group (Figs. 2 and 3).

3.2. Time trends

Age-standardised incidence rates are increasing with time in all countries (Fig. 1). These trends are consistent across all three age groups shown in Figs. 2 and 3, exceptions being Scotland (Fig. 2), and Slovenia and Switzerland (Fig. 3). In these countries, no increase is apparent in the 35–49 age groups and in Switzerland no increase is apparent in the 65–74 age group either. These trends in Slovenia and Switzerland are also reflected in their EAPC shown in Table 4.

There have been striking increases in incidence in Finland and the Eindhoven registry population (Fig. 1), from ASRs well below 100 per 100 000 person-years in the 1950s to around 200 per 100 000 in the 1990s. These increases started long before screening was introduced in those countries, the EAPC in the prescreening years for all age groups being 2.8% in Finland and 2.4% in Eindhoven (statistically significant, Table 3). The increases are visible in all age groups (Fig. 2), screened and unscreened, the EAPC in the prescreening years being in the range 2.2–2.9% (Table 3). In the four other countries with national screening programmes, the EAPC in the pre-screening years varied between 1 and 2% per year for the 35–74 year old age group, the estimates in the 50–64 year, 65–74 year age groups also being statistically significant in all countries except Iceland (Table 3). Screening-related temporary increases in incidence are visible in ASRs in England and Wales, Scotland, and Sweden, but are not apparent in Finland, Iceland or the population of the Eindhoven registry (Fig. 1). The changes are clearly visible in the 50–64 year age groups in England and Wales and in Scotland (Fig. 2), these being the screened age groups in those countries. An increase is also visible in the 50–64 year

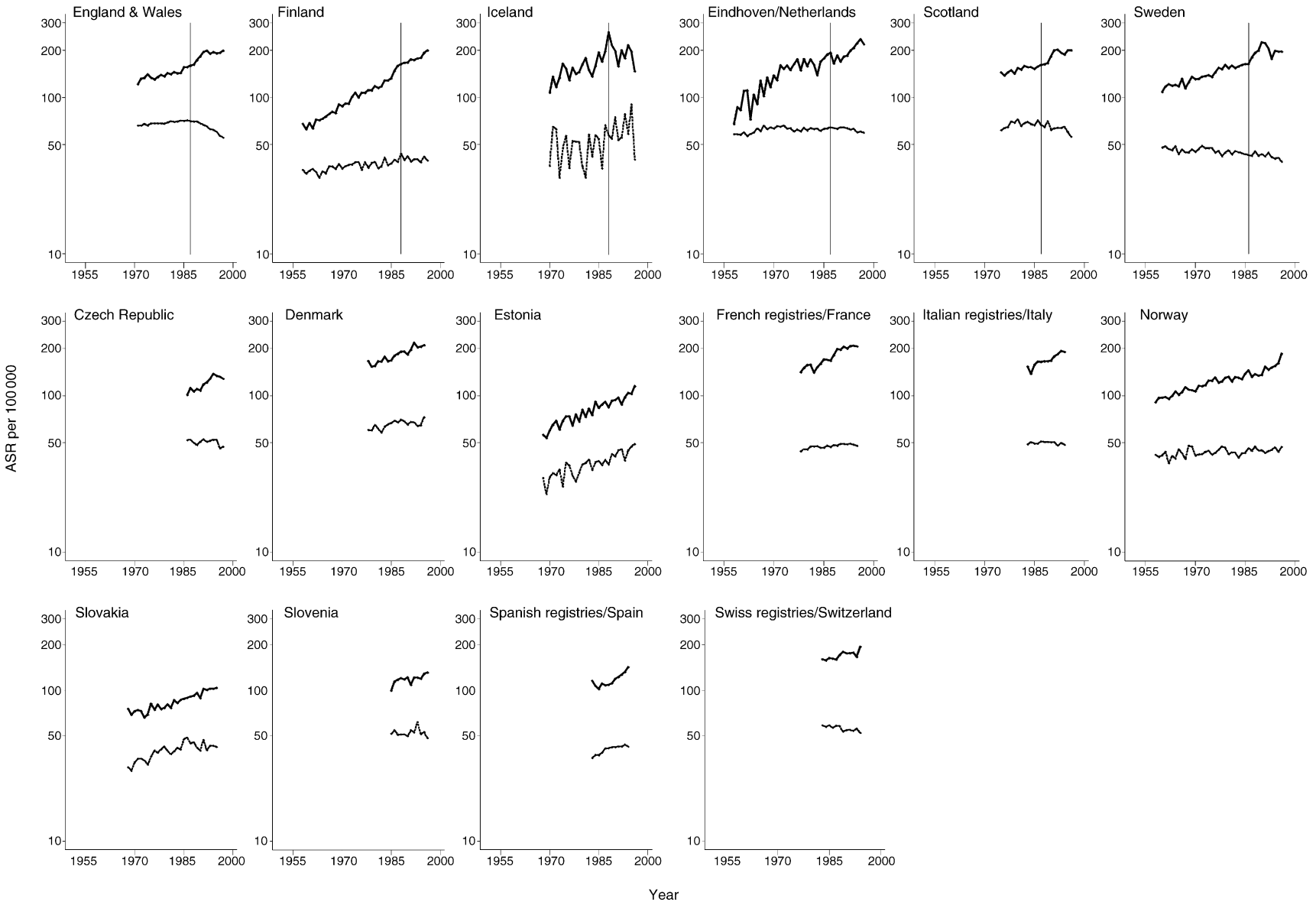

Fig. 1. Age-standardised rates for incidence (thick line) and mortality (thin line). The vertical lines in the first six graphs indicate the start of national screening programmes in those countries.

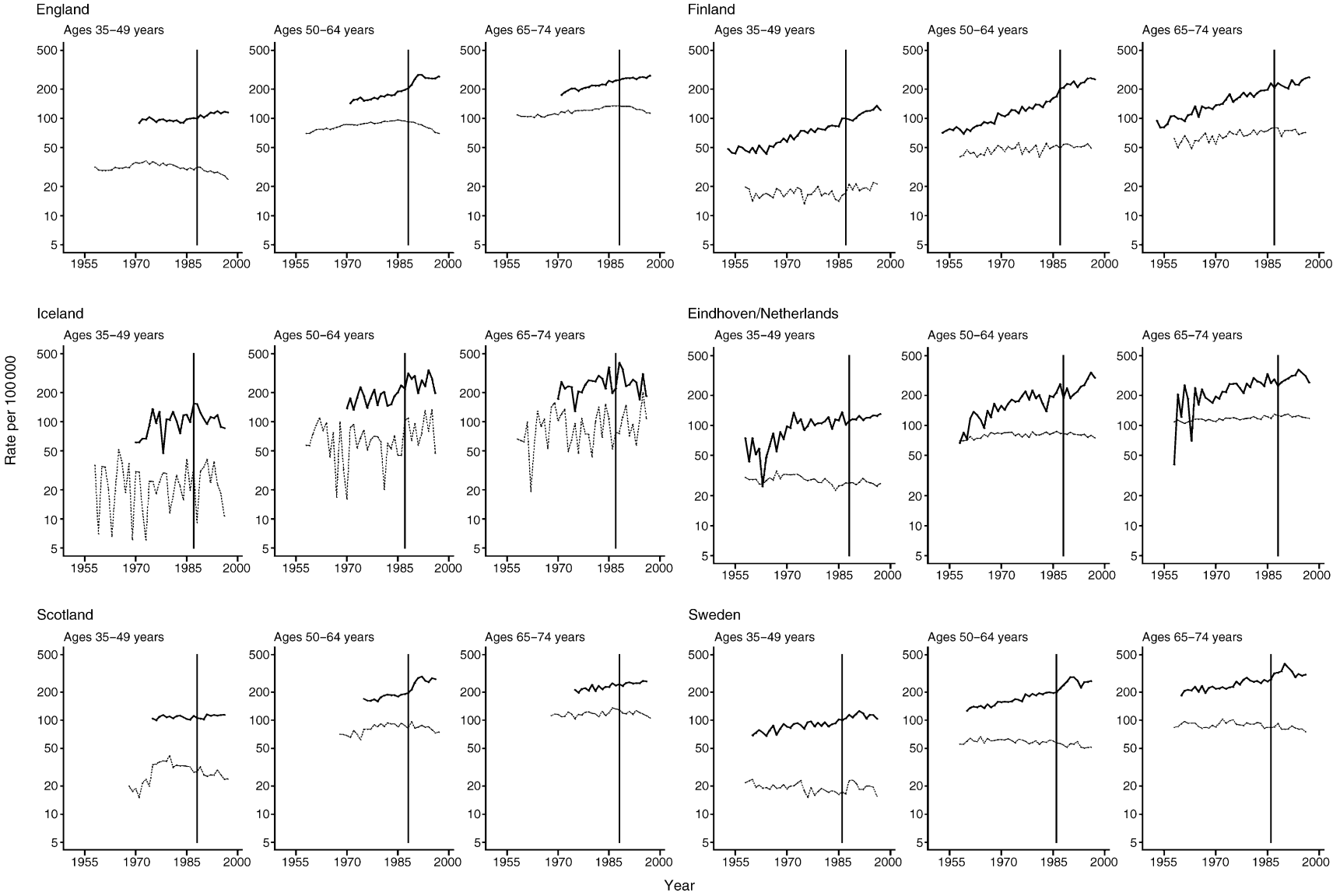

Fig. 2. Age-specific rates for incidence (thick line) and mortality (thin line) for the age groups 35–49 years, 50–64 years and 65–74 years in countries with national screening programmes. The vertical lines in the graphs indicate the start of screening.

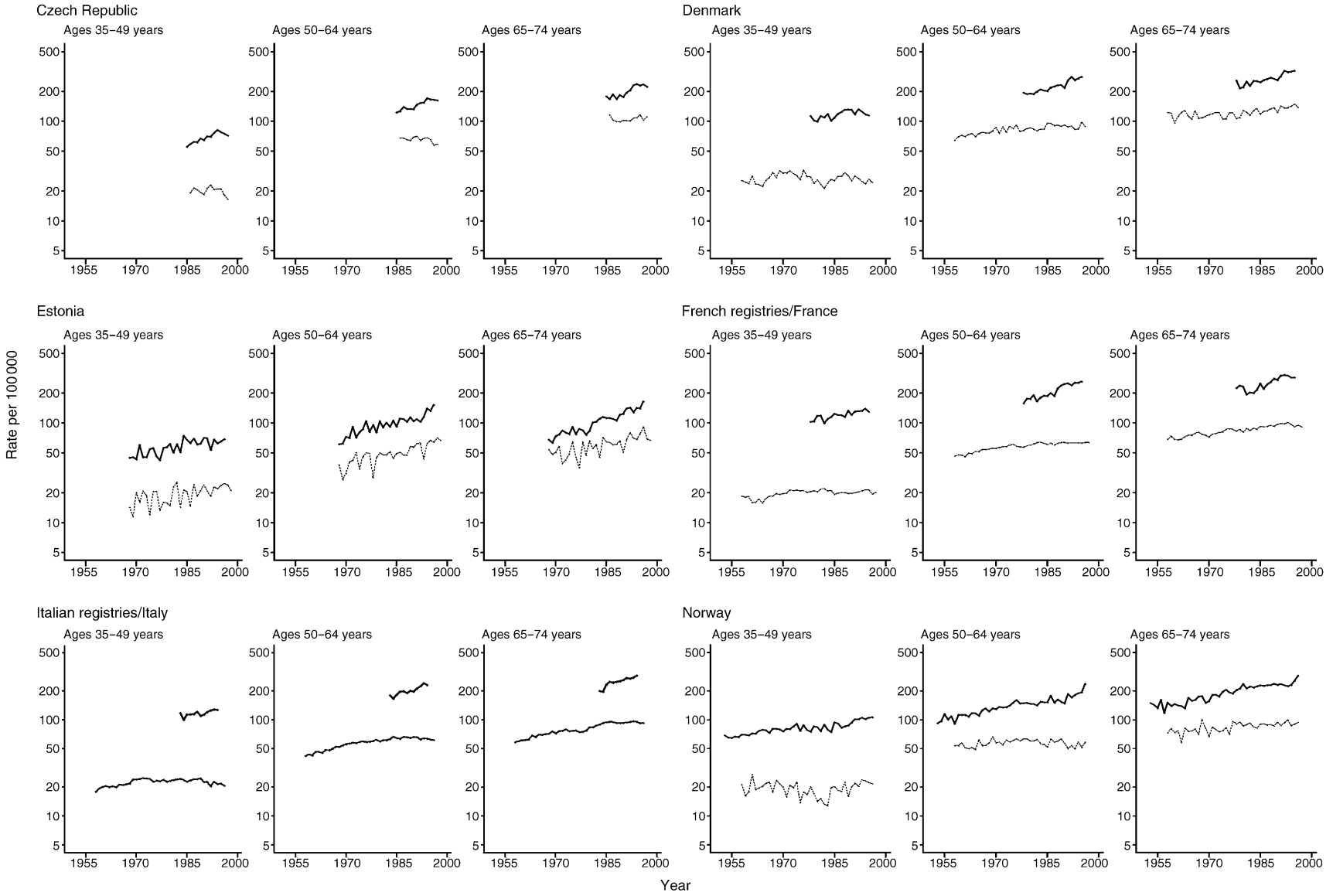

Fig. 3. Age-specific rates for incidence (thick line) and mortality (thin line) for the age groups 35–49 years, 50–64 years and 65–74 years in countries without national screening programmes.

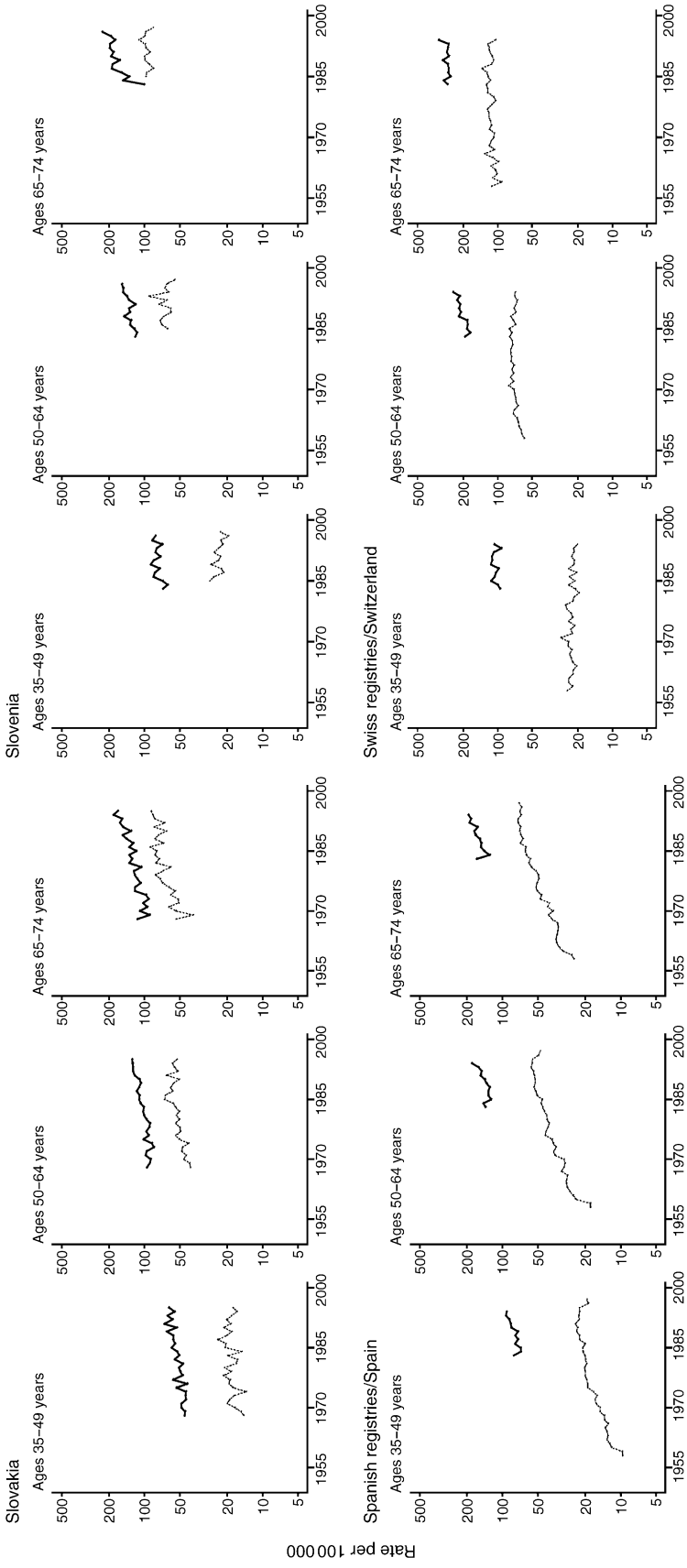

Fig. 3 (*continued*)

Table 3
Estimated annual percent change (EAPC) (and 95% confidence interval (CI)) in countries with national screening programmes

Country	Incidence					Mortality				
	Prescreening period	Age group (years)				Most recent decade	Age group (years)			
		35–49	50–64	65–74	35–74		35–49	50–64	65–74	35–74
England and Wales	1971–1987	0.1 (−0.1 to 0.2%)	1.6 (1.5 to 1.7)	1.8 (1.6 to 1.9%)	1.1 (1.0% to 1.2%)	1988–1997	−2.7 (−3.3 to −2.0%)	−3.5 (−3.9 to −3.0%)	−2.2 (−2.7 to −1.8%)	−3.1 (−3.4 to −2.9%)
Finland	1953–1988	2.4 (2.2 to 2.6%)	2.9 (2.8 to 3.1%)	2.7 (2.5 to 2.9%)	2.8 (2.7 to 2.9%)	1987–1996	1.2 (−0.8 to 3.2%)	−0.1 (−1.6 to 1.3%)	−1.0 (−2.6 to 0.7%)	−0.2 (−1.2 to 0.7%)
Iceland	1970–1986	2.7 (0.3 to 5.1%)	1.3 (−0.6 to 3.3%)	2.1 (−0.3 to 4.6%)	2.0 (0.7 to 3.3%)	1987–1996	−4.9 (−13.8 to 3.7%)	−0.9 (−6.6 to 4.8%)	5.0 (−2.3 to 12.3%)	−0.5 (−4.5 to 3.5%)
Netherlands[a]	1958–1987	2.2 (1.5 to 2.8%)	2.5 (1.9 to 3.1%)	2.2 (1.4 to 3.0%)	2.4 (2.1 to 2.8%)	1988–1997	−0.4 (−1.5 to 0.6%)	−1.0 (−1.7 to −0.3%)	−0.7 (−1.5 to 0.1%)	−1.0 (−1.4 to −0.5%)
Scotland	1975–1987	0.1 (−0.5 to 0.8%)	1.4 (0.9 to 1.9%)	1.2 (0.6 to 1.8%)	0.8 (0.5 to 1.2%)	1988–1997	−2.0 (−3.8 to −0.1%)	−1.8 (−2.9 to −0.7%)	−1.4 (−2.6 to 0.1%)	−2.0 (−2.8 to −1.3%)
Sweden	1960–1985	1.1 (0.9 to 1.3%)	1.8 (1.6 to 1.9%)	1.3 (1.1 to 1.4%)	1.6 (1.5 to 1.7%)	1987–1996	−1.6 (−3.2 to 0.1%)	−0.9 (−2.0 to 0.2%)	−1.1 (−2.2 to 0.0%)	−1.2 (−1.9 to −0.5%)

[a] Eindhoven only.

age group in Finland, perhaps attenuated by the 60–64 year age group not being screened. In Sweden, where women aged 40–74 years are screened, this effect is visible in both the 50–64 year and 65–74 year age groups shown in Fig. 2, but not in the youngest screened age groups, even when analysed separately (40–44 years, 45–49 years).

In countries without national screening programmes (Fig. 3 and Table 4), the EAPC in incidence was greater than 2% per year in all age groups in the Czech Republic and Spain, 2% or greater in the two older age groups in Denmark, Estonia, France, and Italy, greater than 2% in the 50–64 year age group in Switzerland and greater than 2% in the oldest age group in Slovakia and Slovenia. In Norway, the EAPC ranged from 1.0 to 1.6% per year across the age groups.

Age-standardised mortality rates (Fig. 1) appear to be increasing in Estonia throughout the period of observation (1968–1998), consistently so in all the age groups (Fig. 3). The EAPC of 1.8% in the last decade was statistically significant for all age groups together (Table 4). Age-standardised mortality rates (Fig. 1) also increase until approximately 1985 in England and Wales, Finland, Denmark, France, Italy, Slovakia and Switzerland. After 1985, the ASRs have flattened out in Finland, Denmark, France and Slovakia and have decreased in England and Wales, Italy, Spain and Switzerland. The same patterns are visible in all three age groups shown in Fig. 2 for Finland and in Fig. 3 for France, Slovakia and Spain. In England and Wales, the decline appears to have started in the 35–49 year age group approximately 15 years earlier than in the 50–64 year age group, while the rate in the 65–74 year age group was still rising when screening started. Post-screening, the decrease is visibly greater in the 50–64 year old, screened group. In Denmark and Italy, there has been no increase in mortality in the 35–49 year age group (Fig. 3). Age-standardised mortality rates (Fig. 1) are constant in The Netherlands, Scotland and Norway in earlier years, but decrease after the mid- to late 1980s in all except Norway. This appears to be true at all ages (Figs. 2 and 3). Age-standardised and age-specific mortality rates have been decreasing in Sweden since the 1960s (Figs. 1 and 2).

The EAPCs in mortality in the most recent decade of observation are shown in Tables 3 and 4. They confirm that, in addition to the continued long-term downward trend in Sweden, there have been significant decreases in three countries with national screening programmes (Table 3); around 3% per year at ages 35–74 years in England and Wales (and 3.5% in the screened age group), 2.0% in Scotland and around 1% in The Netherlands. There was no decline in Finland or Iceland. In countries without national screening programmes (Table 4), there were declines of around 1% in Slovakia, Spain and Switzerland, in contrast to the long-term increase in Estonia and no marked trends elsewhere.

Table 4
Estimated annual percent change (EAPC) (and 95% confidence intervals (CI)) in populations without national screening programmes

Country	Incidence					Mortality				
	All years	Age group (years)				Most recent decade	Age group years)			
		35–49	50–64	65–74	35–74		35–49	50–64	65–74	35–74
Czech Republic	1985–1997	2.6 (2.1 to 3.1%)	2.7 (2.3 to 3.1%)	3.0 (2.6 to 3.5%)	3.0 (2.7 to 3.2%)	1988–1997	−1.0 (−2.4 to 0.5%)	−1.2 (−2.1 to−0.3%)	1.4 (0.4 to 2.3%)	0.4 (−0.2 to 1.0%)
Denmark	1978–1995	1.0 (0.7 to 1.4%)	2.5 (2.2 to 2.8%)	2.0 (1.7 to 2.4%)	1.7 (1.5 to 1.9%)	1987–1996	−2.0 (−3.8 to −0.2%)	−0.1 (−1.2 to 1.0%)	1.2 (0.0 to 2.4%)	0.0 (−0.8 to 0.7%)
Estonia	1968–1996	1.5 (1.0 to 1.9%)	2.3 (1.9 to 2.7%)	2.9 (2.4 to 3.4%)	2.3 (2.0 to 2.5%)	1989–1998	0.9 (−3.4 to 5.1%)	2.4 (−0.3 to 5.1%)	2.1 (−1.3 to 5.5%)	1.8 (0.2 to 3.4%)
France	1978–1995	1.5 (1.1 to 1.9%)	3.1 (2.7 to 3.5%)	2.5 (2.0 to 2.9%)	2.3 (2.0 to 2.5%)	1988–1997	−0.6 (−1.8 to 0.6%)	−1.1 (−1.9 to−0.3%)	−0.8 (−1.7 to 0.1%)	−0.1 (−0.3 to 0.2%)
Italy	1983–1994	1.4 (0.6 to 2.2%)	2.7 (2.1 to 3.4%)	2.5 (1.8 to 3.3%)	2.7 (2.2 to 3.1%)	1987–1996	−1.8 (−2.3 to−1.2%)	−0.8 (−1.2 to−0.4%)	0.0 (−0.4 to 0.4%)	−0.3 (−0.6 to−0.1%)
Norway	1953–1996	1.0 (0.9 to 1.1%)	1.5 (1.4 to 1.7%)	1.6 (1.4 to 1.7%)	1.4 (1.3 to 1.5%)	1987–1996	2.2 (0.0 to 4.5%)	−1.0 (−2.7 to 0.6%)	0.6 (−1.0 to 2.2%)	−0.3 (−1.3 to 0.7%)
Slovakia	1968–1995	1.2 (0.9 to 1.5%)	1.4 (1.2 to 1.6%)	2.1 (1.8 to 2.4%)	1.5 (1.3 to 1.6%)	1986–199t5	−3.1 (−5.6 to−0.7%)	−0.7 (−2.4 to 0.9%)	2.2 (0.2 to 4.2%)	−1.1 (−2.0 to−0.1%)
Slovenia	1983–1996	1.0 (−0.1 to 2.0%)	1.8 (1.0 to 2.7%)	3.5 (2.4 to 4.6%)	2.1 (1.5 to 2.6%)	1988–1997	−1.6 (−4.7 to 1.4%)	−0.5 (−2.5 to 1.5%)	−0.2 (−2.5 to 2.2%)	−0.3 (−1.7 to 1.1%)
Spain	1983–1994	2.7 (1.8 to 3.7%)	2.6 (1.8 to 3.3%)	3.1 (2.1 to 4.0%)	2.7 (2.2 to 3.2%)	1988–1997	−2.0 (−2.7 to−1.2%)	−0.6 (−1.1 to−0.1%)	0.3 (−0.3 to 0.9%)	−0.7 (−1.0 to−0.3%)
Switzerland	1983–1994	0.4 (−0.6 to 1.4%)	2.4 (1.6 to 3.2%)	0.3 (−0.6 to 1.3%)	1.2 (0.7 to 1.7%)	1985–1994	−0.7 (−2.4 to 1.1%)	−1.0 (−2.0 to 0.1%)	−1.3 (−2.4 to−0.1%)	−1.1 (−1.8 to−0.4%)

4. Discussion

Interpretation of collated and comparative cancer incidence and mortality data is complicated by the quality of the data analysed. To facilitate valid interpretation of EUROCIM data, countries were included in this analysis if their registration had been considered of sufficient quality to be published in Cancer Incidence in Five Continents Volume VII [14]. As shown in Table 1, the percent of breast cancer registrations microscopically-verified (MV%) was above 80% for all registries included and the percent of registrations made using death certificate information only (DCO%) was below 5% in all bar three regional registries. Data are included in the EUROCIM database after validation checks (including multiple tumour rules) used by IARC for all their studies.

4.1. Geographical patterns

The geographical patterns in breast cancer incidence and mortality across Europe described in this paper confirm earlier descriptions [16] and extend them to the late 1990s. Incidence rates tend to be higher in socio-economically well-developed countries in Northern and Western Europe. This is consistent with the distribution of known risk factors: postponement or avoidance of childbearing, use of hormonal contraception and replacement therapy, changes in menstrual history and obesity [2]. There are apparent exceptions to these patterns, but they may well serve to validate the general patterns and trends, given their possible explanations. Estonia, while classified as a Northern European country, has incidence rates similar to Slovakia, an Eastern European country of similar less developed socio-economic status. Existing Italian registries included in this analysis are generally from the industrialised north of the country and therefore socio-economically similar to Northern and Western European countries. The Czech Republic's incidence rates are similar to those in Southern rather than Eastern Europe, possibly explained by its central European situation and level of socio-economic development. In this report, incidence data from countries with national registration can be interpreted with greater confidence than incidence data from countries where data originate from a selection of registries, that are not necessarily representative of the whole population.

The highest mortality rates occurred in some countries in Northern (Denmark, England and Wales and Scotland) and Western Europe (The Netherlands and Switzerland). Lowest mortality rates occurred in Slovakia in Eastern Europe, Estonia, Finland and Sweden in Northern Europe, and Spain in Southern Europe. Mortality rates in France in Western Europe, Italy and Slovenia in Southern Europe, the Czech Republic in Eastern Europe, and Norway in Northern Europe tended to be between the aforementioned countries' rates. The rates in Iceland fluctuated across the whole range. These patterns are complex, with several possible explanations. There are differences between countries in the methods and specificity of certifying cause of death, potentially explaining some of the differences. Mortality reflects incidence as well as the quality and efficacy of care.

4.2. Time trends

The increasing time trends in breast cancer incidence across Europe described in this paper confirm and extend the results of earlier publications [1–3]. The increases occurred in all countries, with or without national screening programmes, and are consistent with changes in the distribution of known risk factors (declines in fertility, increasing obesity, alcohol consumption, and use of hormonal contraception and therapy [17]). The effect of introducing screening resulted in the well-described curvilinear temporary increase in incidence during prevalent rounds of screening.

In interpreting time trends in incidence using data from cancer registries, care is required to ensure that results are not distorted by changes in the completeness of registration, or other aspects of registry practice. To enable robust time trend analysis, countries were included for analysis if they had contributed at least 10 consecutive years of data. The use of data from a subset of the national population (from selected cancer registries) introduces less bias into the evaluation of time trends compared with geographical comparisons. Despite these selection criteria, the increasing incidence in Eindhoven in the earlier years may be explained by increasing completeness of registration.

Until the mid-1980s, mortality rates were increasing or stable in all countries (except for Sweden, where they have been decreasing since the 1960s). By the late 1990s, mortality rates were still increasing in Estonia (no national screening programme) and still decreasing in Sweden (national screening programme since 1986). Of the other countries with national screening programmes started in the late 1980s, mortality rates in the 1990s were stable in Finland, and decreasing in England and Wales, The Netherlands and Scotland, in some, if not all, age groups. However, in some countries without national screening programmes, i.e. Slovakia, Spain and Switzerland declines are similar to The Netherlands. In Denmark, the Czech Republic, France, Norway and Slovenia mortality rates are stable.

Differences between countries in the methods and specificity of certifying cause of death are unlikely to explain variations in time trends within countries. They probably result from changes in either incidence and/or case fatality rates (relative survival). Estimates of trends

in relative survival [18,19] have been published for some countries based on the EUROCARE-1 (1978–1984 cases) and EUROCARE-2 (1985–1989 cases) projects. The trend between these two periods may help in the interpretation of the mortality patterns described, particularly from the late 1980s onwards. Increasing mortality in Estonia and Iceland occurred with increasing incidence and stable survival, so that the increase in mortality is likely to be due to increasing numbers of women being diagnosed with breast cancer. Decreasing mortality in England and Wales, The Netherlands, Scotland, Sweden and Switzerland occurred with increasing incidence and increasing survival (first four) or stable survival (Switzerland). Improved prognosis because of more successful treatment and/or earlier diagnosis is likely to explain the decreasing mortality in England and Wales, The Netherlands, Scotland and Sweden. Mortality rates are stable in Finland and Denmark, where the increases in incidence and survival are similar and relatively small compared with France, where mortality has also been stable, but the increase in survival was larger.

The declines in mortality from breast cancer, which have emerged since the late 1980s may be related to earlier detection by screening programmes, although the declining trends started well before screening was introduced and occurred in non-screened age groups. In addition, there were declines in mortality in a few countries without national screening programmes. Improved survival documented in the EUROCARE projects also relates to prescreening time periods. It is therefore likely that the major determinants of the observed trends vary among the countries and may include earlier detection through screening in countries where this has been introduced. It is also likely, though, that improved breast cancer care, through new effective treatments (e.g. tamoxifen) or improved access to care is the major determinant in countries without screening, and also an important determinant in countries with screening. Detailed analyses of mortality trends in England and Wales support the conclusion of a larger contribution of improved treatment than from screening [10,20]. While the beneficial effects of the widespread introduction of screening will continue to accrue for several years, it is clear that improvements in the management of women with breast cancer has had an important effect, and the development of high quality care deserves our continued attention.

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References

1. Coleman MP, Esteve J, Damiecki P, Arslan A, Renard H. *Trends in Cancer Incidence and Mortality. IARC Scientific Publications No. 121*. Lyon, IARC, 1993.
2. Ursin G, Bernstein L, Pike M. Breast Cancer. In Doll R, Fraumeni Jr JF, Muir CS, eds. *Trends in Cancer Incidence and Mortality. Cancer Survival vols. 19/20*. New York, Cold Spring Harbor Laboratory, 1994, 241–264.
3. Hermon G, Beral V. Breast cancer mortality rates are levelling off or beginning to decline in many western countries: analysis of time trends, age-cohort and age-period models of breast cancer mortality in 20 countries. *Br J Cancer* 1996, **73**, 955–960.
4. Blot WJ, Fraumeni Jr JF. Time-Related Factors in Cancer Epidemiology. *J Chronic Dis* 1987, **40**, 1S–8S.
5. Shapiro S, Coleman EA, Broeders M, *et al*. Breast cancer screening programmes in 22 countries: current policies, administration and guidelines. *Int J Epidemiol* 1998, **27**, 735–742.
6. Quinn M, Allen E, on behalf of the United Kingdom Association of Cancer Registries. Changes in incidence of and mortality from breast cancer in England and Wales since introduction of screening. United Kingdom Association of Cancer Registries. *Br Med J* 1995, **311**, 1391–1395.
7. Chu KC, Tarone RE, Kessler LG, *et al*. Recent trends in U.S. breast cancer incidence, survival, and mortality rates. *J Natl Cancer Inst* 1996, **88**, 1571–1579.

8. Persson I, Bergstrom R, Barlow L, Adami HO. Recent trends in breast cancer incidence in Sweden. *Br J Cancer* 1998, **77**, 167–169.
9. Carnon A, Hole D, Gillis C, Brewster D. Incidence of and mortality from breast cancer since introduction of screening. Several factors must have a role in improved figures. *Br Med J* 1996, **312**, 640.
10. Blanks RG, Moss SM, McGahan CE, Quinn MJ, Babb PJ. Effect of NHS breast screening programme on mortality from breast cancer in England and Wales, 1990–8: comparison of observed with predicted mortality. *Br Med J* 2000, **321**, 665–669.
11. Peto R, Boreham J, Clarke M, Davies C, Beral V. UK and USA breast cancer deaths down 25% in year 2000 at ages 20–69 years. *Lancet* 2000, **355**, 1822.
12. European Network of Cancer Registries. *EUROCIM Version 4.0. European Incidence Database V2.3. ICD-10 Dictionary (2001)*. Lyon, IARC, 2001.
13. European Network of Cancer Registries. *EUROCIM Version 4.0. European Mortality Database V2.3 (2001)*. Lyon, IARC, 2001.
14. Parkin DM, Whelan SL, Ferlay J, Raymond L, Young J, eds. *Cancer Incidence in Five Continents, IARC Scientific Publication No. 143,* 7th edn. Lyon, IARC, 1997.
15. Stata Corporation. *Stata Statistical Software: Release 7.0*. College Station, TX, Stata Corporation, 2001.
16. Bray F, Sankila R, Ferlay J, Parkin DM. Estimates of cancer incidence and mortality in Europe in 1995. *Eur J Cancer* 2002, **38**, 99–166.
17. Dos Santos Silva I, Swerdlow AJ. Recent trends in the incidence of and mortality from breast, ovarian and endometrial cancers in England and Wales and their relation to changing fertility and oral contraceptive use. *Br J Cancer* 1995, **72**, 485–492.
18. Quinn MJ, Martinez-Garcia C, Berrino F. Variations in survival from breast cancer in Europe by age and country, 1978–1989. *Eur J Cancer* 1998, **34**, 2204–2211.
19. Sant M, Capocaccia R, Coleman MP, *et al*. EUROCARE Working Group. Cancer survival increases in Europe, but international differences remain wide. *Eur J Cancer* 2001, **37**, 1659–1667.
20. McCann J, Duffy S, Day N. Predicted long-term mortality reduction associated with the second round of breast screening in East Anglia. *Br J Cancer* 2001, **84**, 423–428.