

# Estimates of the cancer incidence and mortality in Europe in 2006

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**Background:** Monitoring the evolution of the cancer burden in Europe is of great value. Estimates of the cancer burden in Europe have been published for 2004 and estimates are now being presented for cancer incidence and mortality in Europe for 2006.

**Methods:** The most recent sources of cancer incidence and mortality data have been collected and projections have been carried out using short-term prediction methods to produce estimated rates for 2006. Additional estimation was required where national incidence data were not available, and the method involved the projection of the aggregations of cancer incidence and mortality data from representative cancer registries. The estimated 2006 rates were applied to the corresponding estimated country population to obtain the best estimates of the cancer incidence and mortality in Europe in 2006.

**Results:** In 2006 in Europe, there were an estimated 3 191 600 cancer cases diagnosed (excluding nonmelanoma skin cancers) and 1 703 000 deaths from cancer. The most common form of cancers was breast cancer (429 900 cases, 13.5% of all cancer cases), followed by colorectal cancers (412 900, 12.9%) and lung cancer (386 300, 12.1%). Lung cancer, with an estimated 334 800 deaths (19.7% of total), was the most common cause of death from cancer, followed by colorectal (207 400 deaths), breast (131 900) and stomach (118 200) cancers.

**Conclusions:** The total number of new cases of cancer in Europe appears to have increased by 300 000 since 2004. With an estimated 3.2 million new cases (53% occurring in men, 47% in women) and 1.7 million deaths (56% in men, 44% in women) each year, cancer remains an important public health problem in Europe and the ageing of the European population will cause these numbers to continue to increase even if age-specific rates remain constant. Evidence-based public health measures exist to reduce the mortality of breast and colorectal cancer while the incidence of lung cancer, and several other forms of cancer, could be diminished by improved tobacco control.

**Key words:** cancer, deaths, Europe, incidence, mortality, predictions

## introduction

Comprehensive estimates of the incidence and mortality from Cancer at a European level can be extracted from the GLOBOCAN 2002 project of International Agency for Research on Cancer [1], but there is still no way of monitoring the evolution of the cancer burden at the European level. In 1989, the European Network of Cancer Registries (ENCR) was established within the framework of the Europe Against Cancer programme of the European Commission. One of the objectives was to provide regular information on the burden of cancer in the European Union (EU). Starting from 1995 [2], the ENCR published regular estimates of the incidence and prevalence of and mortality from cancer in the EU using the EUCAN software [3]. The ENCR activities have suffered an interruption so that

the latest estimates available using the EUCAN system are of less use for today's cancer control and planning.

In an attempt to monitor the evolution of cancer mortality in the EU, it was observed that the expected number of cancer deaths in the (15 Member State) EU fell by >9% from 1985 to 2000 [4]. During the lifetime of the Europe Against Cancer programme, favourable trends in cancer mortality were established for several common forms of cancer death in many countries [4] which appear likely to continue in the near future [5] although there were notable exceptions including lung cancer in women and most forms of cancer in Spain and Portugal [4].

In the year 2000, there were 1 122 000 deaths from cancer recorded in the 25-Member EU [5]. Even if the age-specific cancer mortality rates remain constant at year 2000 levels, there will be large increases in the absolute numbers of cancer cases and deaths into the foreseeable future. Although the total population will remain fairly constant, compared with 2000, by 2015 there will a 22% increase in the numbers in the population

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aged >65 and a 50% increase in the number of persons aged >80. Given the strong association between cancer risk and age, this will lead to a major increase in the cancer burden. Using population projections, if the age-specific death rates remain constant, the absolute numbers of cancer deaths in 2015 will increase to 1 405 000. Even if the forecast trends are taken into account, it is still expected that there will be an increase but this will only be lesser and result in an estimated figure of 1 249 000 cancer deaths [5].

Boyle and Ferlay [6] produced estimates of cancer incidence and mortality in Europe for the year 2004, using the most recent sources of cancer data available at that time, applied to population projections. This was the first of a series designated to provide regular and timely estimates of the cancer burden in Europe. The aim of this report is to provide more up-to-date estimates of the incidence of and mortality from 18 cancers in 39 European countries in 2006, using the most recent incidence and mortality data available and short-term prediction methods and to monitor the evolution of the cancer burden in Europe. The results are presented for the 25 countries of the EU, the European Economic Area plus Switzerland and for the entire Europe.

### data sources

Estimates of cancer incidence and mortality for 2006 have been produced for the 38 European countries, as defined by the United Nations, and Cyprus. The source of the incidence and mortality data together with the methods of estimation are summarised in Table 1. The predictions analysis requires, wherever possible, at least 10 consecutive years of data for each country in Europe. Results are presented for the following cancers: oral cavity and pharynx [International Classification of Diseases (ICD)-10 C00-14], oesophagus (C15), stomach (C16), colorectal cancers (C18-21), liver (C22), pancreas (C25), larynx (C32), lung (C33-34), melanoma of skin (C43), female breast (C50), uterine cancers (C53-C55), ovary (C56), prostate (C61), kidney (C64), bladder (C67), non-Hodgkin's Lymphoma (C82-85, C96), leukaemia (C91-95) and all cancers combined, excluding nonmelanoma skin cancer (C00-96 but C44).

For Belarus Russian Federation and Ukraine, mortality data are not available at the level of detail required by the study, and so predictions could not be calculated for cancer of the liver, pancreas, melanoma of skin, ovary, kidney, bladder and for non-Hodgkin's lymphoma. Therefore, the results for Europe do not include these cancers. The estimates for the category 'all cancers combined (excluding nonmelanoma skin cancer)' were calculated by summing the predictions for each individual cancer site to the predictions of a residual category.

To take into account the random fluctuation of small numbers before the age of 45, the analysis involves only 10 age groups: 0-44 years and the successive traditional 5-year age groups up to 85+.

### incidence data

Recent national incidence data were obtained from national cancer registry websites or annual reports for the registries in Austria, Belarus, Bulgaria, Croatia, Czech Republic, Denmark,

Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Malta, The Netherlands, Norway, Slovakia, Slovenia, Sweden and Ukraine [7-21].

In the UK, historical incidence data were available for the populations of England and Scotland. The predicted rates for England and Scotland combined were then applied to the UK population.

Additional historical and local incidence data for the remaining countries and their corresponding populations were extracted from the EUROCIIM database of the ENCR [22] or from the NORDCAN database of the Association of the Nordic Cancer Registries [23]. For France, the predictions were based on the 1985, 1990, 1995 (partitioned by age group using local incidence data) and the 2000 national estimates [24].

### mortality data

Statistics on cancer mortality are derived from information on death certificates, collected by civil registration systems recording vital events (births, marriages, deaths). The responsible authority varies between countries, but usually the first level of data collection and processing is the municipality or province, with collation of national causes of death statistics the responsibility of the National Statistics Office. However, in spite of these common features, important quality and comparability issues remain [25].

Death certificates record information on the person dying, and the cause of death, as certified, usually by a medical practitioner is recorded on a local version of the World Health Organisation (WHO) recommended international medical death certificate.

The ICDs provide a uniform system of nomenclature and coding and two revisions are currently in use in Europe (ICD-9 and ICD-10). The purpose of the coding process is to select the underlying cause of death and is neither intended nor suitable for indexing distinct clinical entities [26], e.g. the presence of a particular tumour.

Although the ICD contains a carefully defined set of rules and guidelines that allow underlying cause to be selected in a uniform manner, interpretation of the concept probably varies considerably, e.g. when death occurs from pneumonia in a person previously diagnosed as having cancer or if in the opinion of the assessor the patient would not have died when he/she did, had he/she not received a diagnosis of cancer [25].

Even mandatory death certification requires basic additional information to enable verification of the causes of death statistics with other sources. For Albania, the degree of completeness of the vital registration is known to be particularly incomplete and the data have been corrected using the estimated percentage of completeness (60%) in 2001. In this paper the historical mortality data and respective population figures were extracted from the WHO mortality database [27].

Comprehensive mortality statistics thus require that diagnostic data are available on decedents, which are transferred in a logical, standardised fashion to a common death certificate, which is then accurately and consistently coded, compiled and analysed in a timely manner. The quality of output can then be readily measured through international studies.

**Table 1.** Data availability and method of estimation

Country	Mortality (WHO)	Incidence	Population (2006)
Albania <sup>a</sup>	1987–2003	Estimated mortality 2006 → incidence (I/M ratio from Bulgaria and Slovenia)	UNO (2004, revision)
Austria	1955–2004	National incidence 1993–2002	EUROSTAT
Belarus <sup>b</sup>	1981–2003	National incidence 1978–2002	UNO (2004, revision)
Belgium	1954–1997	Estimated mortality 2006 → incidence (I/M ratio from France and The Netherlands)	EUROSTAT
Bulgaria	1964–2004	National incidence 1993–2002	EUROSTAT
Croatia	1985–2004	National incidence 1994–2002	UNO (2004, revision)
Czech Republic	1986–2004	National incidence 1983–2002	EUROSTAT
Denmark	1951–2001	National incidence 1957–2001	EUROSTAT
Estonia	1981–2003	National incidence 1968–2002	EUROSTAT
Finland	1952–2004	National incidence 1959–2003	EUROSTAT
France <sup>a</sup>	1952–2002	National incidence estimates 1980, 1985, 1990, 1995, 2000	EUROSTAT
Germany	1982–2004	Estimated mortality 2006 → incidence (I/M ratio from Austria, France, The Netherlands and Switzerland)	EUROSTAT
Greece	1961–2003	Estimated mortality 2006 → incidence (I/M ratio from Italy, Bulgaria and Slovenia)	EUROSTAT
Hungary	1955–2003	Estimated mortality 2006 → incidence (I/M ratio from Austria, Czech Republic and Slovakia)	EUROSTAT
Iceland	1951–2003	National incidence 1958–2002	EUROSTAT
Ireland	1951–2002	National incidence 1994–2002	EUROSTAT
Italy	1951–2002	Estimated mortality 2006 → incidence (I/M ratio from Italian Cancer Registries)	EUROSTAT
Latvia	1980–2004	National incidence 1984–2003	EUROSTAT
Lithuania	1981–2004	National incidence 1978–2002	EUROSTAT
Luxembourg	2000–2004	Recorded mortality 2000–2004 → incidence (I/M ratio from France and The Netherlands)	EUROSTAT
Macedonia	1991–2003	Estimated mortality 2006 → incidence (I/M ratio from Bulgaria and Slovenia)	UNO (2004, revision)
Malta	2000–2004	National incidence 2004	EUROSTAT
Moldova	1981–2004	Estimated mortality 2006 → incidence (Ukraine)	UNO (2004, revision)
Netherlands	1951–2004	National incidence 1989–2003	EUROSTAT
Norway	1951–2003	National incidence 1959–003	EUROSTAT
Poland	1959–2003	Estimated mortality 2006 → incidence (I/M ratio from Polish Cancer Registries)	EUROSTAT
Portugal	1955–2003	Estimated mortality 2006 → incidence (I/M ratio from Spain)	EUROSTAT
Romania	1959–2004	Estimated mortality 2006 → incidence (I/M ratio from Bulgaria and Slovakia)	EUROSTAT
Russian Federation <sup>b</sup>	1980–2004	Estimated mortality 2006 → incidence (I/M ratio from Belarus and Ukraine)	UNO (2004, revision)
Serbia Montenegro	1997–2002	Estimated mortality 2006 → incidence (Slovenia and Croatia)	UNO (2004, revision)
Slovakia	1992–2002	National incidence 1973–2002	EUROSTAT
Slovenia	1985–2003	National incidence 1984–2003	EUROSTAT
Spain	1951–2003	Estimated mortality 2006 → incidence (I/M ratio from Spanish Cancer Registries)	EUROSTAT
Sweden	1951–2002	National incidence 1959–2003	EUROSTAT
Switzerland <sup>a</sup>	1951–2002	Estimated mortality 2006 → incidence (I/M ratio from Swiss Cancer Registries)	EUROSTAT
Ukraine <sup>b</sup>	1981–2004	National incidence 2004	UNO (2004, revision)
UK	1951–2003	Incidence (England and Scotland) 1979–2003	EUROSTAT
Cyprus		Simple mean of Albania, Macedonia and Serbia and Montenegro	EUROSTAT
Bosnia Herzegovina		Simple mean of Malta and Greece	UNO (2004, revision)

‘→’ Converted to incidence.

<sup>a</sup>Corrected data.

<sup>b</sup>Main category (ICD special list).

WHO, World Health Organisation.

### population data

The population of each European country in 2006, by sex and age, was extracted from the Eurostat website [28] for the 25 EU member states plus Bulgaria and Romania. For Norway, Iceland and Switzerland the populations were extracted from the corresponding National Bureau of Statistics website [29–31]. For the nine remaining countries (Albania, Belarus, Bosnia

Herzegovina, Croatia, Macedonia, Republic of Moldova, Russian Federation, Serbia Montenegro and Ukraine), estimates of the population for the years 2005 and 2010 were taken from the United Nations population division [32]. The 2006 population figures were estimated by calculating the annual percentage change by sex and age between the years 2005 and 2010.

## methods (1)

### predictions when incidence data available

Changes in the classification over time may affect mortality trends. The change from ICD-8 to ICD-10 in 1995 in Switzerland caused discontinuities in trends [33] and the Swiss data before 1995 have been corrected accordingly. In France, the effect of the introduction of the ICD-10 on mortality statistics has been studied [34] and mortality data before 2000 have been adjusted using the indicated ratios for the most affected sites. A similar study was conducted in England and Wales [35] and corresponding data before 2000 and after 1993 have been corrected for the cancers with significant differences. The correction factors, however, are small, and the changes in death rates across the years of the ICD-9/ICD-10 boundary in other European countries are considered to be still interpretable.

The prediction of the national incidence and mortality rates was computed, in order of priority:

According to the methods described by Dyba et al. [36], three different age-period models were chosen:

$$E(\text{rate}(i, t)) = \alpha_i + \beta_i \times t$$

$$\text{Log}(E(\text{rate}(i, t))) = \alpha_i + \beta_i \times t$$

$$\text{Log}(E(\text{rate}(i, t))) = \alpha_i + \beta \times t$$

Where  $E(\text{rate}(i, t))$  is the expected mortality rate in the age  $i$  and year  $t$ ,  $\alpha_i$ ,  $\beta_i$  and  $\beta$  are unknown parameters. The first model assumes different linear changes over time among different age groups. The second model is the same model on a logarithmic scale: it is usually chosen for cancer with decreasing trends as it avoids prediction of negative values. The third model assumes the same proportional log-linear changes over time within age groups.

For each country in Europe, we first define the most recent available year in the dataset as the target year for prediction (for example, 2004 for mortality in Germany). For the three models, we predict the number of cancer cases or deaths in the target year using the five previous years (1999–2003 for Germany). We then added earlier years one by one up to 9 years to each model and checked if it improved the prediction of the target year. To select the best model between the 15 possible (three models  $\times$  5 years), we first tested the standardised incidence ratio (SIR) and mortality ratio (SMR) of the recorded to the predicted number of cancer cases or deaths, rejecting those models having a  $P$  value  $< 0.05$ . Within the models that passed the first SMR test, we checked the prediction by age group and selected the one having the lowest  $\chi^2$ . This method assumes that if the model is the best to predict the most recent available year, then it will also be the best to predict 2 or 3 years later. Finally, the predictions of the sex and age-specific incidence and mortality rates for 2006 were computed by adding the target year to the years already in the selected model.

We computed trend-based predictions using the NORDPRED package [37], when no model could be selected. This age-period-cohort (APC) model requires at least 15 years of consecutive data, and can only predict 5-year periods. Some parameters can be entered into the model and practically we defined the first age group to be included in the regression model as the first age group for which at least one cancer case or death occurred in each period used for the prediction. If the 5-year predicted period is not centred on 2006 (2004–2008), we predicted two consecutive periods, and the estimated rates for 2006 were computed as the weighted average rates of the two periods. The APC model was used to predict the incidence of cancer in France, taking the 1985, 1990, 1995 and 2000 estimates as the mid-point of 5-year consecutive periods, and to predict the incidence of breast and prostate cancers, as it is greatly influenced by early detection methods. Using the Finnish data and their 2006 estimates as the gold standard [13], we modified the cut in trend parameter in the model until we obtained similar

results. Although the population covered, the starting time and the screening interval are different, the two percentages of reduction of the trends for breast (60%) and prostate (75%) cancers were applied to Finland, France, The Netherlands, Norway, Sweden, and for breast cancer only, in England and Scotland.

For the European countries with national cancer registration system, the overall method for predicting incidence in 2006 was validated by comparing our estimates for Finland to that computed by the Finnish Cancer Registry for the same year [13]. The results are given in Table 2, and showed close results.

## methods (2)

### predictions when incidence data unavailable

For Italy, Poland, Spain and Switzerland no national incidence data exist. In order to achieve consistency with previous publications [1–3, 6], we estimated the national incidence in 2006 ( $I_N$ ) by applying a set of age-, sex- and site-specific incidence/mortality ratios ( $I_R/M_R$ ), obtained from the aggregation of country-specific registries, to the estimated 2006 national mortality data ( $M_N$ ):  $I_N = M_N \times (I_R/M_R)$ . Before aggregation, each registry was weighted to take into account the relative size of the population. The local incidence and mortality data were projected to 2006 using the methods described above (incidence of breast and prostate cancers were adjusted for Italy and Switzerland using the same percentages), and estimates of the country-specific regional incidence/mortality ratios ( $I_R/M_R$ ) were obtained

**Table 2.** Comparison of the estimates in 2006: estimated number of cancer cases in Finland (2006)

Site	Finnish cancer registry <sup>a</sup>	Ferlay et al.
Male		
Prostate	4491	4677
Lung	1458	1433
Colorectal	1209	1206
Bladder	591	569
Non-Hodgkin's lymphoma	509	505
Kidney	432	433
Stomach	385	363
Melanoma	396	403
Pancreas	394	405
Leukaemia	273	292
Oesophagus	165	168
All sites but nonmelanoma skin cancer	12491	12448
Female		
Breast	4060	4085
Lung	617	617
Uterus	948	920
Colorectal	1240	1262
Bladder	194	185
Non-Hodgkin's lymphoma	499	497
Kidney	330	352
Stomach	296	297
Melanoma	392	396
Pancreas	477	474
Leukaemia	237	240
Ovary	507	523
All sites but nonmelanoma skin cancer	12217	11784

<sup>a</sup>Cancer in Finland 2002 and 2003; Helsinki, Cancer Society of Finland Publication No 66, 2005.

**Table 3.** Estimated age-standardised incidence rates (European standard) per 100 000 by site, sex and country, 2006

Country	Stomach (C16)		Colon and rectum (C18–21)		Lung (C33–34)		Breast (C50)	Uterus (C53–55)	Prostate (C61)	All cancers (C00–97/C44)	
	M	F	M	F	M	F				M	F
	Austria	14.3	8.8	57.6	30.9	54.0				22.3	91.5
Belgium	10.3	3.8	53.3	34.3	93.0	22.9	137.8	32.7	160.8	543.3	343.1
Cyprus	16.2	8.7	41.2	29.0	66.1	9.5	88.4	23.3	74.6	373.3	269.6
Czech Republic	17.0	8.2	94.4	46.0	78.9	22.9	84.8	44.8	76.1	484.0	346.0
Denmark	9.1	4.5	61.0	48.0	65.0	48.7	122.6	28.7	80.3	442.0	413.6
Estonia	33.4	17.5	50.0	33.9	80.3	13.2	71.1	40.5	65.3	411.1	298.5
Finland	11.8	6.8	39.2	29.4	45.8	14.7	119.8	25.4	149.7	406.0	314.0
France	12.0	4.5	59.8	36.8	75.5	15.0	127.4	22.2	133.5	527.5	329.0
Germany	17.6	8.5	70.2	45.1	61.2	20.8	121.2	26.4	113.0	451.4	333.7
Greece	18.9	8.9	31.0	21.3	88.7	12.7	81.8	21.3	81.0	423.9	259.5
Hungary	26.6	10.9	106.0	50.6	119.3	42.4	118.0	51.6	85.6	598.8	408.7
Ireland	14.7	7.6	65.2	36.9	60.2	34.1	131.4	28.8	182.0	513.6	382.2
Italy	22.1	11.1	52.0	30.3	84.7	15.6	105.3	25.1	108.4	499.7	323.6
Latvia	28.6	14.6	47.0	28.7	82.5	10.2	64.8	39.7	85.7	419.4	265.2
Lithuania	36.8	17.9	53.1	32.5	91.9	9.9	68.7	63.4	109.7	500.1	320.5
Luxembourg	14.8	5.4	61.9	36.1	69.8	16.3	116.9	20.0	93.6	440.0	312.5
Malta	13.7	7.7	51.5	36.2	43.9	6.5	94.5	25.7	68.8	322.8	279.5
The Netherlands	13.4	6.3	61.2	43.9	63.4	32.5	128.0	22.1	98.4	435.0	355.4
Poland	34.8	8.8	43.1	27.7	103.0	28.6	74.1	37.9	51.0	443.2	311.9
Portugal	28.9	15.4	58.9	30.9	44.5	11.7	103.5	33.1	101.2	427.8	289.4
Slovakia	25.2	10.3	87.1	42.6	71.7	11.6	69.7	40.0	51.2	434.4	288.4
Slovenia	27.5	11.0	69.0	36.3	75.6	22.9	87.5	42.8	70.2	438.5	319.0
Spain	15.9	8.4	54.4	25.4	68.3	13.8	93.6	24.5	77.2	416.9	263.4
Sweden	9.2	4.9	49.2	37.4	28.6	23.8	125.8	31.7	157.2	418.2	361.3
United Kingdom	14.3	5.7	54.9	34.8	57.1	34.6	122.2	25.2	107.3	410.5	348.9
<b>European Union (EU25)</b>	<b>18.2</b>	<b>8.1</b>	<b>59.0</b>	<b>35.6</b>	<b>71.8</b>	<b>21.7</b>	<b>110.3</b>	<b>28.3</b>	<b>106.2</b>	<b>463.0</b>	<b>325.5</b>
Iceland	14.1	6.4	50.2	36.8	40.6	45.6	121.6	27.3	140.5	429.2	383.6
Norway	11.2	5.4	66.4	51.2	53.8	33.7	109.1	34.1	133.2	458.7	381.5
Switzerland	16.4	3.9	79.1	55.6	52.7	26.2	126.5	29.2	137.0	493.6	369.0
<b>EEA and Switzerland</b>	<b>18.1</b>	<b>8.0</b>	<b>59.4</b>	<b>36.1</b>	<b>71.3</b>	<b>21.9</b>	<b>110.5</b>	<b>28.3</b>	<b>106.9</b>	<b>463.4</b>	<b>326.7</b>
Bulgaria	25.5	13.6	49.6	31.3	67.3	11.5	74.0	53.0	36.0	336.6	269.0
Romania	30.6	13.0	40.7	25.1	81.0	15.4	61.2	64.1	32.2	371.8	279.1
Albania	59.4	21.5	13.6	21.4	95.0	26.2	82.4	22.2	62.1	444.7	312.1
Belarus	45.1	20.4	42.8	29.0	86.5	6.7	55.5	39.3	38.0	380.7	251.4
Bosnia Herzegovina	37.8	14.4	34.6	27.3	76.0	17.5	79.0	43.8	42.0	369.4	287.0
Croatia	27.5	8.6	57.0	36.9	69.3	13.9	79.4	25.9	67.8	421.3	244.4
Macedonia	37.3	16.0	49.4	30.0	71.8	8.9	85.4	49.1	31.9	363.0	280.2
Republic of Moldova	28.3	14.4	38.7	26.7	63.7	12.5	51.6	45.0	18.7	331.2	238.3
Russian Federation	47.8	21.1	46.5	33.9	92.7	11.2	67.3	39.2	30.1	389.0	261.9
Serbia and Montenegro	16.9	5.9	41.0	30.4	61.5	17.3	69.2	60.0	32.3	300.1	268.5
Ukraine	37.1	15.4	41.7	27.0	74.6	9.5	53.3	40.9	26.7	333.6	227.4
<b>Europe</b>	<b>24.8</b>	<b>11.6</b>	<b>55.4</b>	<b>34.6</b>	<b>75.3</b>	<b>18.3</b>	<b>94.3</b>	<b>33.5</b>	<b>86.7</b>	<b>439.7</b>	<b>303.0</b>

from a log-linear model for the number of incident cases offset by the corresponding number of deaths, including terms for sex and age.

For Albania, Belgium, Germany, Greece, Hungary, Luxembourg, Macedonia, Republic of Moldova, Portugal, Romania, Russian Federation and Serbia and Montenegro neither local nor national reliable historical incidence data exist. To estimate the national incidence in 2006, we used the method described (in the previous paragraph), but the country-specific regional incidence/mortality ratios ( $I_R/M_R$ ) were replaced by the aggregation of the estimated incidence and mortality in neighbouring countries ( $I_C/M_C$ ) in 2006 (Table 1).

For countries with a small population (less than a million), and for which no or few cancer deaths occurred at some sites (Iceland, Luxembourg and

Malta), no reliable mortality predictions could be calculated; we estimated the 2006 rates by the most recent age-specific mortality rates available in the country. Similarly, incidence of cancer in Malta (sparse data) and Ukraine (no historical information) was not predicted; we applied the most recent available rates (2004) to the 2006 population.

No data were available for Cyprus and Bosnia Herzegovina. The country-specific incidence and mortality rates for these two countries were calculated from the simple average of those of neighbouring countries (Greece and Malta; Albania, Macedonia and Serbia and Montenegro, respectively).

Finally, the incidence rates for the category 'all cancers combined (excluding nonmelanoma skin cancers)' were calculated by summing the age-specific predictions for the individual cancer sites to the predictions

of a residual category. For each European country, the number of cancer cases and deaths in 2006 was estimated by multiplying the predicted 2006 incidence and mortality rates by the corresponding 2006 country populations. The rates were also directly age-standardised ratio (ASRs per 100 000 person-years) using the European standard population [38].

## results

The age-standardised incidence and mortality rates (ASRs, European Standard) in each country within Europe in 2006 are presented in Tables 3 and 4, respectively, by sex and for selected

cancers. The figures are also expressed as a percentage of the estimated total number of incident cancer cases and cancer deaths, in Europe and in the EU25, in Tables 5 and 6.

In 2006 in Europe, there were an estimated 3 191 600 incident cases of cancer diagnosed (Table 5). Breast cancer is by far the most common form of cancer diagnosed in European women today, accounting for 429 900 cases (28.9% of total), followed by colorectal cancer (195 400, 13.1%) and by cancer of the uterus (149 300, 10%) (Table 5). With the continuous increase of early diagnosed cases, breast cancer has now become the most common form of cancer diagnosed in Europe, both sexes

**Table 4.** Estimated age-standardised mortality rates (European standard) per 100 000 by site, sex and country, 2006

Country	Stomach (C16)		Colon and rectum (C18–21)		Lung (C33–34)		Breast (C50)	Uterus (C53–55)	Prostate (C61)	All cancers (C00–97/C44)	
	M	F	M	F	M	F				M	F
	Austria	11.3	6.4	29.3	15.6	51.3				18.2	24.6
Belgium	7.7	3.0	25.2	15.4	93.8	20.7	33.5	7.3	36.9	271.9	141.5
Cyprus	11.1	5.7	19.3	14.5	60.3	9.4	22.1	6.3	17.1	198.9	115.8
Czech Republic	14.9	7.0	51.0	24.1	77.3	19.1	26.7	12.0	32.2	309.2	172.2
Denmark	6.1	3.1	30.3	24.1	57.9	41.6	34.5	7.6	36.7	242.9	196.2
Estonia	27.4	12.4	26.6	16.6	88.2	11.1	26.0	9.7	36.0	288.0	136.8
Finland	9.1	5.9	17.8	11.3	43.5	13.0	20.5	4.5	27.1	180.5	113.8
France	7.9	3.1	23.2	13.2	60.0	13.7	25.9	5.7	23.8	247.6	122.8
Germany	11.3	6.2	26.7	16.5	53.8	18.0	26.5	5.9	21.2	213.0	133.1
Greece	12.3	5.9	15.5	10.8	69.0	11.4	21.7	5.1	18.8	219.4	111.8
Hungary	21.0	8.7	54.4	26.7	110.0	34.6	30.3	11.4	24.2	364.5	187.0
Ireland	10.4	4.9	29.4	15.6	48.9	26.2	29.3	6.3	31.1	225.9	157.6
Italy	14.1	7.0	23.5	13.9	63.0	14.0	24.0	5.0	16.7	224.5	126.2
Latvia	27.5	12.0	27.7	16.8	78.7	9.1	26.4	15.3	37.6	297.3	136.6
Lithuania	28.7	11.8	28.8	15.7	74.0	8.3	25.8	17.2	32.8	289.3	140.2
Luxembourg	12.6	3.3	26.1	14.6	62.6	17.0	23.4	3.4	16.3	223.4	127.4
Malta	10.2	5.6	23.4	18.4	50.6	7.4	23.0	6.9	15.3	179.0	119.9
The Netherlands	9.5	5.1	26.3	17.4	67.0	30.6	29.8	5.4	26.0	235.7	155.8
Poland	20.4	7.4	31.5	17.4	92.0	21.8	20.9	12.5	24.3	294.5	159.1
Portugal	22.8	10.4	30.2	17.5	43.3	7.9	21.0	7.4	24.7	224.3	114.1
Slovakia	20.8	7.5	43.3	24.4	64.8	11.6	21.2	9.3	24.0	273.7	137.1
Slovenia	18.0	7.1	39.6	17.3	69.0	20.2	28.6	9.7	38.3	283.1	148.8
Spain	12.7	5.8	28.2	14.6	67.2	8.9	19.2	5.6	18.4	237.0	106.5
Sweden	7.3	4.1	20.7	15.4	29.7	23.5	21.1	6.9	36.5	173.1	137.6
United Kingdom	9.2	3.6	22.8	13.9	50.7	29.7	27.3	6.0	25.4	215.4	154.9
<b>European Union (EU25)</b>	<b>12.2</b>	<b>5.7</b>	<b>26.5</b>	<b>15.6</b>	<b>62.4</b>	<b>18.4</b>	<b>25.0</b>	<b>6.8</b>	<b>23.2</b>	<b>236.4</b>	<b>136.2</b>
Iceland	8.6	3.5	27.5	14.2	40.1	35.1	16.9	5.7	34.3	154.7	146.7
Norway	9.0	4.2	28.7	21.4	48.4	26.1	21.5	8.4	35.2	206.1	142.7
Switzerland	7.2	2.7	19.1	11.6	43.4	18.1	22.8	5.1	29.3	199.0	120.4
<b>EEA and Switzerland</b>	<b>12.1</b>	<b>5.7</b>	<b>26.4</b>	<b>15.6</b>	<b>61.9</b>	<b>18.5</b>	<b>25.0</b>	<b>6.8</b>	<b>23.4</b>	<b>235.5</b>	<b>136.0</b>
Bulgaria	18.8	8.7	26.5	15.0	58.3	9.2	20.4	14.4	15.9	199.4	114.3
Romania	23.8	9.1	23.5	14.5	66.9	12.1	23.9	19.1	16.3	244.8	134.2
Albania	40.1	14.7	7.3	9.9	84.9	22.7	21.3	5.5	29.8	278.0	153.7
Belarus	38.0	15.0	26.9	15.2	74.5	4.8	21.2	11.4	19.6	265.1	116.2
Bosnia Herzegovina	26.0	10.2	19.5	12.9	69.8	15.9	23.5	11.4	19.4	236.1	136.7
Croatia	24.1	9.5	40.7	18.1	81.3	16.1	26.3	8.9	27.0	301.9	141.2
Macedonia	25.2	10.8	26.6	14.1	61.9	7.7	26.0	12.9	14.9	219.9	125.0
Republic of Moldova	21.8	10.3	25.1	15.5	50.4	9.0	23.9	15.4	9.6	228.4	119.8
Russian Federation	38.2	15.4	30.8	19.7	75.2	8.0	29.8	13.1	16.0	271.8	135.4
Serbia and Montenegro	12.9	5.2	24.9	14.9	62.8	17.5	23.0	15.7	13.7	210.7	131.6
Ukraine	28.8	11.1	27.6	15.8	59.2	6.8	24.8	13.8	14.1	228.8	115.7
<b>Europe</b>	<b>18.1</b>	<b>8.3</b>	<b>27.3</b>	<b>16.6</b>	<b>64.8</b>	<b>15.1</b>	<b>26.0</b>	<b>9.3</b>	<b>22.2</b>	<b>244.8</b>	<b>135.4</b>

**Table 5.** Cancer cases (thousands) and *percentage* of total cancer cases in 2006

Men	Europe	EEA <sup>a</sup>	EU25
Oral cavity and pharynx (C00–14)	78.5	55.7	54.5
	4.6	4.3	4.4
Oesophagus (C15)	34.3	25.1	24.5
	2.0	1.9	2.0
Stomach (C16)	96.1	50.6	49.6
	5.6	3.9	4.0
Colon and rectum (C18–21)	217.4	168.3	163.1
	12.8	13.1	13.0
Liver (C22)		34.1	33.6
		2.7	2.7
Pancreas (C25)		30.7	29.7
		2.4	2.4
Larynx (C32)	42.1	27.6	27.1
	2.5	2.1	2.2
Lung (C33–34)	292.2	198.1	194.4
	17.2	15.4	15.5
Melanoma of skin (C43)		28.7	27.6
		2.2	2.2
Prostate (C61)	345.9	311.1	301.5
	20.3	24.2	24.1
Kidney (C64)		40.1	39.4
		3.1	3.1
Bladder (C67)		85.0	82.8
		6.6	6.6
Non-Hodgkin's lymphoma (C82–85, C96)		40.6	39.6
		3.2	3.2
Leukaemia (C91–95)	44.8	34.8	33.8
	2.6	2.7	2.7
All cancers but nonmelanoma skin (C00–97/C44)	1701.8	1285.4	1252.0
	100.0	100.0	100.0
Women	Europe	EEA <sup>a</sup>	EU25
Oral cavity and pharynx (C00–14)	23.1	16.2	15.7
	1.6	1.5	1.5
Oesophagus (C15)	10.7	8.3	8.1
	0.7	0.8	0.8
Stomach (C16)	63.8	31.0	30.5
	4.3	2.9	2.9
Colon and rectum (C18–21)	195.4	138.7	134.1
	13.1	13.0	12.9
Liver (C22)		14.6	14.4
		1.4	1.4
Pancreas (C25)		29.2	28.5
		2.7	2.7
Larynx (C32)	3.8	2.8	2.7
	0.3	0.3	0.3
Lung (C33–34)	94.1	73.5	71.2
	6.3	6.9	6.9
Melanoma of skin (C43)		33.3	32.1
		3.1	3.1
Breast (C50)	429.9	328.6	319.9
	28.9	30.8	30.9
Uterus (C53–55)	149.3	84.9	82.5
	10.0	8.0	8.0
Ovary (C56)		41.9	40.6
		3.9	3.9
Kidney (C64)		24.4	24.0
		2.3	2.3

**Table 5.** (Continued)

Bladder (C67)		22.3	21.6
		2.1	2.1
Non-Hodgkin's lymphoma (C82–85, C96)		34.2	33.2
		3.2	3.2
Leukaemia (C91–95)	36.5	26.6	25.9
	2.5	2.5	2.5
All cancers but nonmelanoma skin (C00–97/C44)	1489.7	1065.7	1036.1
	100.0	100.0	100.0
Both sexes	Europe	EEA <sup>a</sup>	EU25
Oral cavity and pharynx (C00–14)	101.6	71.9	70.2
	3.2	3.1	3.1
Oesophagus (C15)	45.0	33.3	32.6
	1.4	1.4	1.4
Stomach (C16)	159.9	81.6	80.1
	5.0	3.5	3.5
Colon and rectum (C18–21)	412.9	307.0	297.2
	12.9	13.1	13.0
Liver (C22)		48.7	48.0
		2.1	2.1
Pancreas (C25)		59.9	58.1
		2.5	2.5
Larynx (C32)	45.9	30.4	29.9
	1.4	1.3	1.3
Lung (C33–34)	386.3	271.6	265.6
	12.1	11.6	11.6
Melanoma of skin (C43)		62.0	59.7
		2.6	2.6
Breast (C50)	429.9	328.6	319.9
	13.5	14.0	14.0
Uterus (C53–55)	149.3	84.9	82.5
	4.7	3.6	3.6
Ovary (C56)		41.9	40.6
		1.8	1.8
Prostate (C61)	345.9	311.1	301.5
	10.8	13.2	13.2
Kidney (C64)		64.5	63.3
		2.7	2.8
Bladder (C67)		107.4	104.4
		4.6	4.6
Non-Hodgkin's lymphoma (C82–85, C96)		74.8	72.8
		3.2	3.2
Leukaemia (C91–95)	81.3	61.4	59.7
	2.5	2.6	2.6
All cancers but nonmelanoma skin (C00–97/C44)	3191.6	2351.0	2288.1
	100.0	100.0	100.0

<sup>a</sup>EEA plus Switzerland: 25 EU countries plus Iceland and Norway.

Europe: EEA plus Albania, Belarus, Bosnia Herzegovina, Bulgaria, Croatia, Macedonia, Moldova, Romania, Russian Federation, Serbia and Montenegro and Ukraine.

EEA, European Economic Area; EU, European Union.

combined (Figure 1). Similarly, following the widely use of prostate-specific antigen (PSA) tests, prostate cancer is now the most frequent cancer diagnosed in men (345 900, 20.3% of the total), followed by lung cancer (292 200, 17.2%) and colorectal (217 400, 12.8% of the total) cancers (Table 5).

Overall, 1.7 million cancer deaths are estimated in Europe in 2006. The most common cause of cancer death in Europe in

**Table 6.** Cancer deaths (thousands) and *percentage* of total cancer deaths in 2006

	Europe	EEA <sup>a</sup>	EU25
<b>Men</b>			
Oral cavity and pharynx (C00–14)	33.7	19.9	19.5
	3.5	3.0	3.0
Oesophagus (C15)	29.3	21.5	21.1
	3.1	3.2	3.2
Stomach (C16)	70.4	34.6	34.0
	7.4	5.2	5.2
Colon and rectum (C18–21)	107.6	76.2	74.5
	11.3	11.4	11.4
Liver (C22)		28.2	27.8
		4.2	4.2
Pancreas (C25)		32.5	31.7
		4.9	4.8
Larynx (C32)	19.2	10.2	10.1
	2.0	1.5	1.5
Lung (C33–34)	253.3	175.2	171.9
	26.6	26.2	26.3
Melanoma of skin (C43)		7.5	7.2
		1.1	1.1
Prostate (C61)	87.4	70.3	67.8
	9.2	10.5	10.4
Kidney (C64)		16.5	16.2
		2.5	2.5
Bladder (C67)		27.6	27.1
		4.1	4.1
Non-Hodgkin's lymphoma (C82–85, C96)		17.6	17.1
		2.6	2.6
Leukaemia (C91–95)	29.3	21.9	21.5
	3.1	3.3	3.3
All cancers but nonmelanoma skin (C00–97/C44)	952.4	668.9	654.2
	100.0	100.0	100.0
<b>Women</b>			
Oral cavity and pharynx (C00–14)	8.6	5.9	5.8
	1.2	1.1	1.1
Oesophagus (C15)	9.2	7.2	7.1
	1.2	1.4	1.4
Stomach (C16)	47.8	23.7	23.4
	6.4	4.5	4.6
Colon and rectum (C18–21)	99.9	66.5	64.9
	13.3	12.7	12.7
Liver (C22)		15.1	14.9
		2.9	2.9
Pancreas (C25)		33.2	32.3
		6.3	6.3
Larynx (C32)	1.8	1.3	1.3
	0.2	0.2	0.2
Lung (C33–34)	81.5	65.8	64.1
	10.9	12.6	12.5
Melanoma of skin (C43)		6.3	6.0
		1.2	1.2
Breast (C50)	131.9	87.2	85.3
	17.6	16.7	16.7
Uterus (C53–55)	46.6	24.2	23.6
	6.2	4.6	4.6
Ovary (C56)		29.2	28.5
		5.6	5.6
Kidney (C64)		10.4	10.2
		2.0	2.0

**Table 6.** (Continued)

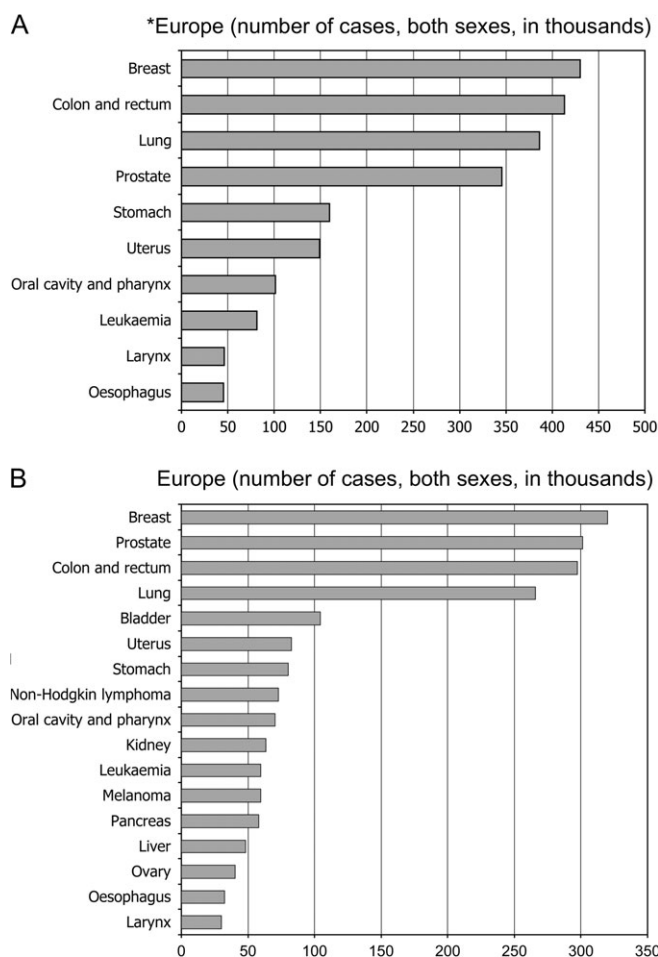
Bladder (C67)		9.7	9.4
		1.9	1.8
Non-Hodgkin's lymphoma (C82–85, C96)		16.3	15.9
		3.1	3.1
Leukaemia (C91–95)	25.1	18.2	17.9
	3.3	3.5	3.5
All cancers but nonmelanoma skin (C00–97/C44)	750.6	523.6	511.3
	100.0	100.0	100.0
<b>Both sexes</b>			
	Europe	EEA <sup>a</sup>	EU25
Oral cavity and pharynx (C00–14)	42.4	25.8	25.3
	2.5	2.2	2.2
Oesophagus (C15)	38.5	28.8	28.2
	2.3	2.4	2.4
Stomach (C16)	118.2	58.4	57.5
	6.9	4.9	4.9
Colon and rectum (C18–21)	207.4	142.7	139.4
	12.2	12.0	12.0
Liver (C22)		43.3	42.6
		3.6	3.7
Pancreas (C25)		65.7	64.0
		5.5	5.5
Larynx (C32)	21.0	11.5	11.4
	1.2	1.0	1.0
Lung (C33–34)	334.8	241.0	236.0
	19.7	20.2	20.2
Melanoma of skin (C43)		13.8	13.2
		1.2	1.1
Breast (C50)	131.9	87.2	85.3
	7.7	7.3	7.3
Uterus (C53–55)	46.6	24.2	23.6
	2.7	2.0	2.0
Ovary (C56)		29.2	28.5
		2.4	2.4
Prostate (C61)	87.4	70.3	67.8
	5.1	5.9	5.8
Kidney (C64)		26.9	26.4
		2.3	2.3
Bladder (C67)		37.3	36.5
		3.1	3.1
Non-Hodgkin's lymphoma (C82–85, C96)		33.9	33.0
		2.8	2.8
Leukaemia (C91–95)	54.4	40.2	39.4
	3.2	3.4	3.4
All cancers but nonmelanoma skin (C00–97/C44)	1703.0	1192.6	1165.5
	100.0	100.0	100.0

<sup>a</sup>EEA plus Switzerland: 25 EU countries plus Iceland and Norway.

Europe: EEA plus Albania, Belarus, Bosnia Herzegovina, Bulgaria, Croatia, Macedonia, Moldova, Romania, Russian Federation, Serbia and Montenegro and Ukraine.

EEA, European Economic Area; EU, European Union.

2006 is lung cancer (334 800), which accounts for one-fifth of the total number of cancer deaths. Colorectal cancer (207 400, 12.2% of total deaths) was the second major cause of cancer death (almost equally distributed between sexes), followed by breast cancer (131 900, 7.8%), which now ranked higher than stomach cancer (118 200, 6.9%) (Figure 2).



**Figure 1.** Estimated incidence of cancer in Europe and European Union, 2006. \*No data for Europe for all the individual sites due to limitations of coding scheme employed.

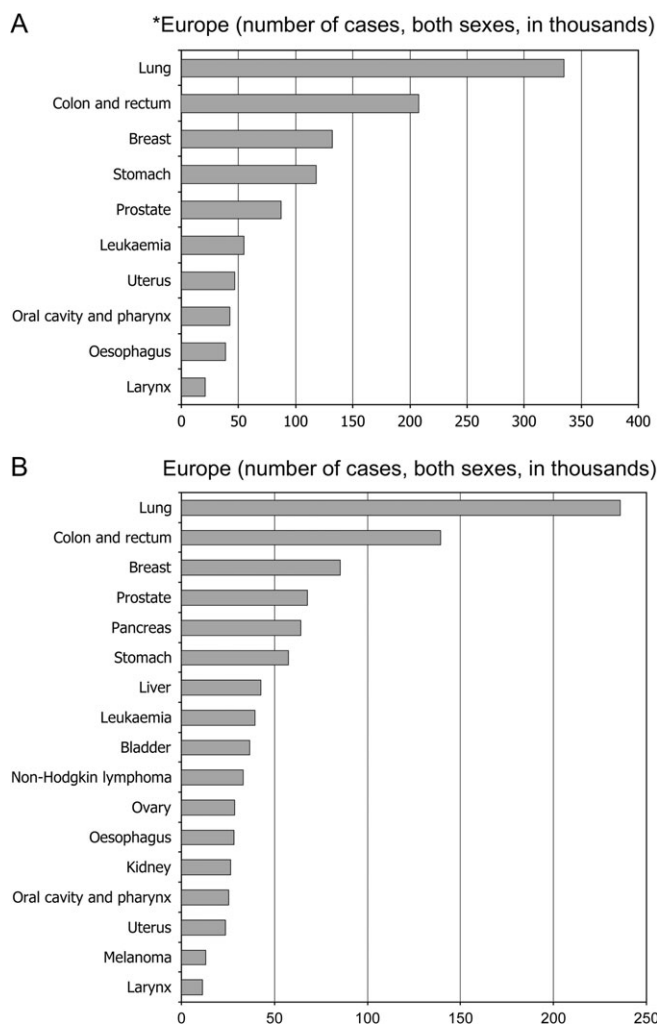
### European Union (EU25)

In the EU, there were over two million (2 288 100) incident cases of cancer in 2006 and over one million cancer deaths (1 165 500).

Prostate cancer was the commonest form of cancer in men (301 500 incident cases, 24.1% of all incident cases) followed by lung cancer (194 400, 15.5%) and colorectal cancers (163 100 cases, 13.0%) (Table 5). In women, breast cancer was by far the most common form of cancer (319 900 cases, 30.9% of all incident cases) while colorectal cancer was second (134 100, 12.9%). There were 82 500 (8.0%) cases of uterus cancer and 71 200 (6.9%) incident cases of lung cancer (Table 5).

Lung cancer continued to be the most common causes of cancer death in men with 171 900 deaths estimated in 2006 (26.3% of all cancer deaths). Although less common than in men, it is the third cause of death from cancer in women (64 100, 12.5% of total deaths), with high rates observed in Northern and Central Europe. In Denmark, Sweden, The Netherlands, Poland and UK it has now become the first cause of death from cancer (Table 4).

In men, colorectal cancer was the second most common form of cancer death (74 500, 11.4%) followed by prostate

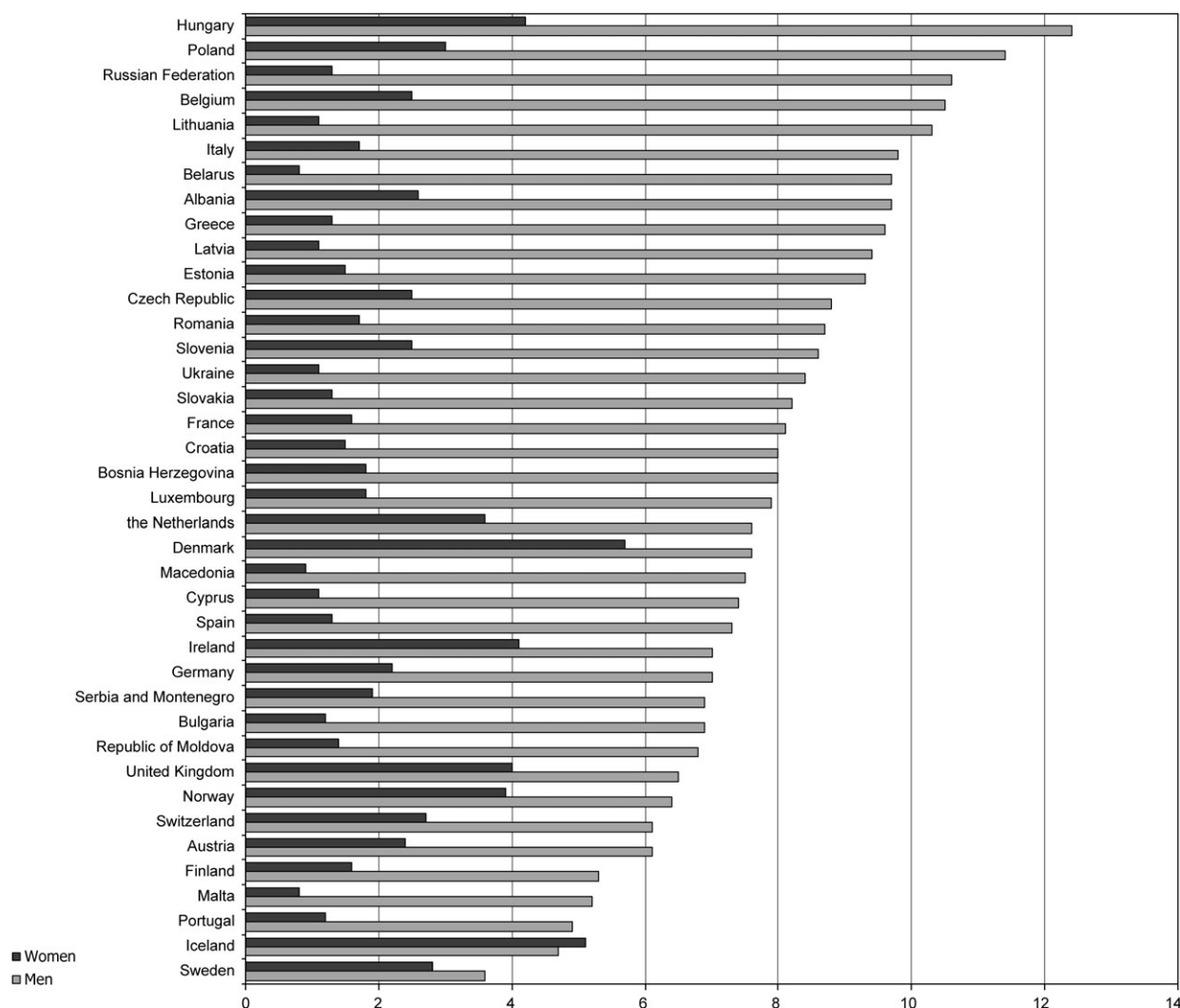


**Figure 2.** Estimated mortality from cancer in Europe and European Union, 2006. \*No data for Europe for all the individual sites due to limitations of coding scheme employed.

cancer (67 800, 10.4%) (Table 6). In women, breast cancer was ranked the leading cause of cancer death (85 300, 16.7%), then colorectal cancer (64 900, 12.7%) closely followed by lung cancer (64 100, 12.5%) (Table 6).

### discussion

This study provides updated estimates of the burden of cancer in Europe. Several sources of information and different methods have been used to generate these statistics. The predictions of the national incidence rates have been calculated for half of the European countries, which represent only 28% of the total European population. For the others, it was necessary to estimate incidence from the predicted national mortality and projected incidence; mortality ratios of aggregated data from either regional cancer registries or neighbouring countries. The inclusion of non-invasive tumours of the bladder in cancer registry files, and the early detection of breast and prostate cancers leads to overestimation of the overall incidence of these



**Figure 3.** Cumulative lifetime (age 0–74 years) risk (percent) of lung cancer in men and women in Europe.

cancers in some countries. With respect to mortality, the inclusion of metastatic cancers along with primary neoplasms of the liver, the difficulties in certifying the cause of death and the differences in coding the underlying cause of death are well-identified sources of error and bias [39]. However, despite the provisos about data quality for some sites, the general patterns of cancer in Europe are clearly established, and with the data presented herein, it is possible to define the priorities for cancer control actions in Europe.

Lung cancer retains its status of the leading cause of cancer death in Europe in 2006 (Figure 2). The overwhelming majority of lung cancer is caused by tobacco smoking [40, 41] and tobacco control is clearly a number one priority in the EU, not only aimed at men, particularly the male populations of Central and Eastern Europe, but also increasingly targeted towards women, especially in Northern Europe (Figure 3).

Colorectal cancer is the second most common cause of cancer death in both men and women [42]. There remains hope that dietary modification, increased physical activity and avoidance of obesity could lead to reductions in the incidence

and mortality from colorectal cancer. Progress, however, has been very slow; the number of deaths from colorectal cancers has increased by 1.8% since our previous 2004 estimates (203 700 deaths). Screening for colorectal cancer has been shown to be effective [43, 44], and clearly there is a need for organised colorectal cancer screening programmes throughout Europe.

Breast cancer is the leading cause of death from cancer in women in Europe. A fall in breast cancer mortality rates in most European countries in the 1990s was reported by several studies [45, 46]. These declines have been attributed to the combined effect of earlier detection and improving treatment, but it was observed mainly in young women, and because of the ageing of the European population the number of deaths from breast cancer is still rising (130 000 in 2004, 132 000 in 2006). The introduction of organised mammography screening programmes throughout Europe will lead to a reduction in breast cancer mortality [47] but will have the short-term consequence of increasing the incidence (which has risen by 16% since our latest 2004 estimates). The maximum effect will

be derived from programmes with effective quality-control procedures in place.

The decline in mortality rates from stomach cancer in both men and women throughout Europe is generally attributed to improved food preservation, better nutrition and better control of *Helicobacter pylori* infection. Higher incidence and mortality rates are still recorded in Eastern European countries (Tables 5 and 6), possibly reflecting a lower level of affluence, a diet lower in fresh fruits and vegetables and higher rates of *H. pylori* infection.

The recording of prostate cancer on death certificates and its selection as the underlying cause of death remains a challenge for descriptive epidemiology [48]. Prostate cancer (345 900 cancer cases, 87 400 deaths in Europe) is a disease predominantly affecting elderly men, and, despite the widespread use of PSA testing in many European countries, the number of deaths from prostate cancer has increased by around 16% since 1995 due in large measure to the rapid increase in the numbers of men reaching older ages.

In European women, the number of deaths from cancer of the uterus (46 600) is considerably lower as compared with the number of deaths from breast (131 900), colorectal (99 900) or lung (81 500) cancers (Table 6). There is, however, a large difference in the risk of dying from uterine cancers between Eastern (and Baltic) European and other European countries (Table 4), and the number of years of life lost could be reduced in women living in Eastern European countries if efficient national cervical cancer screening programmes were in place.

Thankfully, stomach cancer incidence and mortality are declining throughout Europe, in both men and women [6]. Lung cancer incidence and mortality will be reduced by effective tobacco control and while there has been substantial progress in men in Europe, the situation in women, particularly young women, is cause for concern. Furthermore, the situation differs greatly between Northern Europe and Central and Eastern Europe and these regions of Europe should be a special target for tobacco control.

These are among the key recommendations of the recently revised European Code Against Cancer, which provides a public health roadmap for cancer risk reduction in Europe [49].

The increased burden of cancer incidence in Europe from 2004 (2.9 million) to 2006 (3.2 million), although partly due to differences in the estimation methods, demonstrates the impact of the ageing of the European population and underlines the necessity of taking urgent action on Cancer Control in Europe.

A final reminder that the figures provided here are estimates, albeit using the most up-to-date available data on incidence and mortality. The statistical approach taken maximises the value of the available data to provide these estimates. More precise estimates will be available when more population-based data are available from the next volume of 'Cancer Incidence in Five Continents', due in 2007.

It, however, requires complete national coverage in all European countries to be sure of the accuracy of the statistics. Improved cancer registration with increased population coverage at member state level is an essential component for evidence-based decision making within the European Commission.

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