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EUROCARE-3 summary: cancer survival in Europe at the end of the 20th century

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Introduction

At the end of the 20th century, more than 930 000 people died of cancer every year in the 15 member countries of the European Union (EU) [1], among a total of 2 500 000 cancer deaths a year in the continent of Europe, excluding the Russian Federation [2]. This annual death toll can be reduced in only two ways: by reducing the number of new cancers that occur each year—primary prevention—and by increasing the chances of survival and cure among those who do develop cancer, through earlier diagnosis and better treatment.

Information on the survival of all patients after a cancer diagnosis is thus a key indicator of cancer control, alongside the numbers of new cases (incidence) and deaths (mortality). It is also required for estimating how many cancer survivors are alive at any one time, in order to plan health services [3]. This information can only be derived from population-based cancer registries.

Before 1995, international comparison of cancer survival rates relied on painstaking compilation of figures scattered in the literature or in cancer registry reports.

Cancer patient survival is estimated as the cumulative probability (range 0 to 1) of survival up to a stated time after diagnosis [4].The ratio of the survival observed in a group of cancer patients to the survival that would be expected from general population mortality is referred to as relative survival. This can be interpreted as an estimate of the proportion of patients who survive, after correction for background mortality. Relative survival is usually expressed as a percentage, and is very commonly described as a 'survival rate'. For brevity, we mostly use the familiar terms 'survival' or 'survival rate' to refer to the cumulative probability of survival.

Such comparisons were compromised by international differences in the definition, classification and grouping of the cancers to be analysed, in the procedures for patient follow-up, in methods of data quality control, in the statistical methods of survival analysis, and in the presentation of results. The standards of international comparability achieved for cancer incidence data [5], partly through regular compilation of data for *Cancer Incidence in Five Continents* since the late 1960s [6, 7], had not yet been reached for cancer survival data. More reliable evidence of international patterns of cancer survival in Europe has begun to emerge since 1995.

EUROCARE project

The EUROCARE project was set up in 1989 to measure and explain international differences in cancer survival in Europe. The aim was to optimise the comparability of survival estimates by using standard definitions of the cancers selected for analysis, central quality control and standard analytic techniques and software, and by taking due account of basic demographic variables and background mortality. A further aim was to compare diagnostic and therapeutic practices in large random samples of patients, to help interpret international differences in survival.

The first EUROCARE report identified substantial international differences in survival for many common cancers for the first time. It covered the survival of 800 000 cancer patients who were diagnosed during 1978–1985 and followed up to the end of 1990 by 30 population-based cancer registries in 12 European countries (Denmark, England, Estonia, Finland, France, Germany, Italy, The Netherlands, Poland, Scotland, Spain and Switzerland) [8]. Survival rates up to 10 years after diagnosis were reported for 27 types of cancer in adults and eight childhood cancers by age, sex, country and period of diagnosis. Weighted European average survival rates were also provided. International differences in survival were not large for tumours amenable to cytotoxic therapy, such as testicular cancer and Hodgkin's disease. For cancers where survival depends heavily on diagnosis being made at an early stage, when local treatment of curative intent with surgery and/or radiotherapy can still be attempted, the range of survival rates across Europe was much wider.

The EUROCARE-2 study showed that survival rates for most cancers had improved by 1994, but trends were less marked in eastern Europe [9]. EUROCARE-2 included data on 1.3 million cancer patients who were diagnosed with one of 42 cancers during

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the period 1985–1989 and followed up to the end of 1994 by 45 cancer registries in 17 European countries, from Estonia to Spain and from Slovenia to Iceland. Survival was generally highest in Sweden, The Netherlands, France and Switzerland, and lowest in Estonia, Poland, Slovakia and Slovenia. Survival in England, Scotland and Denmark was often low for common tumours, such as those of lung, breast, stomach, large bowel, prostate and kidney [10].

The EUROCARE Working Group has explored survival patterns for individual cancers in over 100 published papers [11]. Special studies have been carried out to explain international survival differences for cancers of the stomach, large bowel, breast, prostate and testis. In these 'high-resolution' studies, detailed clinical information is collected by selected registries for large random samples of patients from the EUROCARE data, in order to identify the clinically important prognostic factors that could help explain international survival differences. For patients diagnosed with breast and colorectal cancers during the early 1990s, these studies showed that differences in stage at diagnosis were a key explanation for differences in survival between western European countries, and differences in therapy contributed to survival differences between eastern and western European countries [12–14].

Key findings from the EUROCARE study, based on the follow-up of European cancer patients to 1994, include the following:

- Large differences in cancer survival exist *between* and *within* European countries for most adult cancers [8, 9].
- Large differences in adult cancer survival exist between western and eastern European countries [9].
- International variation in childhood cancer survival within Europe is also marked [15, 16].
- Survival in the UK [17] and Denmark [18] for several major cancers is lower than in other western European countries [8, 9].
- Survival was increasing for most cancers and in most European countries up to 1994, but wide international differences remained [10, 19].
- Survival falls with age for most cancers, even after adjustment for intercurrent mortality [20].
- Survival is higher for women than men, for most cancers [21].
- Survival rates in the areas of the USA covered by the Surveillance, Epidemiology and End Results (SEER) programme up to the 1990s were higher than in western Europe for most of the common adult cancers [22].
- Cancer survival rates for children in northern and western Europe are broadly similar to those for children in the SEER programme areas of the USA [23].

Other outcomes of the study include:

- the first population-based cancer survival rates published from Austria and Spain;
- population-based estimates of survival for rare tumours, e.g. soft tissue sarcoma [24], nasopharyngeal carcinoma [25] and childhood cancers in general [16];
- population-based estimates of cancer survival for anatomic sub-sites within the larynx [26] and stomach [27], and for different morphological types of cancer in certain organs, e.g. lung [28], nasopharynx [25] and stomach [27].

The EUROCARE study has had an impact on national cancer plans in the UK [29–32] and Denmark [33], where survival rates for patients diagnosed for several of the most common cancers up to 1989 were lower than in comparable western European countries [9]; in Italy, where the aim has been to reduce geographic disparities in cancer survival [34], and in Norway, on the quality of care for rectal cancer [35].

Cancer survival data from EUROCARE have been used to estimate the number of patients living with cancer (prevalence), and the proportion they represent among the general population in Europe, in the EUROPREVAL project [3]. They have also been used to estimate the proportion of patients who are cured of their cancer [36]. EUROCARE survival data have been included in EUCAN [1], an electronic database of adult cancer in Europe, and used as indicators of progress in cancer control in the European Cancer Health Indicators Project (EUROCHIP), part of the European Health Monitoring Programme [37]. EUROCARE data have also enabled large-scale comparisons of cancer survival between Europe and the USA for the first time since the 1960s [38].

EUROCARE-3 study

This issue of *Annals of Oncology* includes detailed information on survival up to 5 years after diagnosis for 1.8 million adults and 24 000 children who were diagnosed with cancer during the period 1990–1994 and followed up to the end of 1999.

The 20 participating countries are scattered across the continent of Europe—north, south, east and west (Figure 1). They include 11 of the 15 European Union (EU) member states (Table 1). The national cancer registry of Ireland could not be included because follow-up data were not available for patients diagnosed during 1990–1994 [39], while Belgium, Greece and Luxembourg do not have a population-based cancer registry. Six of the 10 countries likely to become EU member states in 2004 are also included in EUROCARE-3. Iceland, Norway and Switzerland are not in the EU.

The 20 countries involved in EUROCARE-3 have a combined population of over 400 million people (Table 1). Data from three of the four UK nations (England, Scotland and Wales) are presented separately, making 22 countries for descriptive purposes. For adults, the 56 contributing registries cover a total population of over 100 million, 25% of the combined population of the countries involved.

The countries participating in EUROCARE-3 include some of the most developed economies in the world and some of the poorest countries in Europe. Health care systems in these countries varied widely in organisation and staffing in the 1990s. The proportion of gross domestic product devoted to health care in 1995 ranged from 6.0% in Poland to 10.6% in Germany, and total expenditure on health care in 1995 covered a six-fold range, from US $420 (Purchasing Power Parity dollars per head of population) in Poland to $2555 in Switzerland [40]. Some international variation in cancer survival might therefore be expected [41–43].

Survival rates are available for 42 different cancers in adults (aged 15–99 years), representing about 90% of all malignancies arising in adults in the participating countries during the early

Figure 1. Countries and regions participating in EUROCARE-3 with data on adult cancer patients. The data on children with cancer from England, Germany and The Netherlands had national coverage.

Table 1. Countries participating in EUROCARE-3: national population, population covered by participating cancer registries (% of national population) and number of first primary malignancies included in analyses: Europe, patients diagnosed 1990–94 and followed up to 1999

Country		National population	Population coverage of EUROCARE-3 registries[a]		No. of patients included in analyses	
		(000s)	(000s)	%	Adults (15–99 years)	Children (0–14 years)
Austria	A	7930	637	8.0	11 659	73
Denmark	DK	5205	5205	100.0	102 884	630
England[b]	UK	49 310	30 880	62.6	636 060	5835
Finland	FIN	5023	5023	100.0	76 277	799
France[c]	F	56 567	3199	5.7	33 948	1419
Germany[b]	D	82 183	2290	2.8	22 349	7473
Italy	I	56 318	8618	15.3	195 786	1228
The Netherlands[b]	NL	15 047	3567	23.7	62 993	822
Portugal[c]	PT	10 019	1145	11.4	5048	0
Scotland	UK	5119	5119	100.0	108 878	636
Spain[c]	E	38 714	5628	14.5	72 270	1185
Sweden	S	8918	8918	100.0	162 248	1215
Wales[b]	UK	2925	2925	100.0	63 896	–
Total for EU member states		**343 278**	**83 154**	**24.2**	**1 554 296**	**21 315**
Czech Republic	CZ	10 331	861	8.3	15 175	119
Estonia	EST	1544	1544	100.0	21 749	199
Malta	MLT	365	365	100.0	2064	23
Poland	P	38 370	2366	6.2	36 740	287
Slovakia	SK	5344	5344	100.0	62 401	711
Slovenia	SL	2072	2072	100.0	28 120	228
Total for EU members from 2004		**58 026**	**12 552**	**21.6**	**166 249**	**1567**
Iceland	IS	267	267	100.0	3729	39
Norway	NOR	4618	4618	100.0	78 818	539
Switzerland[c]	CH	6914	821	11.9	12 492	43
Total for non-EU member states		**11 799**	**5706**	**48.4**	**95 039**	**621**
EUROPE		413 103	101 412	24.5	1 815 584	23 503

[a]Population coverage data refer to general (all cancers, all ages) cancer registries.

[b]Specialised national childhood cancer registries for England (and Wales), Germany and The Netherlands (acute lymphocytic leukaemia) contributed data with 100% national coverage. Childhood cancer data are pooled for England and Wales.

[c]For selected adult cancers. Some registries in these countries only collect data on cancers of certain organs, others are general (all cancers) but only provided follow-up data for certain types of cancer.

1990s [7, 44]. The 24 childhood malignancies for which data are published here represent almost all childhood cancers.

Cancer survival in Europe 1990–1999

We present here brief commentary on survival rates for some of the major cancers in adults and children in Europe. The survival rates reflect the outcome up to 5 years after diagnosis for cancer patients who were diagnosed during the period 1990–1994 and received their principal treatment then or shortly thereafter, and who have been followed up for ≥5 years, to the end of 1999.

Relative survival rates [45–48] were used to adjust for differences of up to two-fold in background mortality by age and sex between European regions and countries [49]. International comparisons are age adjusted [50], because relative survival varies widely with age for many cancers, and cancer patients in some countries are on average older than in others. The European average survival rate is an estimate of the average relative survival of all cancer patients in the 20 participating countries in Europe, for each cancer and for each sex. It is a weighted average of the corresponding survival estimates from each country (or the contributing set of registries in each country), weighted by the annual

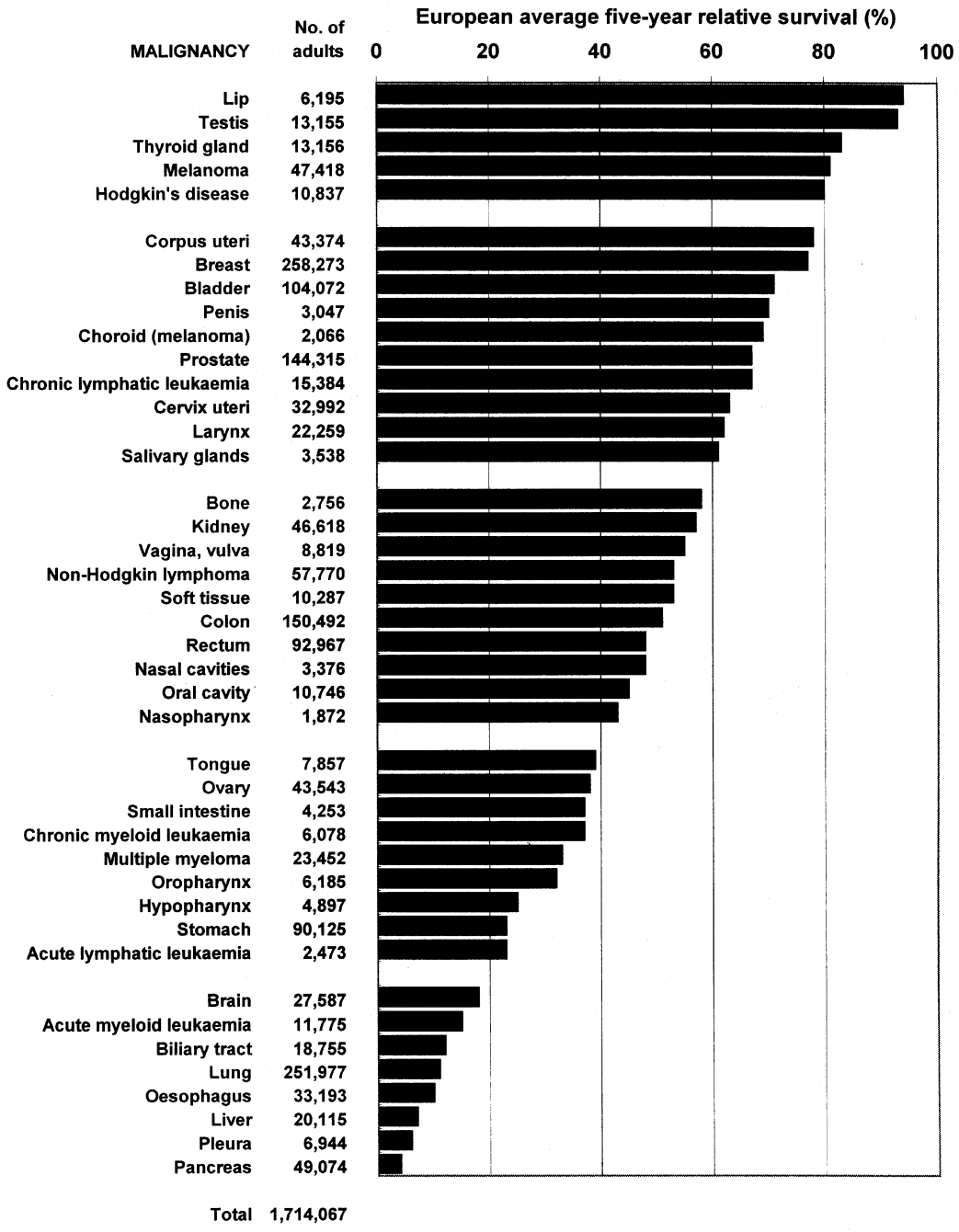


Figure 2. European average 5-year relative survival rates (%) for 42 cancers, adults (15–99 years) diagnosed in the period 1990–1994 and followed up to 1999.

number of cases observed (or estimated) in each country. Accompanying articles in this issue should be consulted for full details of methods [4] and for extended commentary on survival from each of the common cancers [51]. Complete results are also available electronically [52].

Adult cancers

European average survival rates at 5 years after diagnosis range from 94% for lip cancer to <4% for cancer of the pancreas (Figure 2). For 21 of the 42 different types of cancer analysed in adults, accounting for about 58% of all cancers, 5-year survival is ≥50%.

Survival rates are generally high for cancers of the lip, testis and thyroid, and for melanoma of the skin and Hodgkin's disease (European average 5-year relative survival ≥80%). The fact that the European average survival rate is so high for testicular cancer and Hodgkin's disease suggests that most patients with these malignancies have access to effective treatment. Cancers of the lip, thyroid and melanoma of the skin are also fairly accessible for diagnosis and treatment. These five cancers account for ~4% of adult malignancies in Europe.

For a larger group of cancers, the European average 5-year relative survival rates are in the range 60–79%. These include the very common cancers of breast, prostate and bladder—survival estimates for these cancers are each based on 100 000–250 000 cases—as well as cancers of the cervix and body of the uterus, and the larynx. Collectively, these cancers account for about a third of all adult malignancies in Europe.

The group of cancers with only moderate prognosis (European average 5-year survival 40–59%) includes the common cancers of the colon, rectum and kidney, and non-Hodgkin's lymphoma, for each of which the survival estimates are based on >40 000 cases. These account for ~20% of all adult cancers in Europe.

Malignancies with a poor prognosis (European average 5-year relative survival 20–39%) account for some 10% of adult cancers in Europe. They include cancers of the stomach and ovary, and multiple myeloma, for which the survival estimates are all based on >20 000 cases.

Cancers with the worst prognosis (European average 5-year survival <20%) include lung cancer (estimate based on over 250 000 cases), and cancers of the pancreas, oesophagus, brain and liver, for which the estimates are all based on >20 000 cases. These cancers, which account for a quarter of all adult malignancies in Europe, are relatively inaccessible and often advanced when diagnosed: treatment of curative intent is rarely possible. Primary prevention of lung cancer by reduction of tobacco use is the most obvious approach to reducing the lung cancer burden. Some liver malignancies can be avoided by immunisation against viral hepatitis in southern Europe, where chronic infection and mother–child transmission are increasingly common [53].

Age at diagnosis

Survival for most cancers in adults depends strongly on age, even after adjustment for mortality from other causes at each age [51] (Figure 3). Relative survival at 5 years is highest in the age range 45–54 years for women with breast cancer and in the range 55–64 years for men with prostate cancer, but for most other cancers, survival declines steeply with age at diagnosis. Similar observations were made in previous EUROCARE reports [8, 9].

The relationship between age and survival is less marked for breast and colorectal cancers in the US SEER data [22]. This suggests that lower survival for older patients in Europe may not be explained solely by age-related biological factors, such as co-morbidity, immune function and responsiveness to drugs, or compliance with treatment. Socio-economic and health care system factors in Europe and the USA may have a different impact on the decision to offer treatment of curative intent to elderly cancer patients with co-morbidity. The elderly represent an increasing proportion of the European population. Achieving better outcomes for elderly cancer patients will be a major challenge for Europe.

Childhood cancers

In sharp contrast with adults, the prognosis for childhood cancers is generally good (Figure 4). For 13 of the 24 malignancies examined, accounting for two-thirds (68%) of all children with cancer, the European average 5-year relative survival rate was ≥75%. Survival from childhood tumours depends less on the stage of disease at diagnosis than for adult tumours, and more on the availability of effective treatment [54]. This suggests that most children in the countries and regions contributing to EUROCARE do have access to effective treatment.

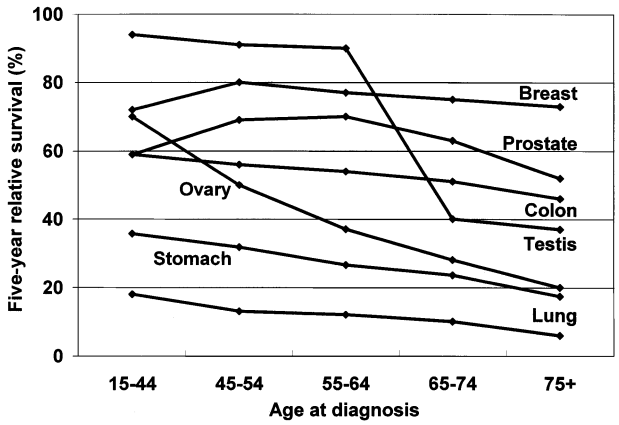


Figure 3. European average 5-year relative survival rates (%) for selected cancers by age at diagnosis, adults diagnosed in the period 1990–1994 and followed up to 1999.

The European average 5-year survival rate was ≥50% for all except three childhood cancers: chronic myeloid leukaemia (47%), adrenocortical carcinoma (46%) and acute non-lymphocytic leukaemia (45%), which only accounted for ~6% of childhood cancers in the EUROCARE-3 data.

Differences between men and women

Survival for patients diagnosed during the period 1990–1994 was higher in women than in men for 30 of the 35 cancers examined that occur in both sexes (Figure 5), broadly confirming the EUROCARE-2 observation for patients diagnosed during the period 1985–1989 [9, 21].

The relative survival rates used for these comparisons compensate for background mortality in men and women separately, and they are standardised to the combined age distribution for men and women with each cancer, to remove any effect of sex differences in the age distribution of cancer patients [20]. Differences in survival between men and women are thus more likely to arise from sex differences in tumour biology, host defence mechanisms, awareness of symptoms, stage of disease at diagnosis or access to effective treatment.

The survival advantage at 5 years for women is ≥15% for four cancers arising in the head and neck—salivary glands, tongue, oral cavity and oropharynx—and almost 10% for thyroid cancer and melanoma of the skin. Survival differences are expressed for simplicity as the absolute percentage difference {e.g. a 17% difference between 52% for women and 35% for men; not a 49% difference [100 × (52 – 35)/35]}. These large differences are likely to be due in part to earlier diagnosis in women. Earlier stage at diagnosis probably contributes to the survival advantage for women with melanoma and colorectal cancers [13]. The small

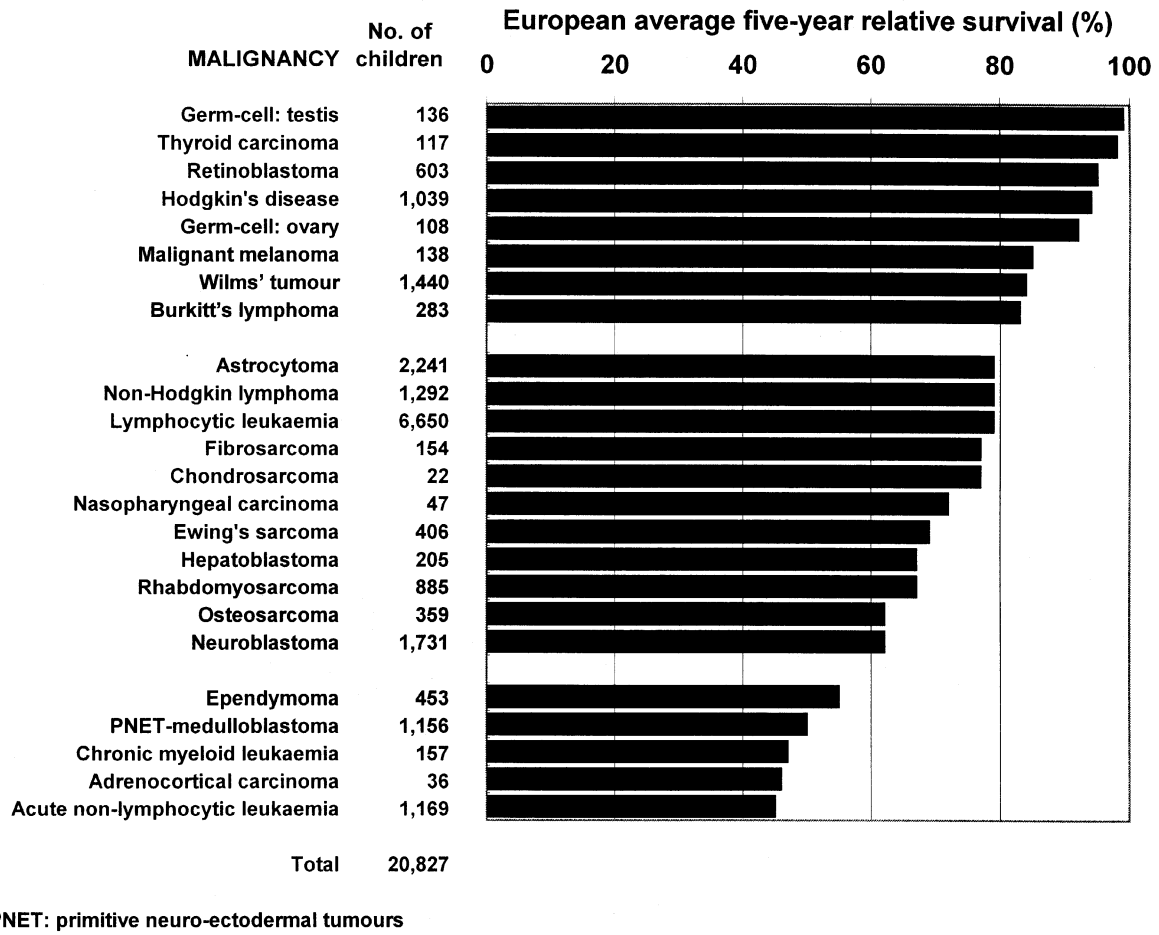


Figure 4. European average 5-year relative survival rates (%) for 24 malignancies, children (0–14 years) diagnosed in the period 1990–1994 and followed up to 1999.

survival advantage for men with laryngeal cancer was not seen in earlier EUROCARE data [26].

European differences in cancer survival

Cancer survival patterns across Europe are briefly reviewed here for nine major cancers with a wide range in survival, and for all cancers combined. For simplicity, survival patterns are presented for 22 contributing countries, 11 of which provided complete national data, but coverage in the other 11 countries varied from 3% to 63% of the national population, and this must be borne in mind when interpreting the results (Table 1). For children, the specialised national childhood cancer registries in England and Wales, Germany and The Netherlands (for leukaemia only) contributed data with 100% national coverage, so that data sets from 14 of the 21 countries were national (Portugal did not contribute data for children).

Survival is generally below the European average in the five eastern European countries (the Czech Republic, Estonia, Poland, Slovakia and Slovenia), and in Denmark, England, Scotland, Wales, Malta and Portugal among the western European countries. For the UK and Denmark, melanoma of the skin, testicular cancer and Hodgkin's disease are notable exceptions to this pattern. Sweden tends to have the highest survival rates among the five Nordic countries, and Poland the lowest among the five eastern European countries, whilst French and Swiss populations often have the highest survival rates among western European countries.

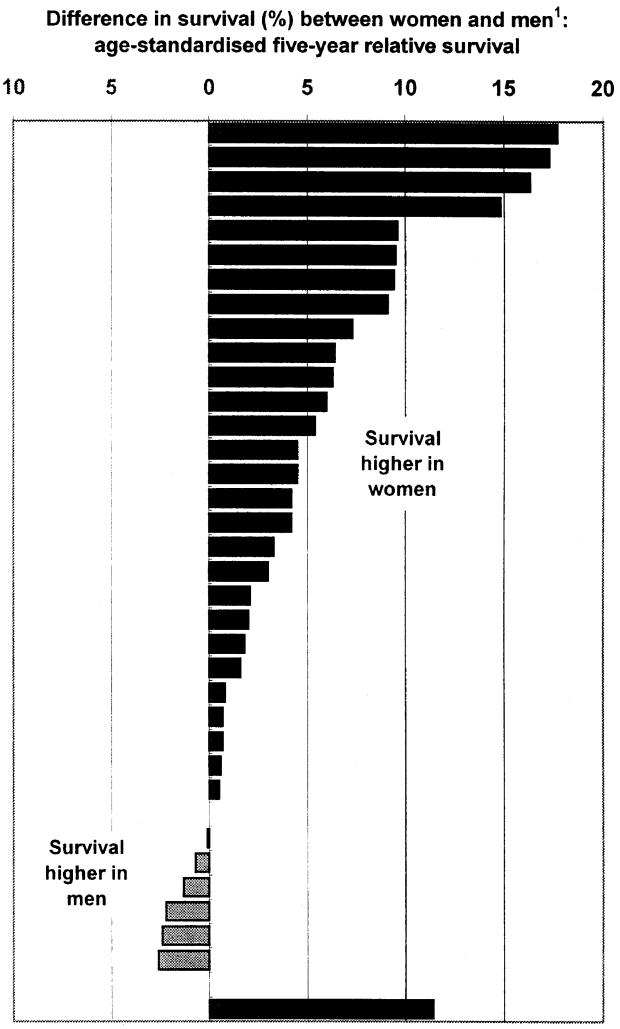
Lung

Among the most lethal and common cancers, lung cancer survival varies by more than two-fold across Europe, but the highest 5-year survival rate for men diagnosed during the period 1990–1994 was still <15% (Figure 6A). The patterns for women are similar. Most patients are still diagnosed with metastatic disease, and treatment of curative intent is rarely possible. The very low survival rate in Denmark may be due to late stage at diagnosis [55].

Stomach

For stomach cancer, the range of survival is wider, from 30% in Iceland to 10–12% in Denmark, Scotland, Wales and Poland (Figure 6A). In some of these countries, the relatively low proportion of tumours for which microscopic verification was available

MALIGNANCY	Women No. of patients	Women Five-year survival	Men No. of patients	Men Five-year survival
Salivary glands	1,612	68.7	1,926	51.0
Tongue	2,302	52.2	5,555	34.9
Oral cavity	3,431	56.9	7,315	40.6
Oropharynx	1,170	43.5	5,015	28.7
Thyroid	9,953	81.4	3,203	71.8
Melanoma of skin	26,793	84.3	20,625	74.8
Nasopharynx	573	49.3	1,299	39.9
Hypopharynx	868	32.3	4,029	23.2
Choroid (melanoma)	967	72.3	1,099	65.0
Chronic myeloid leukaemia	2,687	36.9	3,391	30.5
Hodgkin's disease	4,658	81.5	6,179	75.2
Non-Hodgkin lymphoma	27,068	53.7	30,702	47.7
Stomach	34,871	25.4	55,254	20.0
Rectum	40,463	49.6	52,504	45.1
Multiple myeloma	11,501	33.0	11,951	28.5
Nasal cavities	1,330	48.0	2,046	43.8
Chronic lymphatic leukaemia	6,411	66.4	8,973	62.2
Bone	1,241	56.3	1,515	53.0
Kidney	18,082	57.2	28,536	54.2
Brain	11,976	18.5	15,611	16.4
Oesophagus	11,491	10.5	21,702	8.5
Colon	78,258	51.0	72,234	49.2
Small intestine	2,039	39.2	2,214	37.6
Pancreas	25,004	4.6	24,070	3.8
Acute myeloid leukaemia	5,555	13.4	6,220	12.7
Pleura	1,374	5.5	5,564	4.8
Breast	256,464	76.1	1,809	75.5
Liver	7,368	6.7	12,747	6.2
Soft tissues	4,612	54.2	5,675	54.2
Lung	68,463	9.6	183,514	9.7
Biliary tract	12,164	11.6	6,591	12.3
Larynx	2,590	59.4	19,669	60.7
Lip	1,231	90.3	4,964	92.5
Bladder	25,558	67.1	78,514	69.5
Acute lymphatic leukaemia	1,068	21.6	1,405	24.2
Total	*711,196*		*713,620*	
All malignant neoplasms[2]	878,319	51.2	911,574	39.8



[1] Absolute difference - e.g. for kidney, 57.2% - 54.2% = 3.0% (see text)
[2] Including cancers that only arise in one sex

Figure 5. Difference between men and women in 5-year age-standardised relative survival (%), Europe, adults (15–99 years) diagnosed in the period 1990–1994 and followed up to 1999: 35 cancers affecting both sexes, and all malignancies combined.

[4] suggests later stage at diagnosis and reduced access to surgical treatment of curative intent. Survival is higher in western Europe, where incidence is high, than in the Nordic countries and the UK, where incidence is lower. These patterns suggest that the nature of stomach cancer differs between northern and southern Europe [51]. Survival is relatively high in southern Europe, e.g. Italy and Spain, in part because of a higher proportion of stomach tumours in which either the precise location of the tumour in the stomach or the specific type of stomach cancer confers a more favourable prognosis [27].

Colon and rectum

Survival from cancers of the colon and rectum in eastern European countries, Denmark and the UK is lower than the European average (~50% at 5 years), but even in the countries with the highest survival rates, 5-year survival is still <60% (Figure 6A). Unusually, survival for colon cancer is somewhat higher in several of the western European countries than in the Nordic countries. Detailed studies suggest that differences in stage at diagnosis are likely to be largely responsible for the survival deficit in the UK and Denmark [18], and that quality of treatment may also play a role in eastern Europe [13, 56].

Breast (women)

Breast cancer survival in women is higher than for colorectal cancers, but the geographic pattern is similar (Figure 6A). Survival is highest in the Nordic countries and in most southern and central European countries (~80% at 5 years), and lowest in all five eastern European countries (60–70%). Survival is below the European average in Denmark, England, Scotland and Wales. Survival in Malta and Portugal is also below the European mean, but the confidence intervals are wide. A key explanation for sur-

vival differences in western Europe is likely to be more advanced stage of disease at diagnosis in the countries with lower survival rates, while in eastern Europe, differences in treatment are also likely to play a role [14].

Melanoma of the skin

The range in survival rates for melanoma of the skin is wide, particularly among men (Figure 6B). In most western European countries, relative survival rates among women are close to the European average, 85%. Survival is higher in most Nordic and western European countries, where incidence is also high. This may be due to the diagnosis of more superficial spreading melanomas, and more detailed studies are required of melanoma survival by morphological type. Uncharacteristically, survival is significantly above the European average for both men and women in Scotland, where there is an active programme of early diagnosis [57], and lower than the European average in several Mediterranean countries, where less attention has been paid to early diagnosis.

Cervix

The European average 5-year survival rate for cervical cancer was 60%, with somewhat less international variation than for other epithelial cancers (Figure 6B). Unusually, survival in the Czech Republic (W. Bohemia) is higher than the European average.

Prostate

The European range in 5-year survival rates for men diagnosed with prostate cancer during the period 1990–1994—from <40% to >80%—is wider than for any other cancer (Figure 6B), and wider than the corresponding range for men diagnosed with prostate cancer during 1985–1989 (35–71%) [9]. In Tyrol (Austria), where 5-year survival is >80%, intensive prostate-specific antigen (PSA) screening has been in place since 1992 [43]. The wide European range in survival is largely attributable to differences in the intensity of diagnostic and screening activity with fine needle aspiration and, more recently, PSA testing.

Testis

Testicular cancer is relatively uncommon, although incidence varies five-fold across Europe, but it has been eminently treatable since the introduction of cis-platinum therapy in the 1970s. Survival rates in western European countries are now all within a fairly narrow range, and 5-year survival in Slovenia slightly exceeds the European average of 87% (Figure 6B). Five-year survival in Estonia is particularly low at 65%; platinum treatment did not become widely available until much later than elsewhere. Differences in the age distribution or biology of testicular cancers cannot account for the international variability in testicular cancer survival, which is more probably attributable to differences in the accessibility of effective treatment.

All cancers combined

To facilitate international comparison of cancer survival, we have provided an overall cancer survival index for each country, for men and women separately. This index is a weighted average for each country of the age-adjusted 5-year relative survival rates for 38 different cancers in men and 39 cancers in women, including all adults diagnosed during the period 1990–1994. The total numbers of patients included in the European analyses for each cancer for each sex were used as weights. The survival index therefore adjusts not only for international differences in the age distribution of cancer patients and in background mortality rates, but also for the widely different proportion of cancers with low and high survival in each country. Thus lung cancer represented between 9% (Sweden) and 29% (Poland) of all cancers analysed for men, and breast cancer represented between 21% (the Czech Republic) and 31% (Finland) of all cancers analysed for women. The index was not estimated for Iceland, Malta or Portugal, because they contributed fewer than 10 000 cases to the analyses.

Where the age-standardised relative survival rate for a given cancer, sex and country was not available, the corresponding European average age-standardised survival rate was used instead. This imputation for missing values was required most often in eastern European countries. Survival in those countries was lower than the European average for most cancers, so the imputation tended to increase the survival index for those countries, slightly narrowing the European range of the index. The effect was small. The value of the all-cancers survival index for a given country using European average imputation when the age-standardised survival rate for a given cancer and sex was not available was always within 1% of the value obtained by imputing the unstandardised survival rate for that country instead.

For men, the all-cancers survival index ranged from 25% to 32% in the five eastern European countries and from 40% to 47% in most of the Nordic and western European countries (Figure 7). In between, the index ranged from 33% to 37% in England, Scotland, Wales and Denmark, slightly below the European average value of 38%.

For women, the survival index ranged from 41% to 47% in the five eastern European countries, and in the remarkably narrow range of 55–58% for 10 countries in western Europe and the Nordic group. Again, Denmark and the UK (England, Scotland and Wales separately) were in the intermediate range of 47–51%, just below the European average of 52%.

The all-cancers survival index is higher for women than men in each country. This is for two reasons. First, women have higher survival than men for most individual types of cancer (Figure 5). Second, the most common cancers in women have moderate to good survival (e.g. breast, uterus), whilst the most common cancers in men have poor survival (e.g. lung, stomach). Thus for 50% of women diagnosed with cancer, the European average 5-year survival rate for that cancer is ≥60%, and only for one in four women (26%) is the 5-year survival rate <40% (Table 2). For men, in contrast, only one-third of cancers have a European average 5-year survival of ≥60%, while for two men in five (42%), the survival rate is <40%. Since the all-cancers survival index is

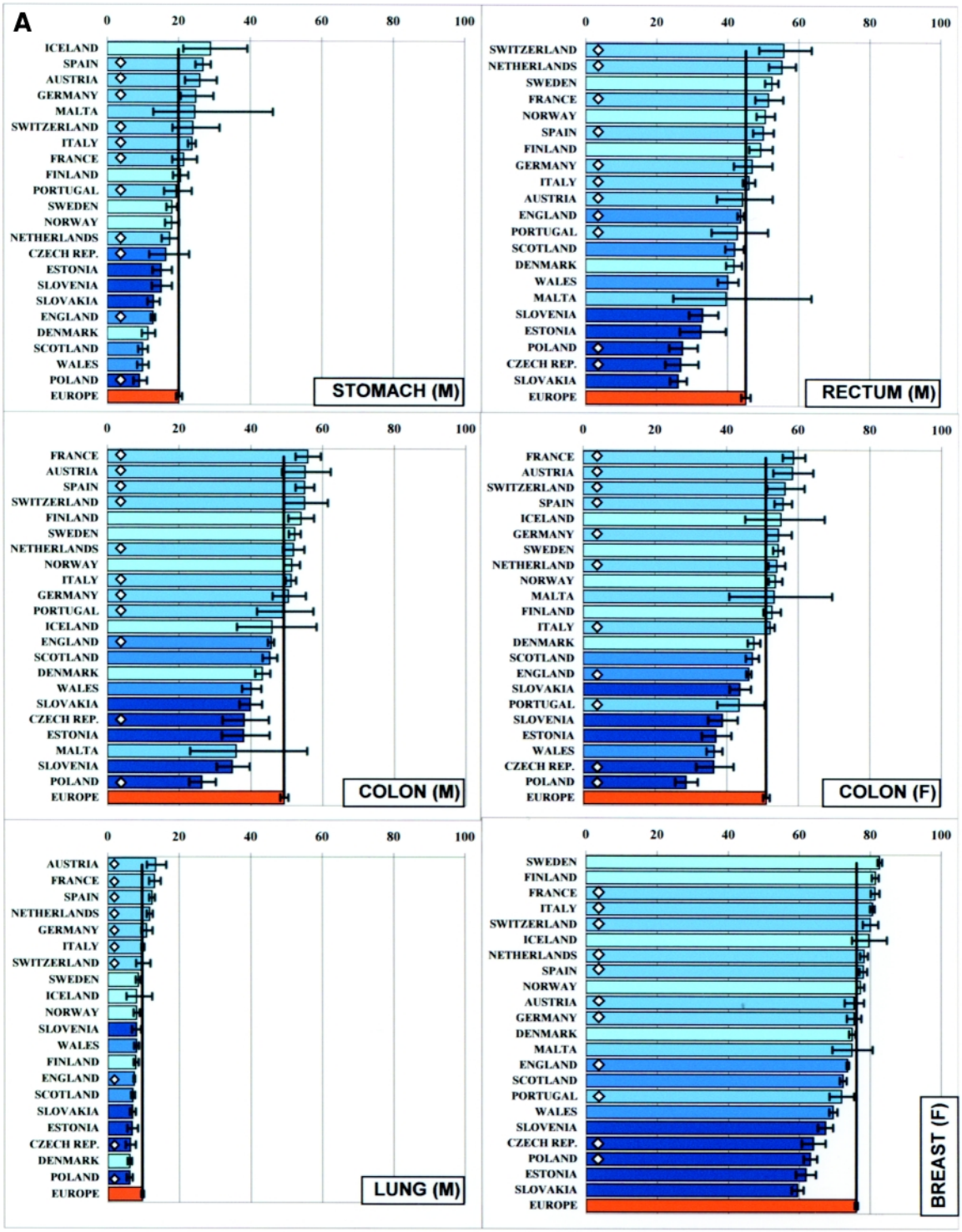


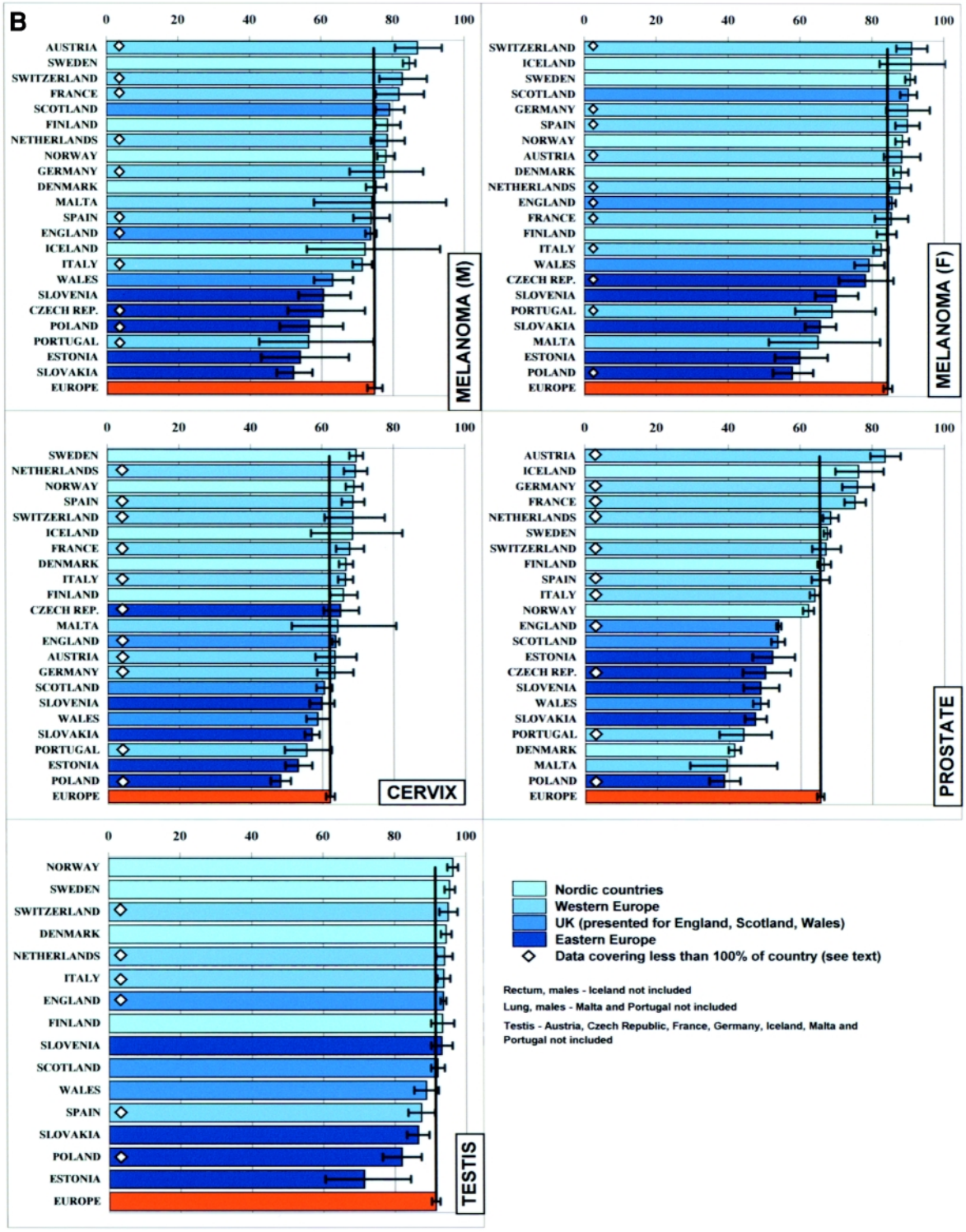
Figure 6. Five-year survival (%) for selected cancers, by country, Europe: age-standardised relative survival, adults (15–99 years) diagnosed in the period 1990–1994 and followed up to 1999.

incidence-weighted, it also reflects these differences in case-mix between men and women.

The index is best viewed as a comparative index of overall cancer survival that takes account of international differences in case-mix, or the proportion of tumours of widely different lethality in each country. It is a very broad indicator of cancer outcomes: for example, it takes no account of factors such as health care expenditure, and it should not be over-interpreted as the sole measure of success in cancer control in any given country.

World-wide differences in cancer survival

Cancer survival rates in Europe can be roughly compared with those reported from other parts of the world. For colorectal cancer,



the range in age-standardised 5-year relative survival rates for men diagnosed during the period 1990–1994 among the 22 countries contributing to EUROCARE-3 (27–55%) is much wider than—and has no overlap with—the corresponding range in colorectal cancer survival among men in the nine populations covered by the SEER programme in the USA during the same period (60–65%) [58] (Figure 8). Relative survival rates for men diagnosed during 1982–1992 in five developing countries, China, Cuba, India, the Philippines and Thailand, ranged from 28% to 42% [59].

The pattern is similar for breast cancer in women: the European range in age-standardised 5-year relative survival (60–82.6%) is wider than—and again, does not overlap—the range in the USA

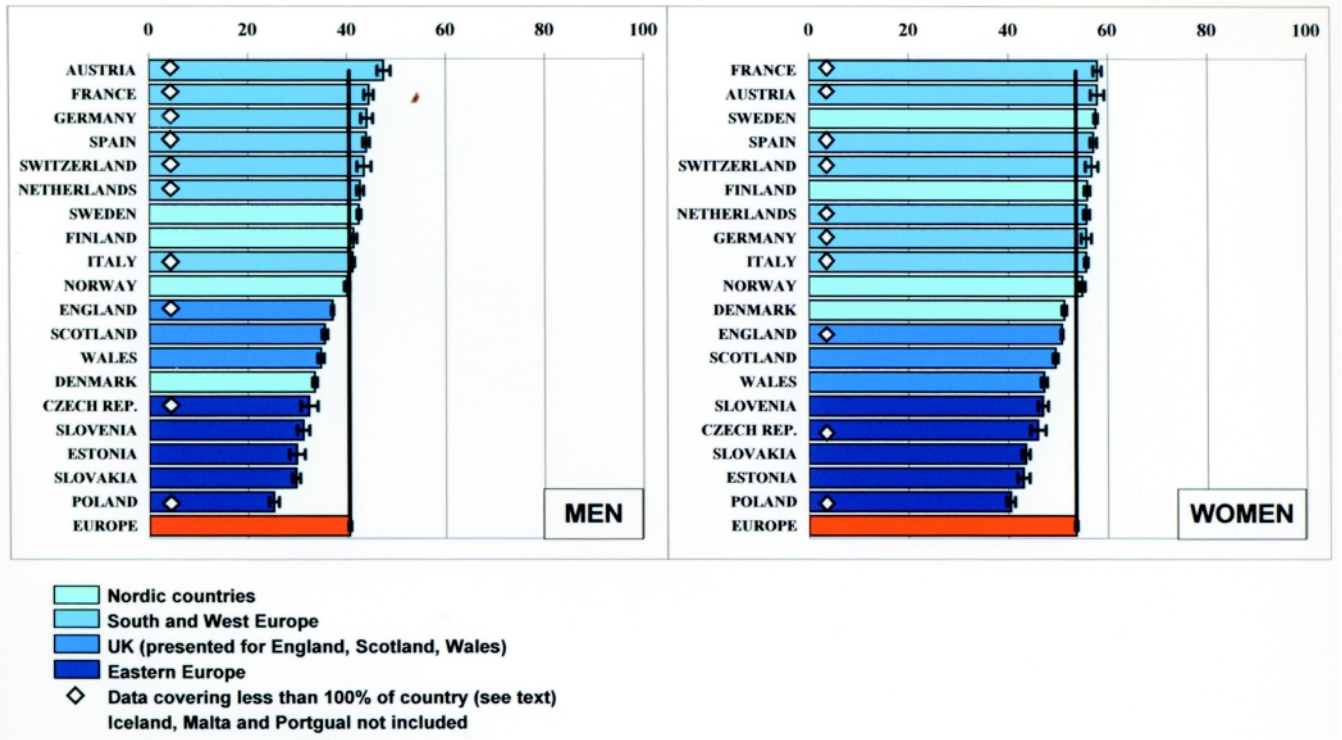


Figure 7. Comparative index of 5-year relative survival (%) for all cancers combined, by country and sex, age-standardised and incidence-weighted (see text), Europe: adults (15–99 years) diagnosed in the period 1990–1994 and followed up to 1999.

Table 2. Distribution of cancers by category of 5-year survival[a], Europe, adults diagnosed 1990–1994, followed up to 1999

Five-year survival (%)	Men		Women		Persons
	Types of cancer	Percentage of all cancers	Types of cancer	Percentage of all cancers	Percentage of all cancers
≥80%	2	2	4	5	4
60–79%	9	31	7	45	38
40–59%	10	25	13	23	24
20–39%	9	10	7	12	11
<20%	8	32	8	14	23
	38	100	39	100	100

[a]European average 5-year relative survival.

(83.1–88%). Survival rates in the same five developing countries are generally lower than in Europe, and the range is even wider (45–72%).

For these two common cancers, even the highest survival rates in Europe are not as high as the lowest survival rate in any of the nine areas covered by the SEER programme in the USA. The same pattern was observed for patients diagnosed with cancers of the breast (women), prostate, large bowel and lung in the period 1985–1989 [22]. Most European countries provide universal access to health care, but 44 million US citizens have no health insurance, another 30 million under 65 years of age are under-insured [60], and cancer survival varies with the type of health insurance [61]. Even though the US survival rates used here are not age-standardised, the size of these transatlantic differences in survival raises questions about the comparability of the definition and diagnosis of malignancy, as well as about differences in stage at diagnosis and access to treatment. The wide range of cancer survival rates between EU member states represents a major challenge for public health.

Cancer survival trends at the end of the 20th century

We have analysed trends in age-adjusted relative survival for patients diagnosed during the 12 years from 1983 to 1994 and fol-

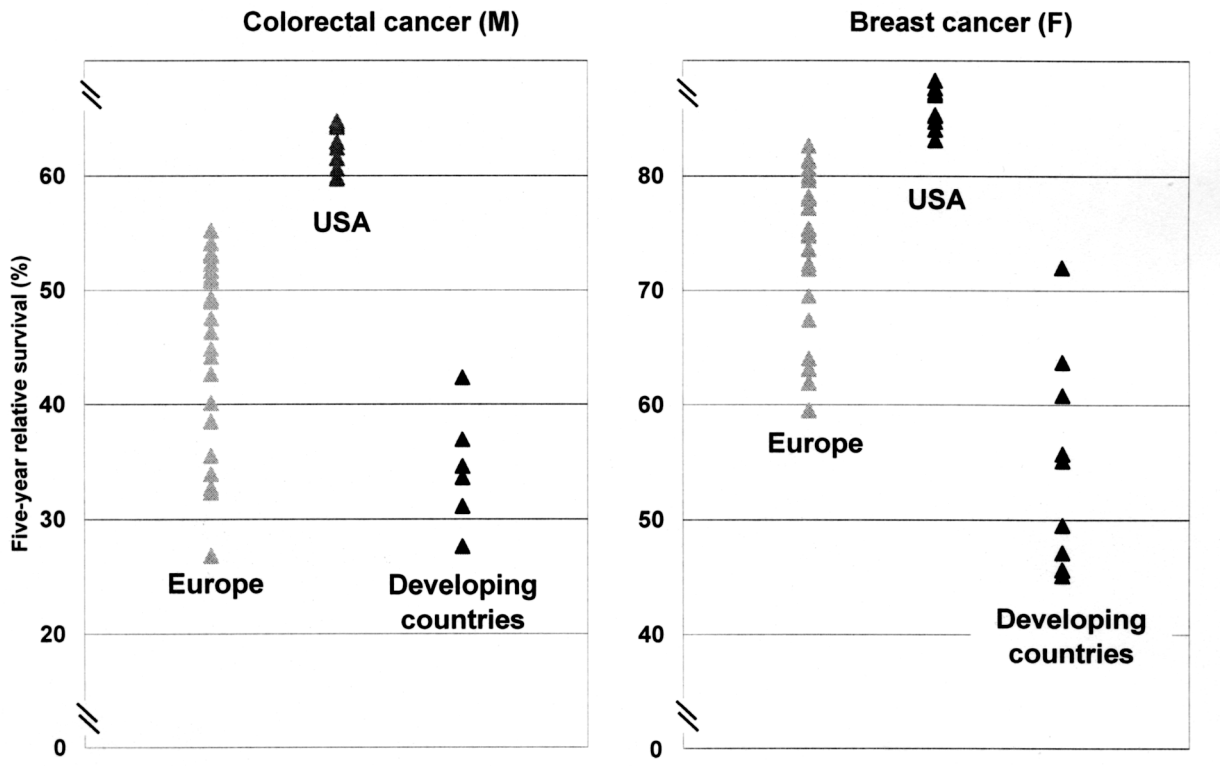


Figure 8. Five-year relative survival (%) for men with colorectal cancer and women with breast cancer in 22 countries in Europe (EUROCARE-3, see Table 1 for list; patients diagnosed in the period 1990–1994), nine areas of the USA [San Francisco-Oakland, Connecticut, Detroit (Metropolitan), Hawaii, Iowa, New Mexico, Seattle (Puget Sound), Utah, Atlanta (Metropolitan), SEER programme, patients diagnosed in the period 1990–1994], and five developing countries (Cuba and selected areas in China, India, the Philippines and Thailand, patients diagnosed in the period 1982–1992). Note different vertical scales.

lowed up to the end of 1999. A systematic modelling approach was used, with patients grouped into four consecutive 3-year periods of diagnosis. A full report will appear later, but here we provide a brief outline of survival trends for cancers of the breast (women), cervix, large bowel and prostate. We also present trends in survival for all malignancies combined. These trends are adjusted for age but not for differences in case-mix between countries, since case-mix did not change markedly during the 12 years from 1983 to 1994.

Survival trends were analysed for 18 of the 22 countries contributing to EUROCARE-3, excluding Austria, the Czech Republic, Malta and Portugal. Only cancer registries that provided data for the entire period 1983–1994 with follow-up to 1999 were included in trend analyses. For countries with regional registries, the data were therefore limited to Calvados and Côte d'Or (France), Saarland (Germany), Latina, Parma, Ragusa, Turin, Tuscany and Varese (Italy), Eindhoven (The Netherlands), Cracow (Poland), Mallorca, Navarra and Tarragona (Spain), and Basel and Geneva (Switzerland). None of the English registries were excluded. Thus national data were available for 10 countries, but for the other eight countries, population coverage of the data used in these analyses varied from 2% to 63%, and this must be borne in mind when interpreting the trends.

Breast (women)

Relative survival from breast cancer improved steadily in all European countries, but at different rates (Figure 9A). Improvements were more marked for western Europe than in the Nordic countries, where survival rates were already high for patients diagnosed in the 1980s. As a result, the range of breast cancer survival rates between the Nordic countries and western Europe has been greatly reduced. There is some evidence of a more rapid improvement in survival in the UK, with a gradual reduction of the survival deficit relative to other western European countries. This is reflected by a fall in mortality of some 20% among women aged 20–69 years in the 10 years to 1997 [62, 63]; better treatment [64] and mammographic screening [65] probably both contributed. Conversely, improvements in survival were less marked for eastern European countries, and the gap between eastern and western European countries has increased.

Cervix

Survival has improved steadily in most countries, but not in eastern European countries, where it has remained low (Figure 9A). Even though the survival of women with cervical cancer in northern and western European countries with effective Pap smear screening programmes tends to reflect the more aggressive cancers for

which screening has failed, survival in these countries is still higher than in the eastern European countries, which do not have organised cervical screening programmes. This suggests differences in the availability of effective treatment.

Colon and rectum

Improvements in survival from large bowel cancer are more marked in western Europe than elsewhere, particularly in The Netherlands, Italy and England (Figure 9B). As a result, differences in survival between the Nordic countries and the western European countries have diminished for patients diagnosed in the early 1990s. These encouraging trends may reflect more widespread use of endoscopy for earlier diagnosis, but improved surgical techniques [66] and lower post-operative mortality [67] have probably also contributed. Survival rates in eastern European countries were already lower than elsewhere in Europe for patients diagnosed during the early 1980s, and they have improved less. The gap in survival between eastern and western Europe has widened as a result.

Prostate

Prostate cancer survival trends vary widely, between an increase, no change and a decline (Figure 9B). Survival has increased in most countries, but international differences in survival have widened. Prostate cancer survival has remained low in Denmark; it was already much higher in the other Nordic countries for men diagnosed in the early 1980s, and it has increased further in those countries since then. Survival has increased sharply since the early 1990s in France, Germany, Italy, England, Scotland and Wales. Survival trends in eastern European countries have been very diverse, with a rapid increase in Estonia and a decline in Poland and Slovakia.

Widespread dissemination of PSA blood tests in some European countries since the 1990s has led to the diagnosis and treatment of many asymptomatic prostatic cancers that might never have been diagnosed in life [68]. Mass population PSA screening has been in operation in Tyrol (Austria) since the early 1990s [69], and opportunistic testing had become widespread in several western European countries by that time. This has led to a rapid increase in recorded incidence and a change in the clinical spectrum of reported disease. Since most PSA-detected asymptomatic tumours have an inherently excellent prognosis, population-based survival rates have also increased rapidly where PSA testing is widely used. Fine needle aspiration biopsy was not widely used in Denmark, and the use of PSA as a screening test has been actively discouraged: this may contribute to the divergence from other Nordic countries in incidence and survival trends.

The sharp and diverse trends in prostate cancer survival are not an artefact. On the contrary, they accurately reflect a rapid and substantial shift in the biological spectrum of prostate tumours that are now being detected and treated as a result of new diagnostic techniques. Prostate cancer treatment regimes have not improved markedly in recent years. Mortality trends would not therefore be expected to change rapidly, because most men dying of prostate cancer in any given year would have been diagnosed a number of years earlier. Even so, the absence of a marked decline in prostate cancer death rates, coupled with the trends in diagnostic activity and incidence rates, suggests that the geographic variation in survival trends primarily reflects changes in the nature of prostate cancer as it is now diagnosed and treated. Whether the trends also represent an improvement for prostate cancer patients is a more difficult question. Prostate cancer survival trends cannot be reliably interpreted as a reflection of international differences in outcome without more detailed information on patterns of early diagnostic activity, and on survival by stage of disease.

All cancers combined

Trends in survival for all cancers combined do not have clinical relevance as such, because the grouping of diseases is so broad. However, even though the trends are not adjusted for differences in case-mix between countries (cf. Figure 7), they are remarkably consistent, and appear to offer an overall indicator of the performance of health care systems in each country in dealing with cancer.

Three or four geographic clusters of countries with markedly different cancer survival trends can be identified for men and women—the Nordic countries, western European countries, the UK and eastern European countries (Figure 9C). Relative survival has increased at a similar speed in the Nordic and western European countries, leaving the comparative geography of cancer survival unchanged. For women, the survival rates for all cancers combined are very similar in the Nordic countries and in western Europe, but for men, survival is consistently higher in the Nordic countries than in other regions of Europe. Survival rates in Denmark are lower than in the other Nordic countries. Survival in the three contributing countries of the UK (England, Scotland and Wales) is generally lower than in other western European countries, and this overall pattern is particularly clear for women. In the eastern European countries, cancer survival has been consistently lower than in any of the other 15 European countries contributing to EUROCARE, and it has improved less with time.

European cancer survival trends reflect a substantial and increasing gap in the overall prognosis of cancer between eastern and western Europe. Since all five eastern European countries participating in EUROCARE may well join the EU in 2004, this raises a major new problem of inequality in health within the EU. The wide differences are likely to reflect differences in both stage at diagnosis and the availability of and access to health resources, both of which are amenable to intervention. They represent a benchmark for reduction in inequalities in cancer survival across Europe in the future. Generating an appropriate level of concern to address this problem would be an important outcome of the EUROCARE project.

Discussion

The highest achievable survival rates are obtained in randomised controlled clinical trials comparing new treatments with the best available treatment, but trials for most adult cancers involve only a small and selected group of patients. Clinical trials do identify the potential for better survival for all cancer patients, if the results can be successfully incorporated into routine clinical practice.

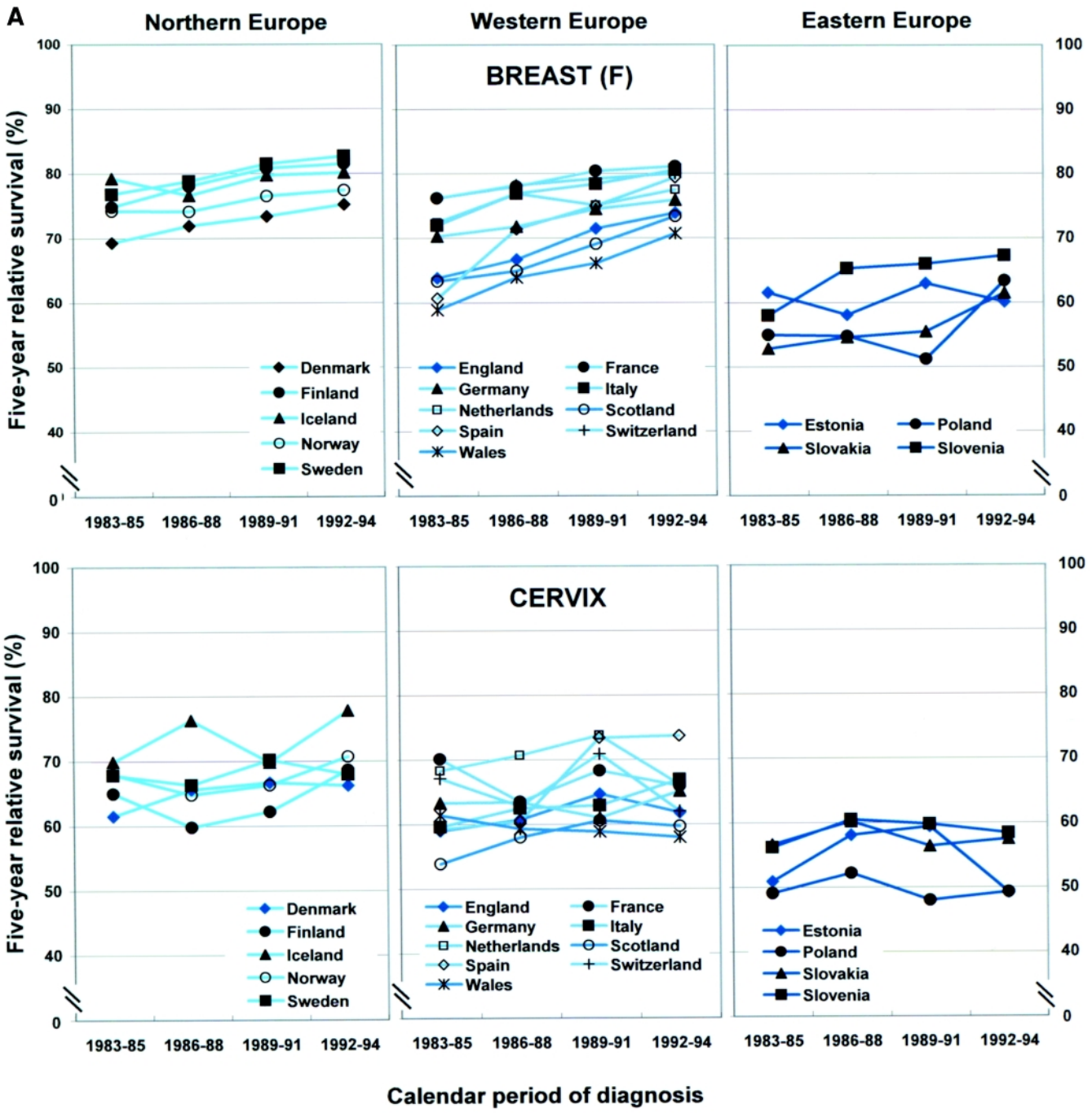
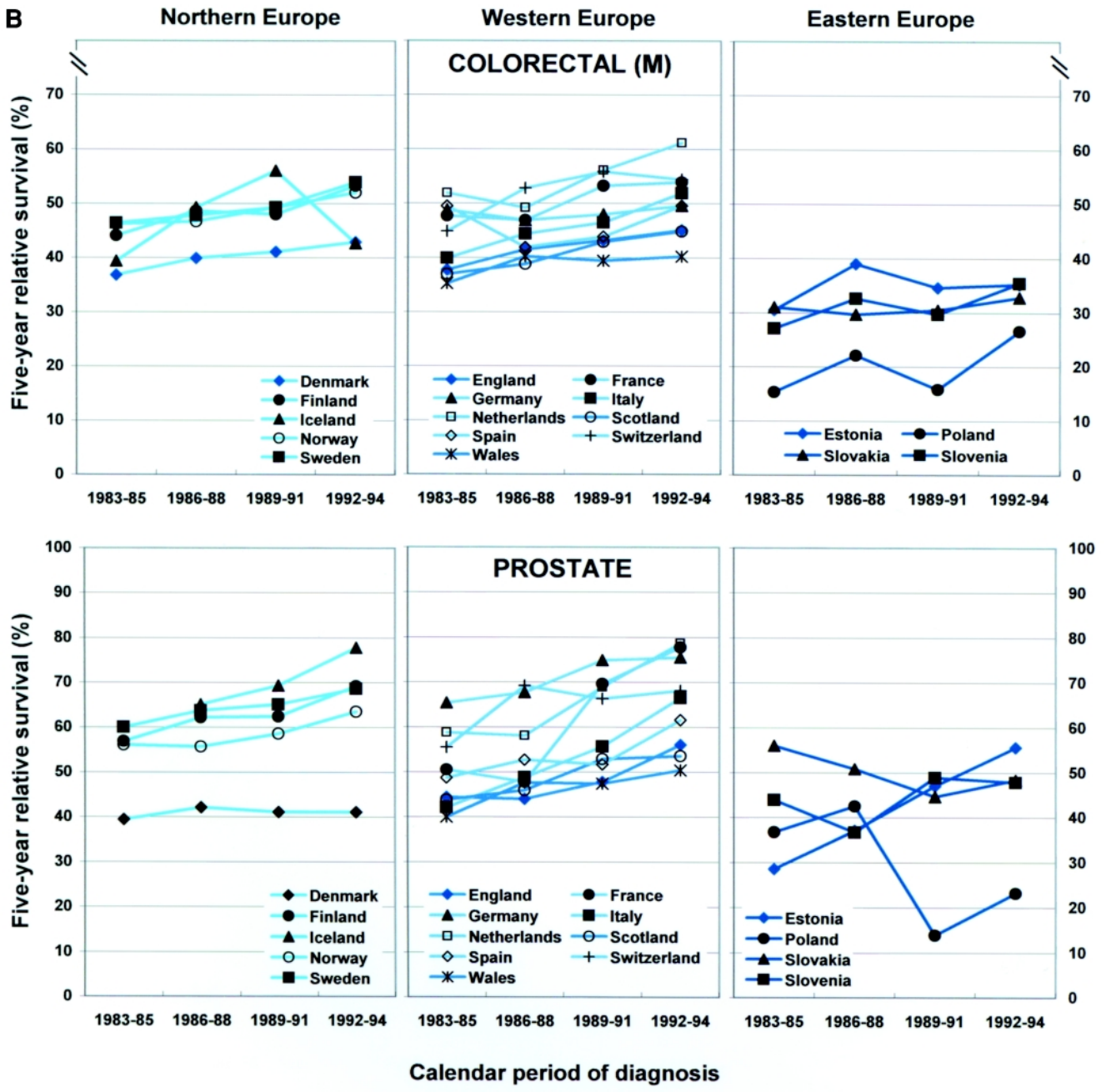


Figure 9. Trends in age-standardised 5-year relative survival (%), by country, Europe, selected cancers, patients diagnosed during the period 1983–1994 and followed up to 1999: breast (women); cervical cancer; colorectal (men); prostate cancer; and all malignancies, men and women. Note different vertical scales.

However, information on population-based survival rates—the survival achieved for *all* cancer patients diagnosed in a given period—is required to evaluate the overall efficacy of cancer diagnosis and treatment services, both within a country and as part of international comparisons. This information is more difficult to collect and interpret than survival rates from clinical trials. Central co-ordination of European cancer survival analysis has enabled the use of comparable definitions of disease, quality control of the data and completeness of follow-up, analytic methods and evaluation of the impact of these issues on differences in cancer survival between populations. Equivalent approaches have been equally important for international comparisons of cancer incidence and mortality [7, 70].

Survival rates from countries with <100% coverage by cancer registries contributing to EUROCARE-3 should, strictly, be interpreted as reflecting cancer survival only in the populations covered by those registries, but with the exception of Austria and Italy, the evidence for lack of national representativeness of the



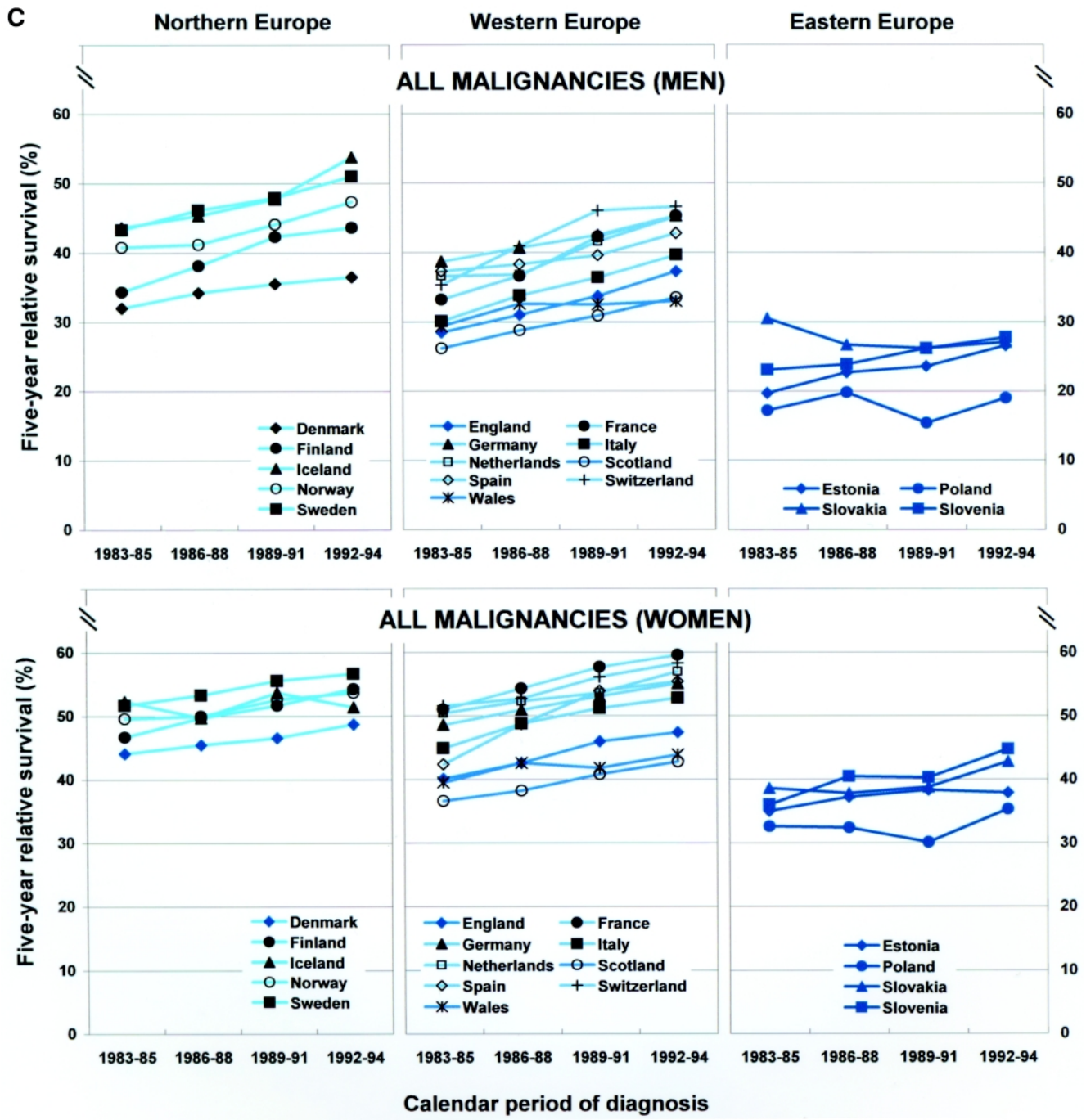
EUROCARE data is weak, and it is simply more convenient to use the countries as a basis for presentation of the results.

In principle, period analysis [71] could have been used to predict the 5-year survival rates that will probably be experienced by patients diagnosed more recently, say up to 2001, even though many of these patients will not yet have been followed up for 5 years, but the requisite information on cases diagnosed since 1995 and deaths within the past 1–2 years was not available.

Explanations for international differences in cancer survival after adjustment for age and background mortality may be grouped into several categories: artefacts in the data; differences in the general health of patients or their compliance with treatment; differences in the stage of disease at diagnosis, whether due to patient delay or health care system factors; differences in access to optimal treatment and care, and differences in human resources, organisation, funding and equipment in the health care system.

Survival rates may differ between countries or increase over time for several reasons:

- wider availability of more effective treatment;
- conventional treatment being more effective because patients are diagnosed earlier;



- better treatment for associated diseases (co-morbidity);
- earlier diagnosis without postponement of death, when screening leads to earlier diagnosis, but treatment is not more effective as a result (lead time);
- diagnosis of cancers that would not have caused symptoms in the patient's lifetime, and would not have been diagnosed or treated in the absence of screening or early diagnostic activity, and would therefore not have shortened the patient's life (over-diagnosis).

Only the first three of these reflect real improvement in the survival of cancer patients.

Artefact

The artefacts in cancer registry data most likely to cause bias in comparative survival estimates are incomplete ascertainment of cases (incidence), especially if short-term or long-term survivors are particularly affected, and incomplete ascertainment of death in registered cancer patients (linkage of death data with tumour records). We have shown that under-ascertainment of deaths among registered cancer patients, which can arise in registries reliant on passive follow-up methods, only has a minor effect on survival estimates, particularly for cancers with good prognosis [72, 73].

Under-ascertainment of long-term survivors could explain part of the difference in survival observed between, say, Denmark or the UK and other western European countries [74–76]. However, in order for under-ascertainment of survivors to account for a 6% difference in survival, say, 44% in some areas and 50% in others, it would be necessary to suppose (a) that the areas with artefactually low survival had 20% under-ascertainment of 5-year survivors, but complete registration of all cancer deaths, including successful tracing of all registrations initiated by a death certificate, and (b) that there was 100% ascertainment of survivors and deaths in all the other areas.

Consider 100 cases with 50% observed survival at 5 years. If 10 (20%) of the 50 5-year survivors are not registered but all 50 fatal cases are successfully registered, including 10 registrations initiated by a death certificate (DCI, 20% of death certificates received), then in a steady state, 40 survivors and 50 deaths will be registered, giving 44% survival (40/90). If only half the DCI cases are successfully traced back to enable full registration of the case, the proportion of registered cases for which a death certificate is the only source (DCO) will be 5.5% (5/90): these patients are excluded from survival analyses because their date of diagnosis is unknown. In this case the survival rate will be 47% (40/85). The absolute difference in survival from this bias (6%) is maximal for 50% survival. Similar calculations show that 20% under-ascertainment of survivors would reduce 10% survival to 8% (or 9% if only half the DCIs were traced), and would alter 90% survival to 88% (89%).

This pattern is implausible. It would also need to apply selectively to the cancers for which such international differences arise, and not others, even though availability of effective treatment appears a better explanation for the similarity of survival rates for testicular cancer and Hodgkin's disease in western Europe. Evidence from high-resolution studies also suggests that differences in stage at diagnosis contribute to the differences in survival between western European countries [12–14].

Representativeness

The extent to which cancer registry data from countries participating in EUROCARE produce survival rates that may be considered as representative of cancer survival in those countries has been the subject of criticism, and the international comparisons of cancer survival in EUROCARE have been dismissed as fundamentally flawed [77–81]. Interestingly, equivalent criticisms are not made of international comparisons of cancer incidence—derived from the same regional and national cancer registries—or of cancer mortality, even though both measures are also susceptible to artefact, as well as amenable to human intervention.

The criticism that cancer survival rates from EUROCARE are not nationally representative is weak. First, it could be argued that cancer registries contributing to EUROCARE have arisen in just those regions of a country where cancer care is seen as a priority, and where survival is higher than elsewhere in the country. This is likely to be the case for Tyrol, the only Austrian registry contributing to EUROCARE, where about 50% of cancer patients are treated in the university hospital [43], and it may be partly true in Italy, where most registries contributing to EUROCARE are from the wealthier north, with higher survival rates than in the poorer south [82]. There is little evidence for this pattern in France, Germany or Spain, however, and for 11 of the 22 countries contributing to EUROCARE-3 the data have national coverage, so the issue of representativeness simply does not arise. It should also be noted that the highest survival rates in Europe are often those seen in one of the Nordic countries, all of which contributed national cancer data, while the lowest survival rates are often those in the five eastern European countries, three of which also contributed national data.

Secondly, the international 'rankings' of survival are not the same for all cancers, as might be expected if the rankings were the result of systematic bias in cancer registration. For example, in contrast to all other cancers, survival rates for melanoma are noticeably higher for both sexes in Scotland than in England or Wales. The difference may be attributable to a public education programme for early detection and treatment of melanoma in Scotland [57, 83, 84].

Thirdly, international differences in survival are smaller for Hodgkin's disease and testicular cancer. These cancers are more readily treatable than many cancers for which the international range of survival rates is wide. It is hard to conceive of any bias or artefact that would produce such a strikingly different international range of cancer survival for the more treatable malignancies. This suggests the influence of stage of disease and access to treatment is at least part of the explanation for international differences in cancer survival. Support for this interpretation comes from recent detailed studies of breast and colorectal cancers, which suggest that differences in stage of disease are key explanations for differences in survival in western Europe, and that low survival rates in several eastern European countries are also likely to be attributable to lack of adequate treatment [12–14, 85].

Fourth, an increase in population coverage did not reduce the international range of cancer survival rates. EUROCARE-2 included data from additional cancer registries in six of the 12 countries that contributed to the first EUROCARE study (England, France, Italy, The Netherlands, Poland and Spain), as well as new data from Austria, Iceland, Slovakia, Slovenia and Sweden, but the international differences in cancer survival identified 4 years earlier did not disappear [10]. The position in England (46% coverage in EUROCARE-2) merits particular comment. Survival rates for patients diagnosed up to 1990 have been published for all the regions of England, as well as for affluent and deprived subgroups of the national population. For most cancers, both the highest regional survival rate in England and the survival rate for patients in the most affluent areas of England were below even the average survival rate in Europe for patients diagnosed up to 1989 [17]. Further, the data from Scotland and Wales do have national coverage, and they are collected independently of those for England (63% coverage in EUROCARE-3), but survival rates in these three UK nations are generally similar (Figures 6 and 7). None of this suggests that the European cancer survival 'rank' for England is seriously misrepresented by the fact that data from some regional registries are not included in the EUROCARE study.

Finally, the criticism of lack of national representativeness misses a crucial point, namely that in some parts of Europe — whether an entire country or a region of a country—survival rates

that are based on the experience of all cancer patients are much higher than in other parts of Europe. Survival also varies within countries, both by region and by socio-economic status [86].

Mortality rates and treatment guidelines

Geographical comparisons of survival from the EUROCARE study have generated wide debate [34], and assertions that such comparisons or trends are too complex to interpret reliably, or that they add little insight to that obtained from monitoring mortality rates [62, 87] or compliance with treatment guidelines [88].

Mortality rates provide crucial evidence of progress against cancer, but they are not easy to interpret in terms of the effectiveness of cancer care. Mortality trends are affected by trends in incidence and survival, and can rarely help disentangle the effects of primary prevention, earlier diagnosis and better treatment. They provide a blurred and delayed reflection of trends in the success of treatment, because persons who die of cancer in a given year will have been diagnosed (and received their principal treatment) in any of the 5, 10 or more preceding years, the degree of backscatter in time depending on the lethality of the tumour [63]. Further, incorrect death certification or attribution of the underlying cause of death may contribute substantially to observed mortality trends [89]. It is also important to monitor compliance with treatment guidelines, but improvements in compliance do not necessarily predict generalised improvements in survival, because not all patients will obtain the same response to treatment as the highly selected patients included in the clinical trials which contribute to the evidence base for such guidelines.

In short, while it remains important to monitor incidence, mortality and compliance with treatment guidelines, monitoring cancer survival is also likely to remain an important public health tool in cancer control for the foreseeable future. Survival rates are also likely to be more readily understood by cancer patients, and perceived as more relevant to them personally, than either incidence or mortality rates.

Summary

International differences and trends in cancer survival within Europe are larger than can reasonably be accounted for by artefact, bias or chance. The geographical patterns and trends in survival are often broadly consistent with geographical differences or trends in the type of cancer, diagnostic investigations or overall investment in health care, and for several major cancers, supporting evidence is available from population-based studies of clinical information. Incomplete ascertainment of cancer cases, particularly of long-term survivors, may contribute to some regional and international differences in survival, however, and more systematic information on completeness is required. We may conclude that large international differences in survival do exist for many cancers, but we should be cautious in drawing quantitative or causal conclusions from observational survival data.

We do not yet have a fully satisfactory interpretation of these differences, but we have few alternatives to this type of study if we are to understand the determinants of improved outcome for all cancer patients, and to enable better planning of their health care. The EUROCARE Working Group has developed several strategies to disentangle the various possible explanations [73]. These include further development of high-resolution studies to examine the impact on survival differences of disease stage, staging techniques and treatment; and further development of mathematical models of cure. Extension of systematic international survival comparisons to other regions of the world, such as Australia, Canada, Japan and the USA, is also in progress (the CONCORD study) [22].

Oncologists and epidemiologists may provide insight into the geographic differences and trends in survival reported by this study, and may suggest further lines of enquiry. Do we need more refined studies of survival to monitor progress against cancer and to plan future cancer care? Will such analyses help us quantify the effect of new treatments arising from recent progress in the basic sciences and genomics on population cancer survival rates? Substantial human and financial resources are required to improve the outcome of cancer treatment. Will future investments in cancer services include matching investment to monitor their impact on survival and mortality?

Earlier diagnosis and prompt, universal access to optimal treatment would be expected to reduce international differences in cancer survival in Europe. To achieve this, oncologists and health care planners will need better information on the comparative performance of their health systems. Population-based cancer registries provide some of the information for such comparisons, but their traditional output may no longer be sufficient to evaluate the effectiveness of health systems, and especially to explain geographical differences in survival. In some countries, their role is also under threat. Confidentiality constraints recently inhibited the collection of cancer registration data in the UK [90], and the linkage of cancer registrations and deaths is currently illegal in Estonia [91]. Both activities are essential for internationally comparable survival rates. Legal protection for cancer registration across Europe will be required.

The mission of cancer registries should be reconsidered, and the priority shifted from classical descriptive epidemiology and geographical pathology toward more analytical monitoring of progress against cancer, including the probability of survival and cure, the burden of cancer prevalence, and the late effects of therapy. Several European studies of this type have been reported recently [3, 36, 92–94] and others are in progress. Many cancer registries are developing closer relationships with cancer clinicians and general practitioners, and some now systematically collect detailed clinical information that was collected either irregularly or not at all in the past. These developments will improve the power of population-based cancer data to explain differences in cancer survival, and should enhance their relevance to clinical practice.

European average survival rates are useful for comparative purposes, but they should not become the goal for cancer control programmes: the benchmark should always be the highest achievable survival rates.

The aim of exploring geographic differences in cancer survival is not to establish international league tables or to excite national rivalries, but to estimate the range of survival rates, and to identify regions or countries in which survival could be improved.

There is increasing evidence that international survival differences are at least partly attributable to factors that are susceptible to intervention, such as differences in stage at diagnosis, access to optimal treatment and investment in health care. Unless we wish to argue that the survival of Estonian cancer patients (say) *should* be much lower than that of cancer patients in neighbouring Finland, the observation of such differences in cancer survival should stimulate efforts to explain and reduce them.

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