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Cancer prevalence estimates in Europe at the beginning of 2000

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Background: Complete cancer prevalence data in Europe have never been updated after the first estimates provided by the EUROPREVAL project and referred to the year 1993. This paper provides prevalence estimates for 16 major cancers in Europe at the beginning of the year 2003.

Patients and methods: We estimated complete prevalence by the completeness index method. We used information on cancer patients diagnosed in 1978–2002 with vital status information available up to 31 December 2003, from 76 European cancer registries.

Results: About 11.6 millions of Europeans with a history of one of the major considered cancers were alive on 1 January 2003. For breast and prostate cancers, about 1 out of 73 women and 1 out of 160 men were living with a previous diagnosis of breast and prostate cancers, respectively. The demographic variations alone will increase the number of prevalent cases to nearly 13 millions in 2010.

Conclusions: Several factors (early detection, population aging and better treatment) contribute to increase cancer prevalence and push for the need of a continuous monitoring of prevalence indicators to properly plan needs, resource allocation to cancer and for improving health care programs for cancer survivors. Cancer prevalence should be included within the EU official health statistics.

Key words: aging, cancer, cancer registry, Europe, prevalence

introduction

Cancer prevalence is defined as the number or proportion of individuals in a population living with cancer at a given point in time. Thus, it helps us to quantify the demand for health care services. Cancer prevalence is important for planning the provision of health and oncological services after the first-line treatment. It gives information on the need for treatment of subsequent disabilities, psychosocial care, continuing medical consultations, clinical follow-ups for recurrences and second cancers and for long-term counseling. Prevalence is not routinely provided by population-based cancer registries (CRs), since observed data allow to estimate only the number of most recently diagnosed prevalent cases, whose completeness depends on the length of the registration activity. Complete prevalence can be estimated on the basis of its mathematical relationship with incidence and survival [1–7].

In 2002, the EUROPREVAL project gave prevalence estimates [8] for Europe at the end of 1992. No updates were subsequently provided and no comprehensive evaluation is still possible of the impact on the prevalence of several important changes in cancer care occurred after the early 1990s in European countries: the diffusion of cervical and breast screenings, the spread of prostate cancer early diagnosis, the introduction into clinical practice of biologically targeted therapies, the development and application of national or regional cancer plans, including primary prevention measures. The aim of this paper is to present prevalence estimates for the common cancers in Europe. Since prevalent cancer cases are a highly heterogeneous group in terms of quality and life expectancy, both complete and limited-duration prevalence estimates will be provided.

materials and methods

We estimated complete prevalence by the completeness index method [9]. This approach is based on an estimate of limited-duration prevalence obtained from observed CR data, to which an appropriate coefficient (the completeness index) is applied to calculate the complete prevalence, i.e. the prevalence irrespective of the time elapsed since the cancer diagnosis. The set of applied completeness indices was modeled from CR incidence and survival data, and derives from the Surveillance of rare cancers in Europe

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(RARECARE) project [10], a study aimed to provide a list of rare cancers as well as incidence, prevalence and survival indicators for rare cancers in Europe. The RARECARE project estimated the completeness indices for 259 cancer entities (rare and common and defined by topography and morphology) on the basis of a subset of the CR participating to EUROCARE-4 (see appendix). In this paper, we applied the corresponding completeness indices to the observed prevalence of a group of RARECARE cancer entities. Subsequently we aggregated those entities by anatomical site in order to obtain the complete prevalence of 16 major cancers at the index date of 1 January 2003. Due to the particular definition of RARECARE entities, only epithelial cancers were included, the great majority of cancers diagnosed in the considered sites.

cancer patients and cancer definition

We used information on cancer patients diagnosed in 1978–2002 and with vital status information available up to 31 December 2003, from 76 CRs participating in the RARECARE project [10]. The data were checked for errors, inconsistencies or unusual combinations of site, morphology, sex and age at diagnosis [11] according to the standard EUROCARE procedures. Only a negligible proportion (0.14%) of cases had major errors and were excluded [11].

We considered 16 cancers (Table 1) defined according to the ICDO-3 topography and morphology classifications [10]. We selected for each site only epithelial cancers (Table 1, last column). A more restrictive definition was used for skin, where only melanomas were included. Only the first primary of each cancer was considered so that we estimated the prevalence of *persons* with cancer and not the prevalence of *cancers*. Table 1 presents, for each cancer, the number of epithelial incident cases included in the analysis and their percentage on the total incident cases of the same site. Epithelial cancers (Table 1, 4th column) were the great majority of diagnoses for each site, from a minimum of 92% for corpus uteri to 99.9% for prostate. Skin melanoma accounts for ~20% of all skin cancers collected by the participating CR. Table 1 reports also some of the basic data quality indicators. The proportion of cases based on death certificate only (DCO) per each cancer ranged from 0.7% (skin melanoma) to 8.7% (pancreas). The proportion of cases microscopically verified varied between 47.5% (pancreas) and 97.3% (skin melanoma).

the observed and complete prevalence

The counting method [12] was applied to 22 CRs representing 12 European countries, which covered the period 1988–2002, to obtain the observed prevalence of cases by duration (within 2, 5, 15 years) at the reference date (1 January 2003). The 22 CRs were: Amsterdam (The Netherlands), Austria, Cracow (Poland), East Anglia, Northern and Yorkshire, Oxford, Wales and West Midlands (UK), Firenze, Modena, Parma, Ragusa, Romagna (Italy), Geneva, St. Gallen (Switzerland), Iceland, Norway, Saarland (Germany), Scotland, Slovakia, Slovenia and Sweden. No French and Spanish registries could be included because none of them could provide incidence data updated till the beginning of 2003. Overall, 4 302 067 cancer cases were used to produce the observed prevalence. Cases lost to follow-up before the end of the year 2000 were also included in the count, estimating their survival probability up to the reference date from the life tables of patients successfully followed-up, and matched by age class, sex and study period. SEER*STAT software was used for the calculation.

Complete cancer prevalence is the number (or proportion) of people in a given population, at a given point in time, alive after a diagnosis of cancer made previously. Complete prevalence can be written as:

$$N_C = N_O + N_U,$$

where N_O is the prevalence at the reference date of incident cases observed during the registration time, and N_U is the number of cases who were diagnosed before the start of the registration and are expected to be alive at the same reference date, the so-called 'unobserved' prevalence. Complete prevalence can be estimated, after modeling incidence and survival data, as follows:

$$N_C(x) = N_O(x;L) + N_U = \int_{x-L}^{x} I(t)\cdot S(t, x-t)dt + \int_{0}^{x} I(t)\cdot S(t, x-t)dt,$$

where $I(t)$ is the cancer incidence at age t, $S(t, x-t)$ is the relative survival at age x for a person who has received a cancer diagnosis at age t and L is the length of the registration period. The ratio between the observed and the complete prevalence for a specific cancer, age class x and duration of registration activity L, is the completeness index [9], i.e. a corrective factor which leads from the L-year observed prevalence to the complete prevalence:

$$R(x;L) = \frac{N_O(x;L)}{N_C(x)}.$$

Thus, the complete prevalence can be obtained adjusting the L-year observed prevalence by the completeness index $R(x;L)$ according to the previous relation:

$$N_C(x) = \frac{N_O(x;L)}{R(x;L)}.$$

In this work, the completeness index was obtained by modeling incidence rates (only primary cancers) in the period 1985–1999 and relative survival data (excluding second and subsequent primaries) of patients diagnosed between 1988 and 1999 and followed-up at least to the end of 2003. Data from 25 CRs [(Albacete, Castellon, Girona (Spain), Alto Adige, Biella, Ferrara, Friuli, Genova, Napoli, Palermo, Reggio Emilia, Salerno, Sassari, Trento, Umbria, Veneto (Italy), Basel, Ticino, (Switzerland), North Netherlands, Eindhoven, Stedendriehoek-Twente, (the Netherlands), Flanders (Belgium), Kielce (Czech Republic), Northern Ireland, Warsaw (Poland)] were used for the incidence modeling. Data from 24 CRs [(Bas Rhin, Basel, Calvados, Calvados digestive, Côte d'Or digestive, Côte d'Or haematological, Doubs, Haut Rhin, Isère, Somme, Tarn (France), Eindhoven (the Netherlands), Genova, Varese, Veneto (Italy), Grisons, Zurich, Valais (Switzerlands) South West, Trent (UK), Tarragona, Navarra, Basque Country (Spain) Warsaw (Poland)] were considered for survival modeling.

We tested two alternative models for incidence data (the polynomial and the exponential model), while survival data were modeled by using the 'cure-model'.

Survival and incidence data were calculated by using the SEER*Stat software and the parameters of the models were estimated with the SAS software. More details on the whole estimation process can be found in previous publications [8, 12]. The vector of estimated incidence and survival model parameters as well as the corresponding elements of the estimated covariance matrix provided the information needed by the COMPREV software [13] for the estimation of the completeness index.

The completeness index was then used as a corrective factor which leads from the 15-year observed prevalence to the complete prevalence at the index date of 1 January 2003.

The expected number of prevalent cases in Europe at 2010 was estimated projecting by age class the complete prevalence proportions to the EU27 population provided by EUROSTAT [14] at 2010 (501.1 million).

results

Observed prevalence by duration and complete prevalence by cancer entity in EU27 are presented in Table 2. The proportion of prevalent cases having a diagnosis of cancer within 2 years from the reference date, over all the prevalent cases, varied greatly: from 14% (skin melanoma) to 59% (pancreas). The proportion of patients still alive >15 years since the diagnosis

Table 1. Quality indicators of common tumors. Cases diagnosed in 76 RARECARE cancer registries in 1995–2002

Cancer site	Number of malignant cancers			DCO	MV	Topography code	Morphology code
	N	*N* (epithelial only)	%	%	%		
Epithelial tumors of							
Head and neck	135 122	129 948	96.2	1.6	94.0	C00–C14, C30, C31, C32	8000, 8001, 8004, 8010, 8011, 8020–8022, 8032, 8050–8076, 8078, 8082–8084, 8123, 8144, 8560, 8980
Esophagus	62 160	61 258	98.5	3.6	86.5	C15	8000–8001, 8004, 8010–8011, 8020–8022, 8032, 8035, 8050–8076, 8078,
Stomach	158 642	151 482	95.5	4.5	86.2	C16	8082–8084, 8123–8124, 8140–8145, 8147, 8160–8162, 8170–8175, 8180,
Colon–rectum–anal canal	503 245	497 843	98.9	2.6	89.4	C18-C21	8190, 8200–8201, 8210–8211, 8214–8215, 8220–8221, 8230–8231, 8255,
Pancreas	97 621	95 608	97.9	8.7	47.5	C25	8260–8263, 8290, 8310, 8315, 8320, 8323, 8333, 8380–8384, 8401, 8430,
Liver and intrahepatic bile tract (IBT)	51 529	50 558	98.1	8.0	56.1	C22	8440–8441, 8450, 8452–8453, 8470, 8480–8482, 8490, 8500, 8503–8504,
Gallbladder and extrahepatic biliary duct (EBT)	36 104	35 824	99.2	6.3	66.2	C23, C24	8510, 8512, 8514, 8525, 8542, 8550–8551, 8560, 8562, 8571–8576, 8980
Lung and trachea	456 222	454 816	99.7	5.1	75.0	C33, C34	8000–8001, 8004, 8010–8014, 8020–8022, 8031–8032, 8034, 8041–8046, 8050–8084, 8123, 8140–8141, 8143, 8144, 8147, 8190, 8200–8201, 8210–8211, 8221, 8230, 8231, 8240–8246, 8249–8254 8255, 8260–8263, 8290, 8310, 8315, 8320, 8323, 8333, 8380–8384, 8430, 8440–8441, 8460, 8470, 8480–8482, 8490, 8504, 8510, 8512, 8514, 8525, 8542, 8550–8551, 8560, 8562–8576, 8980, 8982
Breast	524 433	522 239	99.6	1.6	92.8	C50	8000–8001, 8010–8011, 8022, 8070, 8140–8141, 8143, 8147, 8190, 8200–8201, 8210–8211, 8221, 8230–8231, 8255, 8260–8263, 8290, 8310, 8314–8315, 8320, 8323, 8333, 8380–8384, 8401, 8430, 8480–8482, 8490, 8500–8504, 8508, 8510, 8512–8514, 8520–8525, 8530, 8540–8541, 8543, 8550–8551, 8560, 8562, 8570–8576, 8982
Corpus uteri	92 039	84 479	91.8	1.9	93.9	C54	8000, 8001, 8010, 8011, 8015, 8020–8022, 8032, 8050–8084, 8120, 8122,
Cervix uteri	49 878	49 303	98.8	1.2	95.1	C53	8123, 8140–8141, 8143, 8144, 8147, 8190, 8200, 8201, 8210–8211, 8221,
Ovary and fallopian tube	80 449	75 797	94.2	3.6	84.9	C56.9, C57.0–C57.3	8230, 8231, 8255, 8260–8263, 8290, 8310, 8313, 8315, 8320, 8323, 8333, 8380–8384, 8430, 8440–8463, 8470–8490, 8504, 8510, 8512, 8514, 8525, 8542, 8550–8551, 8560, 8562–8576, 9000, 9014–9015, 9110
Kidney	87 752	85 814	97.8	3.4	78.7	C64	8000–8001, 8010–8011, 8020, 8022, 8030–8035, 8050–8084, 8090, 8094,
Bladder	163 162	162 162	99.4	1.6	90.6	C67	8120, 8122, 8123, 8130–8131, 8140–8141, 8143, 8147, 8190, 8200, 8201,
Prostate	387 318	386 834	99.9	2.2	88.7	C61, C637	8210–8211, 8221, 8230–8231, 8255–8263, 8290, 8310, 8312, 8315–8320, 8323, 8333, 8380–8384, 8401, 8430, 8440, 8480–8490, 8500, 8503–8504, 8510–8512, 8514, 8525, 8542, 8550–8551, 8560–8576, 8980
Malignant skin melanoma	509 768	100 535	19.7	0.7	97.3	C44	8720–8780

DCO, death certificate only; MV, microscopic verification.

Table 2. Limited-duration prevalence by duration (2, 5, 15 years), complete prevalence (per 100 000) at 1 January 2003, prevalent cases in Europe at 2003 and cases in Europe at 2010 due to the 2003-2010 demographic changes, by cancer

Cancer site	Limited-duration prevalence						Complete prevalence 1 January 2003		Prevalent cases in Europe at 2003	Effect of 2003–2010 demographic changes
	2-year		5-year		15-year					
	Prev.	SE	Prev.	SE	Prev.	SE	Prev.	SE	Cases	Cases[a]
Epithelial tumors of										
Head and neck	21.7	0.2	44.1	0.3	81.5	0.4	106.7	0.3	519 026	577 230
Esophagus	6.2	0.1	8.5	0.1	11.1	0.1	12.2	0.2	59 444	66 131
Stomach	13.7	0.1	23.5	0.2	41.8	0.3	49.1	0.3	238 998	246 099
Colon–rectum–anal canal	86.5	0.4	173.9	0.5	309.4	0.7	369.4	1.7	1 797 572	2 035 198
Pancreas	4.9	0.1	6.1	0.1	7.7	0.1	8.4	0.1	40 637	45 343
Liver and intrahepatic bile tract (IBT)	3.1	0.1	4.4	0.1	5.5	0.1	5.7	0.1	27 785	30 471
Gallbladder and extrahepatic biliary duct (EBT)	2.5	0.1	3.9	0.1	6.2	0.1	6.9	0.1	33 376	37 425
Lung and trachea	37.4	0.2	54.2	0.3	77.2	0.3	86.5	0.2	421 166	464 994
Female breast	235.1	0.4	523.1	0.6	1033.7	0.9	1376.8	0.2	3 436 040	3 763 070
Corpus uteri	38.3	0.2	84.3	0.3	183.0	0.4	263.6	0.6	657 925	722 295
Cervix uteri	19.2	0.1	43.7	0.2	115.1	0.3	210.1	0.7	524 256	565 223
Ovary and fallopian tube	23.7	0.1	45.6	0.2	87.1	0.3	118.6	0.4	296 103	321 055
Kidney	14.7	0.2	30.6	0.2	58.1	0.3	73.6	0.4	357 968	396 573
Bladder	26.4	0.2	56.5	0.3	116.1	0.4	147.8	0.6	719 106	815 019
Prostate	206.2	0.4	410.1	0.6	596.2	0.7	625.7	1.4	1 483 458	1 744 019
Malignant skin melanoma	27.9	0.2	59.3	0.3	123.8	0.4	203.3	0.9	989 424	1 088 031

[a]Cases are calculated applying the 2003 complete prevalence proportion to the 2010 EU (27) population distribution by age.
Prev., Prevalence per 100,000; SE, Standard Error.

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was the highest for women with cervix uteri (45%) and corpus uteri (31%) cancers, and for persons with skin melanoma (39%). Among all the considered cancers, most of the 15-year survivors had a diagnosis of epithelial cancers of breast and malignant skin melanoma, with slightly more than 850 000 and 380 000 prevalent cases in Europe, at 2003, respectively. The last column of Table 2 shows the projected prevalence in the year 2010 taking into account the demographic changes of the population and assuming constant prevalence proportions between 2003 and 2010. The comparison between the last two columns of Table 2 shows that we expect an 11% increase of the total number of prevalent cases, due to the demographic changes between the two time points.

Table 3 shows complete prevalence at 1 January 2003 for the considered cancer entities by age class. Prevalence was maximum at ages 75+ for epithelial tumors of stomach (22), colorectal (172), pancreas (3), gallbladder and EBT (3), corpus uteri (107), bladder (72). For epithelial tumors of prostate, the highest prevalence proportions were 313 and 237 among 55–74 and 75–84 aged men, respectively. Among young adults (<45 years), the most frequent prevalent cancers were breast (61 per 100 000), cervix uteri (37 per 100 000) and melanoma (29 per 100 000). Among 45–64 aged people, breast cancer was the most common cancer with 531 per 100 000 women.

discussion

In this paper, we report the complete prevalence at 2003 in Europe for the most common cancers. All together they represent the majority (77%) of all malignant cancers [15]. Breast, prostate and colorectal cancers accounted for more than one half of the prevalence of all the cancers studied in this paper. By contrast, lung cancer accounted for 4% of the prevalence of all the cancer entities considered in this analysis, with an estimated incidence/prevalence ratio of 0.7 [10]. Other cancers with a poor prognosis revealed a low incidence/prevalence ratio as well: pancreas (1.4), liver and IBT (1.1), and gallbladder and EBT (0.6). For cancers with a better prognosis (head and neck, colorectum, ovary, kidney, bladder and prostate), the prevalence was six to seven times higher than the corresponding incidence. For breast, corpus and cervix uteri, and skin melanoma, prevalent cases were even more than 10-fold than incidence cases [10]. It should be noted that, in skin melanoma and cervix uteri, also the young age at diagnosis contributed to increase the number of prevalent cases.

These results come as an extension to the most common cancer entities of prevalence analysis carried out for rare tumors in the framework of the RARECARE project. The completeness index for the estimation of complete prevalence of rare tumors was there derived, due to the small number of cases and to coding changes, without consideration of time trends in incidence models. The same limitation holds for the prevalence estimates presented in this paper. Validation analyses (manuscript in preparation) have shown that such approximation is likely to lead to a maximum 10% overestimation of complete prevalence for cancer entities with increasing incidence (of breast, skin melanoma or prostate) and to a similar underestimation for cancer entities with decreasing incidence (of cervix uteri, stomach or male lung) [16].

In order to keep prevalence estimates as much as possible based on the observed data, we included in the analysis only 22 CRs with ≥15 years of activity up to the year 2003. They represent 12% of the total European population [11]. In the United States, the measures of prevalence utilized for planning health care services were based on SEER CRs, covering in 2009 28% of the US population [17]. However, all the European regions are represented: the North of Europe by the national

Table 3. Complete prevalence (per 100 000) at 1 January 2003 and prevalent cases in Europe at 2003, by cancer site and age

Cancer site	Complete prevalence by age											
	0–44 years			45–64 years			65–74 years			75+ years		
	Prev.	SE	Cases	Prev.	SE	Cases	Prev.	SE	Cases	Prev.	SE	Cases
Epithelial tumors of												
Head and neck	4.6	0.1	22 316	37.0	0.3	180 081	31.7	0.3	154 202	33.4	0.3	162 427
Esophagus	0.2	0.0	1169	3.8	0.1	18 660	4.1	0.1	19 972	4.0	0.1	19 643
Stomach	1.1	0.1	5253	10.7	0.2	51 996	14.9	0.2	72 655	22.4	0.3	109 095
Colon–rectum–anal canal	6.2	0.1	30 010	77.2	0.5	375 664	114.0	0.6	554 727	172.0	0.8	837 171
Pancreas	0.3	0.0	1242	2.4	0.1	11 814	2.8	0.1	13 393	2.9	0.1	14 187
Liver and intrahepatic bile tract (IBT)	0.4	0.0	1788	1.7	0.1	8332	2.0	0.1	9577	1.7	0.1	8089
Gallbladder and extrahepatic biliary duct (EBT)	0.1	0.0	593	1.6	0.0	7828	2.2	0.1	10 866	2.9	0.1	14 088
Lung and trachea	1.9	0.1	9036	25.9	0.3	125 964	31.4	0.3	152 907	27.4	0.3	133 260
Female breast	60.5	0.6	151 031	531.7	1.8	1 327 026	372.9	1.4	930 614	411.6	1.6	1 027 369
Corpus uteri	2.4	0.1	5950	66.1	0.6	165 066	87.9	0.7	219 357	107.2	0.8	267 553
Cervix uteri	37.0	0.5	92 375	91.0	0.7	227 113	40.1	0.5	100 123	41.9	0.5	104 645
Ovary and fallopian tube	9.0	0.2	22 507	47.0	0.5	117 336	32.9	0.4	82 207	29.7	0.4	74 052
Kidney	2.9	0.1	14 200	22.5	0.3	109 690	24.2	0.3	117 573	23.9	0.3	116 506
Bladder	2.2	0.1	10 777	27.8	0.3	135 095	45.7	0.4	222 372	72.1	0.5	350 863
Prostate[a]	9.4	0.2	22 278	312.7	1.4	741 258	237.1	1.3	562 125	66.6	0.7	157 796
Malignant skin melanoma	28.5	0.3	138 541	75.0	0.5	365 135	48.3	0.4	234 982	51.5	0.4	250 766

[a]Age group: 0–54, 55–74, 75–84, 85+.

Prev., Prevalence per 100,000; SE, Standard Error.

registries from Sweden, Norway and Iceland (all with 100% coverage); the UK by Scotland (100% coverage), Wales (100% coverage) and four English CRs (35% coverage); West and Central Europe were covered by registries from Switzerland (13% coverage), the Netherlands (18% coverage), Austria (100% coverage) and Germany (1.3% coverage); Southern Europe from Italy (6% coverage) and Slovenia (100% coverage) and finally Eastern Europe from Slovakia (100% coverage) and Poland (2% coverage). The similarity of the incidence rates estimated from these 22 registries to those estimated by GLOBOCAN [10, 15] suggests that they were a fairly representative sample of the whole European population. Heterogeneity of cancer registration in Europe is not limited to the extension of coverage of the country population, but also regards the completeness of incidence collection, the completeness of follow-up, the accurateness of morphology information and so on. However, the European cancer registry network is active to improve the standardization of the collection and procedure of completeness and quality of cancer diagnoses. Furthermore, all the date used in this work underwent centralized data quality checks and validation [11]. In any case, some cautions are needed in interpreting the prevalence estimates provided in this paper as representative, in the statistical sense, of the European population.

Observed data collected by CRs were only updated till the end of the year 2002, and the complete and limited-duration prevalence proportions have to be referred to the index date of 1 January 2003. The estimated prevalence figures are here referred to Europe as a geographical entity. In order to provide useful figures applicable to a formally defined population, we also projected the same prevalence proportions to the population structure of the European Union with 27 member states at the date of 1 January 2010. The resulting number of expected prevalent cases accounts for the different population sizes between geographical Europe and EU27, and also for the known changes in population age structure between 2003 and 2010 but not, of course, of possible variations in incidence and survival rates.

We compared our estimates with those calculated by the EUROPREVAL project at the reference date of 1 January 1993 [8]. Prevalence figures for all the cancer sites, with the exception of stomach and lung, were higher in this study. Major differences were observed for breast and prostate cancer entities and skin melanoma. Breast cancer was still in the year 2003 the most common malignancy among European women. Its complete prevalence was 916 per 100 000 at 1993 and 1377 per 100 000 at 2003, due to the increase of both incidence (diffusion of screening) and survival (improvement of clinical management). In men, prevalence of prostate cancer was 244 per 100 000 in 1993 and 626 per 100 000 in 2003. This could be explained by the increasing diffusion of the PSA testing across the European countries. Complete prevalence for malignant melanoma of skin was 81 per 100 000 in 1993 and 203 per 100 000 in 2003 and we cannot distinguish to what extent the increase was due to early diagnosis campaign or to a real increase of the risk, since no major innovation in treatment has been introduced. Prevalence increased also for colorectal and anal cancers, from 250 in 1993 [8] to 370 in 2003. This higher level should be in large part attributed to the rising proportion of long-term survivors [18]. Major efforts in colorectal screening started in EU after 2003 [19]. It is therefore unlikely that screening could have had an impact on the prevalence before 2003. Prevalence decreased for stomach cancer: 85 per 100 000 in 1993 versus 49 per 100 000 in 2003). For lung cancer, we obtained a lower prevalence of 87 per 100 000 compared with 95 per 100 000 in 1993. Stomach and lung cancers incidence has been reducing due to major changes in the risk factors. Tobacco smoking, the major determinant of lung cancer [20] but also a risk factor for stomach cancer has greatly reduced in European men. Stomach cancer incidence rates have also decreased due to changing living conditions, such as food preservation and prevalence of *Helicobacter pylori* [21].

We estimated about 11.6 millions of Europeans with a history of one of the major cancers considered in this study alive on 1 January 2003. Assuming both incidence and survival stable during the period 2003–2010, the demographic variations alone increased the prevalent cases to nearly 13 millions (Table 2) in 2010. For breast and prostate cancers, about 1 out of 73 women and 1 out of 160 men were living in 2010 with a previous diagnosis of breast and prostate cancers, respectively.

General mortality is falling, life expectancy is increasing and therefore the age distribution of the population is shifting toward the elderly. Because the incidence of all epithelial cancer entities rises steeply with age, the number of cancer cases will increase. Furthermore, during the past years major investment in early detection, sophisticated diagnostic tools and treatment contributed to the improved survival of cancer patients. All these factors contribute to increase the prevalence of cancer and push for the need of continuous monitoring of prevalence indicators to properly plan and allocate resources to cancer.

The European Cancer Health Indicator Project [22] and the ongoing European Partnership for Action Against Cancer [23] included prevalence within the priority list of Cancer Health indicators, as a relevant measure of cancer burden. However, prevalence figures are still not systematically asked to Member States for their dissemination within the EU official health statistics. We hope that in future there will be a wider availability of this measure which provides important information for improving health care programs for cancer survivors.

disclosure

The authors have declared no conflicts of interest.

references

1. Guzzinati S, Buzzoni C, De Angelis R et al. Cancer prevalence in Italy: an analysis of geographic variability. Cancer Causes Control 2012; 23(9): 1497–1510.
2. Colonna M, Danzon A, Delafosse P et al. Cancer prevalence in France: time trend, situation in 2002 and extrapolation to 2012. Eur J Cancer 2008; 44(1): 115–122.
3. Engholm G, Ferlay J, Christensen N et al. NORDCAN—a Nordic tool for cancer information, planning, quality control and research. Acta Oncol 2010; 49(5): 725–736.
4. Siegel R, Desantis C, Virgo K et al. Cancer treatment and survivorship statistics, 2012. CA Cancer J Clin 2012; 62(4): 220–241.
5. Maddams J, Brewster D, Gavin A et al. Cancer prevalence in the United Kingdom: estimates for 2008. Br J Cancer 2009; 101(3): 541–547.

6. Yu XQ, Smith DP, Clements MS et al. Projecting prevalence by stage of care for prostate cancer and estimating future health service needs: protocol for a modelling study. BMJ Open 2011; 1(1): e000104.
7. De Angelis R, Tavilla A, Verdecchia A et al. Breast cancer survivors in the United States. Geographic Variability and Time Trends, 2005–2015. Cancer 2009; 115 (9): 1954–1966.
8. Capocaccia R, Colonna M, Corazziari I et al. Measuring cancer prevalence in Europe: the EUROPREVAL project. Ann Oncol 2002; 13: 831–839.
9. Capocaccia R, De Angelis R. Estimating the completeness of prevalence based on cancer registry data. Stat Med 1997; 16(4): 425–440.
10. Gatta G, van der Zwan JM, Casali PG et al. Rare cancers are not so rare: The rare cancer burden in Europe. Eur J Cancer 2011; 47: 2493–2511.
11. De Angelis R, Francisci S, Baili P et al. The EUROCARE-4 database on cancer survival in Europe: data standardization, quality control and methods of statistical analysis. Eur J Cancer 2009; 45: 909–930.
12. Micheli A, Mugno E, Krogh V et al. Cancer prevalence in European registry areas. Ann Oncol 2002; 13(6): 840–865.
13. NCI, 2005. ComPrev—Complete Prevalence Software. Program of the National Cancer Institute. Version 1.0 http://surveillance.cancer.gov/comprev/ (4 January 2013, date last accessed).
14. http://epp.eurostat.ec.europa.eu/ (4 January 2013, date last accessed).
15. Ferlay J, Shin HR, Bray F et al. Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008. Int J Epidemiol 2010; 127(12): 2893–2917.
16. Cancer Incidence in Five Continents Annual Dataset. http://ci5.iarc.fr/CI5plus/ci5plus.htm (4 January 2013, date last accessed).
17. Howlader N, Noone AM, Krapcho M et al. (eds). SEER Cancer Statistics Review, 1975–2009 (Vintage 2009 Populations). Bethesda, MD: National Cancer Institute, http://seer.cancer.gov/csr/1975_2009_pops09/ (4 January 2013, date last accessed).
18. Francisci S, Capocaccia R, Grande E et al. The cure of cancer: a European perspective. Eur J Cancer 2009; 45: 1067–1079.
19. European Union: COUNCIL RECOMMENDATION 2003/878/EC of 2 December 2003 on cancer screening. Official Journal of the European Union 16.12.2003.
20. Gandini S, Botteri E, Iodice S et al. Tobacco smoking and cancer: a meta-analysis. Int J Cancer 2008; 122: 155–164.
21. WCRF & AICR. Food, nutrition, physical activity and the prevention of cancer a global perspective. Washington, DC: AICR 2007.
22. European Cancer Health Indicator Project http://www.tumori.net/eurochip/ (4 January 2013, date last accessed).
23. The European Partnership for Action Against Cancer (EPAAC) http://www.epaac.eu/ (4 January 2013, date last accessed).

appendix: The (EUROCARE-4) working group

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