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Standard cancer patient population for age standardising survival ratios

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Abstract

Standard adult cancer patients populations are derived in this paper as a tool for the calculation of age-standardised cancer survival figures. Previously used standards in survival analysis have been site- and/or study-specific. Here, multivariate methods have been used to define the smallest possible number of general standard cancer patient populations which are simple to use and provide standardised survival values close to the raw ones for the largest possible number of cancer sites. The analysis was based on data for over 1.1 million cancer patients included in the EUROCARE-2 study. The proposed standard populations consist of three age distributions, appropriate for cancers with incidence patterns: (1) increasing with age – the vast majority of cancers; (2) broadly constant with age and (3) mainly affecting young adults. The three standard distributions are presented by both broad and five-year age classes. The latter can be used to determine which of the three standards would be used for sites not included in the cluster analysis because their survival is generally calculated in unusual age groups. Overall, standard 1 is appropriate for over 91% of cases, standard 2 for just over 7%, and standard 3 for less than 2%. The proposed standards were tested on European (EUROCARE-2 and EUROCARE-3) and US (Surveillance, Epidemiology and End Results Program, SEER) relative survival data. There was very good correspondence between the raw (population weighted) and age-standardised survival figures.

Keywords: Neoplasms; Survival; Age-standardisation; Standard cancer patient populations; Methods

1. Introduction

Survival rates have often been used to assess changes in the care of cancer patients over time, and disparities among geographical areas [1–5]. Survival generally depends on age at diagnosis, and the age distribution of cancer patients may vary over time in any one area and will almost certainly differ among geographical areas. Then, comparison of ''raw'', i.e. population weighted, results could be misleading and standardisation for age is essential for valid inferences to be made about any apparent pattern. In the results from the EUROCARE study [2,3], standard age distributions were derived empirically from the actual observed distribution of cases in the total cancer patients population. Such empirical internal standards derived from pooling all the populations included in a study solve well the problem of assuring age comparability of survival within that particular study. As they are based on an average age distribution, internal standards produce adjusted survival values that are generally sufficiently close to the observed ones to retain their biological sense of the probability of surviving cancer. For incidence and mortality, rates adjusted for age using the World standard population [6,7] are often only around half the raw

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rates. For survival, however, using age-adjusted values that do not differ too much from the raw figures is particularly important in communicating the results, since the meaning of survival ratios is much more immediately perceived than that of incidence or mortality rates.

Empirical standards do, however, present some drawbacks for comparison of survival between studies. Being specific to a given population and a given time period, they can systematically differ from the actual age distribution of cases in another population, and age-adjusted results could be systematically lower or higher than the corresponding raw values. Further, empirical standards are site-specific. Inclusion of a new site in a survival study requires the definition of a new standard population. This solution is of course unsatisfactory and points to the need for a conventional and more general standard population of cancer patients. Finally, empirical standards, even with some numerical smoothing [8], consist of a large array of numbers – one for each age-site or sex–age–site combination – usually not rounded to some equivalent of small integers as are the World and European standard populations. Empirical standards are therefore both impractical and may prevent valid comparisons of results from different studies.

The purpose of this paper is to define and propose standard cancer patient populations for the age adjustment of cancer survival. Multivariate cluster analysis was used to find the smallest possible set of age distributions representative of all the different cancer sites which, rounded to the two most significant digits (or a single integer) in each age group, resulted in age-adjusted rates as close as possible to the raw rates. Comparisons of age-standardised survival using these distributions with both the raw figures and the age-standardised figures using a previously published set of standards, are illustrated.

2. Methods

We used cluster analysis to group cancer sites according to their similarities in the age distribution of cases. Numbers of cancer patients by sex, site, and broad age group were calculated from over 1.1 million records included in the EUROCARE-2 study [3]. The following age groups were considered: 15–44, 45–54, 55–64, 65–74 and 75–99 years. All the EUROCARE-2 cancer sites were included in the cluster analysis, with the exceptions of prostate and bone cancers, for each of which slightly different age groups were used. Relevant standards were subsequently chosen for these cancers – see below.

We used an aggregative hierarchical procedure, which considers each of the units at the beginning of the analysis as a single-unit cluster, and step by step groups them starting from the nearest two, finally arriving at a unique cluster. At each step a partition of units is defined, accompanied by specific indices which evaluate it. The method specifies the distance measure among cancer sites, that are considered as the statistical units of the analysis and the aggregation rule, based on distances.

When applied to incidence data stratified by sex and site, this method can assign male and female cancers of the same site to different clusters. This is not implausible, because differences in life styles between males and females can produce different levels of exposure to risk factors, and hence different age patterns in the incidence of cancer. However, using a different standard population for men and women precludes between – sex comparisons. Constrained cluster analysis was therefore performed to force cancers of the same site in males and females to belong to the same cluster. This approach is called *contiguous spatial classification* [9].

We consider the combination of site and sex as the statistical units of analysis. Each unit i is described by the variables x_{ki} ($k = 1, 5$) expressing the percentage of cases in the five considered age groups (15–44, 45–54, 55–64, 65–74, 75–99). A principal component analysis was also carried out on the same x_{ki} variables. The first two principal components P_{si} ($s = 1, 2$), accounting for 90% of the total variability, were taken as additional spatial variables in the cluster analysis. According to the method, distances among units i and j, each unit being a combinations of site and sex, were computed as:

$$d_{ij} = \sqrt{\sum_{k=1,K}\left(x_{ki} - x_{kj}\right)^2 + \alpha\sum_{s=1,S}\left(P_{si} - P_{sj}\right)^2} \qquad (1)$$

where $K = 5$, $S = 2$, are the dimensions of the classification variables x and P, and x_{ki}, x_{kj}, P_{si}, P_{sj} are their values for units i and j, respectively. The second term in expression (1) represents a measure of contiguity (in term of the distance) between the two units i and j, according to additional spatial variables P_s. The parameter α is the weight of contiguity: the greater the value of α, the smaller is the contiguity between units i and j, and *vice versa*. The parameter α was set equal to 1 for different sites, irrespective of gender, and equal to 0 for the same site and different genders. Cluster analysis was performed on the distance matrix given by (1). As the principal component score in unit i is a synthesis of all the values of the considered quantitative variables x_{ki}, d_{ij} stresses distances in age structure of cases for different sites with respect to different sexes for the same site.

Once the optimal cluster partition is found, the centroid of each cluster gives the age-specific proportions that define the standard population most appropriate for all cancer sites belonging to that cluster. Let W_k be the percent proportion of the standard population in age class k, and let R_k be the corresponding age-specific relative survival ratios for a given cancer. Age-standardised relative survival (ASR) and its standard error are obtained from the expressions:

$$\mathrm{ASR} = \left(\sum_k W_k R_k\right)/100$$

st. error (ASR) $= \left[\sum_k W_k^2 \text{ st. error}^2(R_k)\right]^{1/2}/100$.

Confidence intervals for age-standardised survival ratios can be computed by assuming the Normal approximation on the logarithmic scale, so constraining the lower confidence limit to be positive. Ninety-five percent confidence limits are then given approximately by: Lower limit = ASR/exp [1.96 * st. error (ASR)/ASR], Upper limit = ASR * exp [1.96 * st. error (ASR)/ASR].

Age-specific relative survival ratios from EUROCARE studies [3,10] and the Surveillance, Epidemiology and End Results Program (SEER) registries [5] have been used to present and evaluate the standards obtained. Formulae for the standard error and confidence limits are here given for completeness of presentation, but are not used in this work.

3. Results

3.1. Broad age groups

The constrained cluster analysis using the complete method of aggregation and the distance matrix described in expression (1) for males and females jointly, produced an optimal partition in three classes. The average age distributions of each cluster are illustrated in Fig. 1. The interpretation of the three clusters is very simple. Cluster 1, includes cancer sites with a steeply increasing age distribution – the vast majority. Cluster 2 includes sites with a weak age dependency, the slightly higher proportion assigned to the first age class being largely due to its wider age range. Finally, Cluster 3 includes cancers particularly frequent in young adults and with a much lower frequency similar across for the remaining age groups. The age class proportions obtained for the three clusters are given numerically in Table 1, where the proportions associated with the last cluster have been rounded to give a smooth age distribution. The identified clusters can be used as a set of three

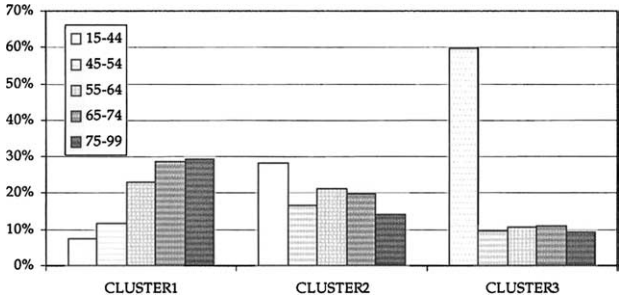

Fig. 1. Age class proportion distributions of the centroid of the three identified clusters.

Table 1
Weights for the three proposed standard cancer patients distribution, and a single standard, in broad age groups

Age group (years)	Standard cancer patient population			Single standard
	1	2	3	
15–44	7	28	60	14
45–54	12	17	10	12
55–64	23	21	10	22
65–74	29	20	10	26
75+	29	14	10	26
Total	100	100	100	100

standard distributions for calculating age-standardised survival. The cancer sites associated with each of the three standard distributions are shown in Table 2. As described in methods above, these apply to both males and females for each of the relevant cancer sites.

Using a single standard distribution for all cancer sites would give a further advantage in terms of simplicity. The standard distribution minimising the sum of distances for all cancer sites given by expression (1) is also reported in Table 1. The single standard is of course closely similar to standard 1, the only marked difference being a higher proportion in the first age group.

3.2. Comparing raw with age-standardised relative survival ratios

As noted above, that a standard cancer patients distribution provides age-standardised survival values close to the raw survival values is highly a desirable property. This was the case for both the EUROCARE-1 and the EUROCARE-2 standards [2,3]. In the case of the proposed standards, some loss with respect to such a property is to be expected, because more general standards have been defined, which are valid for groups of sites. We have therefore compared the raw survival figures from EUROCARE-2 [3] with age-standardised values obtained using both the three (site specific) standards and the single standard presented in Table 1.

Fig. 2(a) and (b) present the results of these comparisons for males and females, respectively. In these figures, x-values are the raw five-year relative survival ratios for all adults aged 15–99, and the y-values are the corresponding age-standardised ratios; each dot represents a single cancer site. For each site, the appropriate one of the three standard populations defined in Table 1 has been used for the sites as listed in Table 2. The diagonal lines represents equality between the raw and age-standardised values. Dots lying below (above) the diagonal line indicate that the corresponding sites have age-standardised values lower (higher) than the raw ones. The same comparisons are also presented in numerical format in Table 3.

Table 2
Cancer sites for which each of the three proposed cancer standard populations apply

Standard	Cancer sites
1	Lip, tongue, salivary glands, oral cavity, oropharynx, hypopharynx, head & neck, oesophagus, stomach, small intestine, colon, rectum, liver, biliary tract, pancreas, nasal cavities, larynx, lung, pleura, breast, corpus uteri, ovary, vagina & vulva, penis, bladder, kidney, choroid melanoma, non-Hodgkin lymphomas, multiple myeloma, chronic lymphatic leukaemia, acute myeloid leukaemia, chronic myeloid leukaemia, leukaemia, all cancers [also prostate – see text]
2	Nasopharynx, soft tissues, melanoma, cervix uteri, brain, thyroid gland [also bone – see text]
3	Testis, Hodgkin's disease, acute lymphatic leukaemia

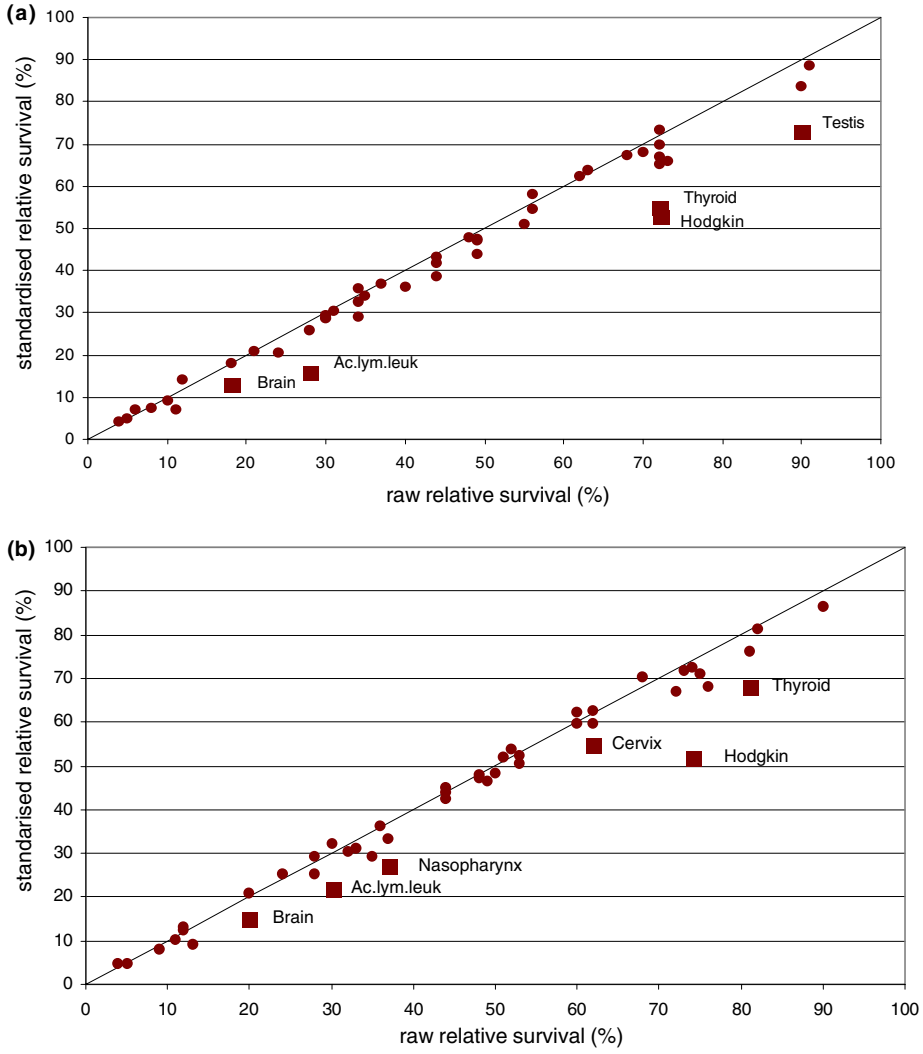

Fig. 2. Comparison of raw and age-standardised five-year relative survival ratios: circular dots – using the appropriate standard for each case; square dots (for selected cancers) – using the single standard: (a) men; (b) women. EUROCARE-2 data: European patients diagnosed in the period 1985–1989.

In general, the age-standardised ratios using the three-standard populations (circular dots) are very close to the raw ones. Sites with the biggest differences between the age-standardised rates and the raw ones are: ovary, corpus uteri, nasopharynx, and lip for females; testis, breast, non-Hodgkin lymphoma, oral cavity, and small intestine for males; and choroid, thyroid, salivary glands and acute myeloid leukaemia for both sexes (Table 3).

Survival figures adjusted using a single standard can, however, be very different from the corresponding raw

Table 3
Comparisons of raw and age-standardised five year relative survival ratios, using both the three standards and the single standard populations

Site	Standard	Sex	Five year relative survival (%)				
			Raw	Adjusted using three standards	Difference between raw and standardised (% points)	Adjusted using single standard	Difference between raw and standardised (% points)
Lip	1	M	91	89	−2	90	−2
		F	90	86	−4	88	−2
Tongue	1	M	37	37	0	38	1
		F	53	50	−3	51	−2
Salivary glands	1	M	55	51	−4	54	−1
		F	72	67	−5	69	−3
Oral cavity	1	M	44	39	−5	39	−5
		F	53	53	0	53	0
Nasopharynx	2	M	34	36	2	29	−6
		F	37	33	−4	27	−10
Oropharynx	1	M	30	29	−1	30	0
		F	44	43	−1	43	−1
Hypopharynx	1	M	24	21	−3	22	−2
		F	28	25	−3	26	−3
Head & neck[a]	1	M	34	32	−2	33	−1
		F	48	47	−1	48	0
Oesophagus	1	M	8	7	−1	8	0
		F	12	13	1	15	3
Stomach	1	M	21	21	0	23	2
		F	24	25	1	26	2
Small intestine	1	M	40	36	−4	37	−3
		F	32	30	−2	32	0
Colon	1	M	48	48	0	49	1
		F	48	48	0	49	1
Rectum	1	M	44	43	−1	43	−1
		F	44	44	0	45	1
Liver	1	M	5	5	0	5	0
		F	5	5	0	5	0
Biliary tract	1	M	12	14	2	16	4
		F	12	12	0	12	0
Pancreas	1	M	4	4	0	5	1
		F	4	5	1	6	2
Nasal cavities	1	M	44	42	−2	42	−2
		F	44	45	1	48	4
Larynx	1	M	62	62	0	63	1
		F	62	63	1	65	3
Lung	1	M	10	9	−1	10	0
		F	11	10	−1	12	1
Pleura	1	M	6	7	1	8	2
		F	9	8	−1	9	0
Soft tissues	2	M	56	58	2	59	3
		F	60	60	0	56	−4
Melanoma	2	M	70	68	−2	65	−5
		F	82	81	−1	80	−2
Breast	1	M	72	67	−5	69	−3
		F	73	72	−1	72	−1
Cervix uteri	2	F	62	60	−2	55	−7
Corpus uteri	1	F	75	71	−4	73	−2
Ovary	1	F	35	29	−6	33	−3
Vagina, vulva	1	F	52	54	2	57	5
Testis	3	M	90	84	−6	73	−17
Penis	1	M	72	73	1	74	2
Bladder	1	M	68	68	0	69	1
		F	60	62	2	64	4
Kidney	1	M	49	47	−2	49	−1
		F	50	48	−2	50	0
Choroid	1	M	73	66	−7	65	−8
		F	76	68	−8	69	−7
Brain	2	M	18	18	0	13	−6

(*continued on next page*)

Table 3 (*continued*)

Site	Standard	Sex	Five year relative survival (%)				
			Raw	Adjusted using three standards	Difference between raw and standardised (% points)	Adjusted using single standard	Difference between raw and standardised (% points)
		F	20	21	1	15	−5
Thyroid gland	2	M	72	65	−7	55	−17
		F	81	76	−5	68	−13
Non Hodgkin lymph.	1	M	49	44	−5	45	−4
		F	49	47	−2	49	0
Hodgkin's disease	3	M	72	70	−2	53	−19
		F	74	72	−2	52	−23
Multiple myeloma	1	M	31	31	0	33	2
		F	28	29	1	31	3
Ac. lymph. leuk.	3	M	28	26	−2	16	−12
		F	30	32	2	22	−8
Chr. lymph. leuk.	1	M	63	64	1	66	3
		F	68	70	2	72	4
Ac. myel. leuk.	1	M	11	7	−4	9	−2
		F	13	9	−4	11	−2
Chr. myel. leuk.	1	M	30	29	−1	30	0
		F	33	31	−2	33	0
All leukaemias	1	M	35	34	−1	35	0
		F	36	36	0	37	1

EUROCARE-2 data: European patients diagnosed in the period 1985–1989.

[a] Lip, tongue, salivary glands, oral cavity, nasopharynx, oropharynx, hypopharynx.

values. The greatest differences appear for those sites for which the second and third of the three standards are more appropriate – some of these are illustrated (with square dots) in Fig. 2(a) and (b).

Based on these results, we propose the three standards as the optimal choice. In the following, we call for brevity the set of three standard populations reported in Table 1 the International Cancer Survival Standards (ICSS).

Comparison of the ICSS standardised survival ratios with the corresponding values standardised with an internal standard has been also carried out for the EUROCARE-3 data set [10], covering patients diagnosed in the period 1990–1994 (Fig. 3). Separate dots representing results for males and females for the same cancer (when appropriate) are given. The correspondence between the ICSS and EUROCARE-3 standardised survival ratios is very close across the whole range of cancer sites and survival values.

A comparison was also carried out with the most recent SEER data, covering patients diagnosed in 1991–1995 and followed up to 2000. In Fig. 4, raw and ICSS standardised survival ratios calculated on these SEER data are plotted for the same sex–site combinations considered in Table 3 and in Fig. 3. The two measures show a good correspondence for almost all sex–site combinations. Cancers with a difference between raw and standardised ratios of greater than 5% points include some sites having a much higher proportion of patients aged 15–44 in the USA than in European countries. These are acute myeloid leukaemia (52% of patients aged 15–44 in the USA *vs.* 17% in Europe), chronic myeloid leukaemia (33% *vs.* 17%), ovary (33% *vs.* 11%), cervix (53% *vs.* 38%), salivary glands (28% *vs.* 15%), Hodgkin's disease (77% *vs.* 61%) and thyroid (56% *vs.* 36%).

3.3. Five-years age groups standard

The age group definition considered above: 15–44, 45–54, 55–64, 65–74, 75–99, is not the only one used in survival analysis. Different groupings, or a more detailed age stratification are sometimes needed to give a proper description of cancer survival. It is therefore useful to provide standard age distributions by five-year age groups, suitable for aggregation according to the user's particular needs. It is important to recognise that consistency is lost in such a splitting procedure. In general, age standardised values obtained from data in five-year age groups standard will not coincide with the corresponding values for the broad age groups. This will happen only if survival is constant within each broad age group, or the positive and negative differences in the contribution of the five-year age groups are compensating.

Owing to the lack, or very small number of cases observed in some age groups and cancer sites, we decided not to repeat the cluster analysis based on five-year age groups. A top-down approach was followed, splitting the broad age groups of the three standards already defined into five-year age groups. The number of cases by five-years age group for all cancer sites belonging

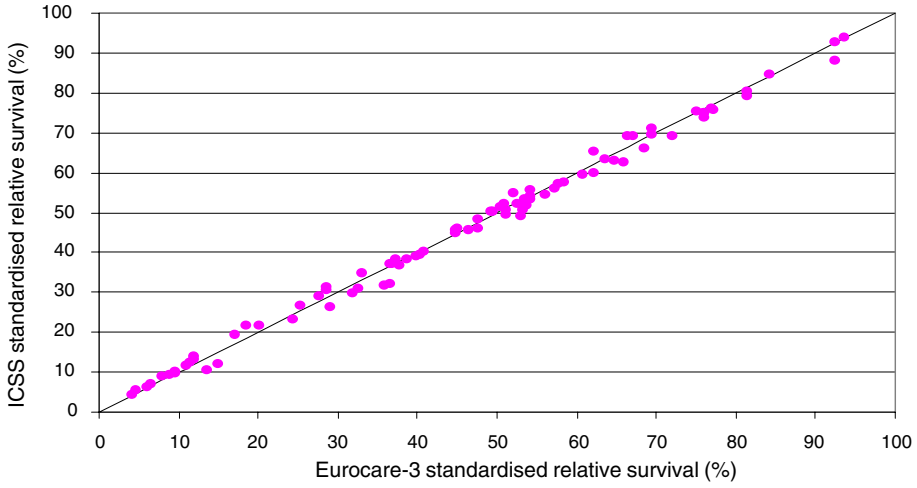

Fig. 3. Comparison of age-standardised 5 year relative survival ratios calculated with the relevant ICSS standard and EUROCARE-3 standard distributions. EUROCARE-3 data: European patients diagnosed in the period 1990–1994.

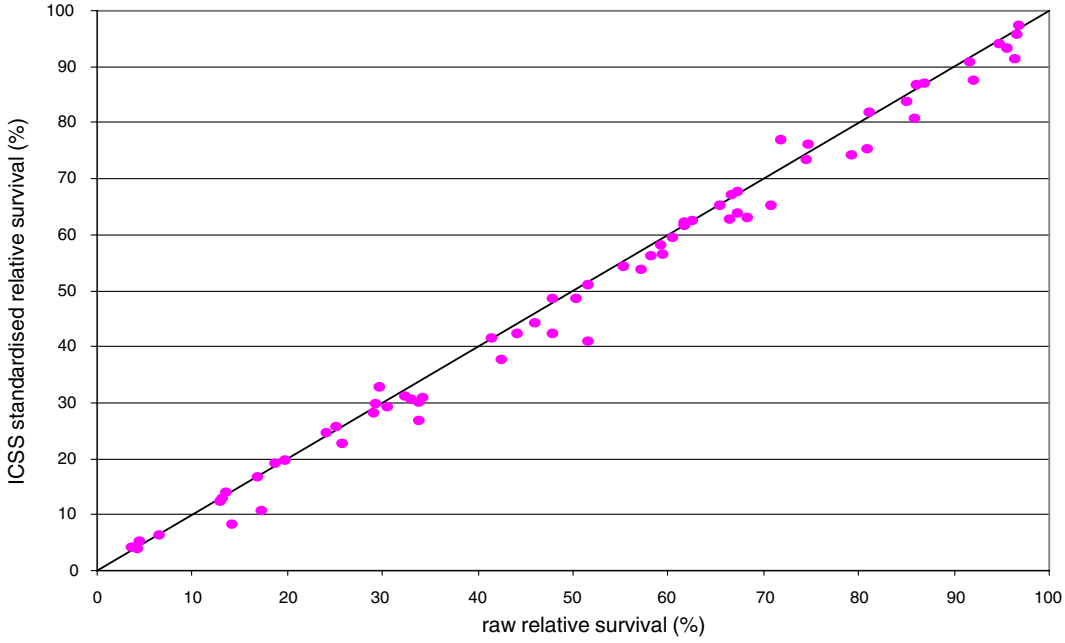

Fig. 4. Comparison of raw and age-standardised 5 year relative survival ratios calculated with the relevant ICSS standard. SEER data: United States patients from SEER registries diagnosed in the period 1991–1995.

to each of the three standards was derived from the EUROCARE-2 database. The empirical age distribution of these cases is of course different from the corresponding standard distribution. The proportion of cases attributed to each five-year age group was therefore derived in two steps. First, empirical five-year age group proportions, within each broad age group, were re-scaled to sum to the broad age group proportion. Second, the re-scaled five-year age group proportions were rounded while leaving their sum unchanged. Table 4 shows the number of cases related to each of the three standards, the corresponding re-scaled five-year age group proportions, and the consequent proposed five-year age group standards.

3.4. Deciding on the standard to be used for a new cancer site

The cancer sites listed in Table 2 are grouped according to the standard which produces age-standardised values as close as possible to the raw ones. The same criterion can be used to select the most convenient

Table 4
Five-year age group weights for the three standards

Age group (years)	Standard 1			Standard 2			Standard 3		
	Number of cases	Rescaled	Five-year standard	Number of cases	Rescaled	Five-year standard	Number of cases	Rescaled	Five-year standard
15–19	1280	0.16	0	1020	1.13	1	1363	6.94	7
20–24	1671	0.21	0	1818	2.01	2	2197	11.18	11
25–29	3240	0.42	0	3386	3.74	4	2547	12.97	13
30–34	6561	0.84	1	5203	5.75	6	2285	11.63	11
35–39	14593	1.88	2	6815	7.54	7	1893	9.63	10
40–44	27175	3.49	4	7073	7.82	8	1503	7.65	8
45–49	41700	4.91	5	6768	8.28	8	928	5.32	5
50–54	60302	7.09	7	7122	8.72	9	815	4.68	5
55–59	92575	9.64	10	7930	9.90	10	769	5.22	5
60–64	128271	13.36	13	8901	11.10	11	703	4.78	5
65–69	147047	14.23	14	8524	11.00	11	647	5.07	5
70–74	152539	14.77	15	6986	9.00	9	630	4.93	5
75–79	148705	14.13	14	5698	7.25	7	520	5.18	5
80–84	98367	9.35	9	3233	4.12	4	326	3.25	3
85+	58106	5.52	6	2066	2.63	3	158	1.57	2
Total	982132	100.00	100	82543	100.00	100	17284	100.00	100

Table 5
Selection of standard population for age standardisation of five year relative survival ratios for (a) prostate and (b) bone cancer

Age group (years)	Number of cases	%	Age-specific and all ages raw survival	Weights derived from ICSS and age-standardised survival		
				Standard 1	Standard 2	Standard 3
(a) Prostate						
15–54	1042	2	50	19	45	70
55–64	8501	13	58	23	21	10
65–74	24474	37	60	29	20	10
75–84	26471	40	52	23	11	8
85+	5240	8	53	6	3	2
Total	65728	100		100	100	100
Overall survival			56	**55.4**	54.0	52.0
				Selected standard for prostate		
(b) Bone						
20–44	646	32	56	7	27	53
45–54	226	11	51	12	17	10
55–64	362	18	58	23	21	10
65–74	400	20	44	29	20	10
75+	384	19	28	29	14	10
Total	2018	100		100	99	93
Overall survival			50	44.2	**49.2**	51.4
					Selected standard for bone	

standard distribution for a cancer site not included in the cluster analysis.

For example, prostate and bone cancers were not considered in the above analysis because in the EUROCARE data base and publications they have different age groupings. Prostate cancer, a disease particularly frequent in very elderly men, is more appropriately partitioned into more groups at older ages. Cutpoints for the age distributions were therefore set at 15, 54, 64, 74, and 84 years. For bone cancer, the lower age for analysis of survival in adults is usually set at 20 years, due to the different biological characteristics of this cancer in adolescents. Table 5 shows the details of a simple procedure for selecting the most appropriate standard for each of these cancers. The numbers and percentage of cases observed for prostate and bone (both sexes) cancers, and the corresponding age-specific relative survival ratios, are shown by age group. The weights for each of the new age groups have been calculated from the five-year age groups in the three ICSS standards (Table 4). Standard 1 gives the age-standardised relative survival figure (55.4%) closest to the raw survival (56.0%) for prostate cancer, and is therefore selected as the best standard population for this site. For the same reason, standard 2 is selected as the best choice for bone cancer.

With the above standard distributions being assigned to prostate and bone cancers, standard 1 is appropriate for 91.1% of the patients in the EUROCARE-2 study, standard 2 for 7.4%, and standard 3 for 1.5%.

4. Conclusions

The choice of a standard cancer patient population is somewhat arbitrary, but should be guided by practical considerations. Our proposed standard populations have been defined on the basis of the observed age distribution of cancer cases diagnosed in 1985–1989 in the EUROCARE-2 database. A statistical cluster analysis of sites according to similarities in age-specific distributions has defined three standard populations, characterising the three main age patterns in the incidence of cancer: cancers typical of older ages; cancers whose modal age at diagnosis is in middle age; and cancers arising mainly in young adults. For the appropriate cancers, standardised survival figures based on these standard populations are closely similar to the corresponding unadjusted figures, thus retaining their biological meaning of the probability of surviving cancer (after elimination of competing deaths, if relative survival is considered). While developed on European data, these standard populations have been shown to perform fairly well also on US data from the SEER registries.

The general shift in the populations of developed countries towards the elderly results in increasing proportions of older cancer cases. This in turn causes a progressive drift between raw and age-standardised survival figures. In order to evaluate this phenomenon, we applied the ICSS distributions to the EUROCARE-3 data [10], which relate to patients diagnosed five years after the period used for definition of the standard populations. The closeness between the five year relative survival ratios calculated using the internal EUROCARE-3 standards and those using the ICSS ones suggests that, at least in the medium term, population ageing is not likely to bias ICSS standardised survival ratios to any important degree.

Changes in the age distribution of incidence may result also from cohort effects of disease risk, or from early diagnostic activities targeted to specific age classes. As a consequence, a fixed standard distribution may progressively differ from the actual age distribution of patient population, and the time trend of ICSS age-standardised survival may diverge from that of raw survival. We explored the effect of breast cancer screening in England on raw and age-standardised survival ratios. The proportion of cases aged 45–64 increased from 40% in 1983–1985 to 45% in 1992–1994, while the proportion of those older than 64 years decreased from 47% to 43%. During this period, five-year raw relative survival for breast cancer in English women increased from 64.0% to 75.4% (+11.4%). The corresponding ICSS age-standardised relative survival increased from 63.0% to 72.2% (+9.2%). The difference between raw and age-standardised survival increased therefore from 1.0% to 3.2%. Simultaneous consideration of raw and age-standardised survival values is advisable in the presence of important changes in the age distribution of patients.

Our study was carried out on data for patients aged 15–99 years, so the proposed standards are suitable for analysis of cancer survival in adults. The number of cancer patients aged 100 or more at diagnosis is very low, and the proposed standard populations can be used, for all practical purposes, with an open-ended age group of 75 and over (or 85 and over if five-year age groups are used). Also, for most of the cancer sites considered, the fraction of childhood cancers is negligible, and the same weights attributed to ages 15–44 can safely be used for ages 0–44. The only sites, among those considered in this paper, for which substantial fractions of cases are diagnosed at ages 0–14 are acute lymphatic leukaemia (52%), bone (13%), soft tissues (6%), brain (8%), and all leukaemias (8%). For these, and for other cancers with smaller proportion of cases occurring in children – such as those of the nasopharynx (2%), testis (1%), kidney (2%), Hodgkin's disease (4%), non-Hodgkin lymphomas (2%), and acute myeloid leukaemia (4%) – data for adults and children are seldom analysed together, because of their different biological characteristics, treatment protocols and survival outcome. For childhood

cancers it is usual to age standardise survival by giving equal weight to the rates in each of the three are groups 0–4, 5–9, and 10–14 [11].

Conflict of Interest

None.

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