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Cancer incidence and survival in European adolescents (1978–1997). Report from the Automated Childhood Cancer Information System project

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ABSTRACT

Data on 15,399 adolescents diagnosed with cancer at age 15–19 years during 1978–1997 in Europe were extracted from the database of the Automated Childhood Cancer Information System (ACCIS). Total incidence in Europe as a whole was 186 per million in 1988–1997. Incidence among males was 1.2 times that among females. Lymphomas had the highest incidence of any diagnostic group, 46 per million, followed by epithelial tumours, 41 per million; central nervous system (CNS) tumours, 24; germ cell and gonadal tumours, 23; leukaemias, 23; bone tumours, 14; and soft tissue sarcomas, 13 per million. Total incidence varied widely between regions, from 169 per million in the East to 210 per million in the North, but lymphomas were the most frequent diagnostic group in all regions. Cancer incidence among adolescents increased significantly at a rate of 2% per year during 1978–1997. Five-year survival for all cancers combined in 1988–1997 was 73% in Europe as a whole. Survival was highest in the North, 78%, and lowest in the East, 57%. Five-year survival was generally comparable with that in the Surveillance, Epidemiology, and End Results (SEER) registries of the United States of America (USA), but for Ewing's sarcoma it was below 45% in all European regions compared with 56% in the USA. Survival increased significantly during 1978–1997 for all cancers combined and for all diagnostic groups with sufficient registrations for analysis.

1. Introduction

The international variations in the incidence of cancer in children are relatively well documented.[1] There has also been detailed exploration of survival rates among children in Europe.[2–4] There is considerably less published information on cancer incidence and survival among European adolescents.[5,6]

In Europe, less than 0.3% of all cancer cases occur in adolescents aged 15–19 years.[7] The pattern of tumour types

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occurring most commonly in this age group is distinctive, including some typical childhood tumours and others that occur mostly in adults. The most frequent tumour types are lymphomas, carcinomas, germ cell tumours, leukaemias, sarcomas and central nervous system (CNS) tumours.[5]

The Automated Childhood Cancer Information System (ACCIS) is a collaborative project of the European cancer registries, aiming at collection, presentation and interpretation of data on cancer incidence and adolescents in Europe.[5] In this paper we use the ACCIS database to present an overview of geographical patterns and time trends in the incidence and survival rates for cancer among European adolescents.

2. Material and methods

Detailed information on the ACCIS database is given elsewhere [Steliarova-Foucher, Kaatsch, Lacour and colleagues, this issue]. For this study, the analyses were based on data from the 49 population-based cancer registries in 16 countries, listed in Table 1, which met defined quality criteria for completeness, validity and comparability. All registrations for malignant neoplasms, together with non-malignant CNS tumours, registered during 1978–1997 in adolescents aged 15–19 years in the participating registries were extracted from the ACCIS database. A total of 15,399 registrations were included in the analyses. Standard variables available for each case included basic demographic data (age, sex, country or region of residence) and information on the tumour (date of incidence, site, morphology, basis of diagnosis, grade and laterality). In 39 registries, more than 90% of cases were microscopically verified and, in the registries with access to mortality data, fewer than 1% were registered from death certificate only (DCO). Diagnoses were grouped according to the International Classification of Childhood Cancer (ICCC).[8] The subgroup of other and unspecified carcinomas (ICCC XIf) was further divided into 13 categories to show site-specific incidence of carcinomas at a wider range of primary sites.

The contributing countries were grouped into five European regions according to geographical location, socioeconomic characteristics and data availability, as shown in Table 1. The underlying population at risk for each combination of registration area, calendar year, sex and single year of age was extracted, where available, from official statistics and otherwise was estimated by linear interpolation from available data [Steliarova-Foucher, Kaatsch, Lacour and colleagues, this issue].

For the analyses of time trends, the available time-span was divided into four periods of 5 years: 1978–1982, 1983–1987, 1988–1992 and 1993–1997. The registries included in these analyses were those contributing to at least three periods, as shown in Table 1. Quality indicators for the combined data included in the analyses of time trends are shown in Table 2, by time period and geographical region.

Incidence rates were calculated as the average annual number of cases per million person-years. The 95% confidence intervals for incidence rates were calculated using the Poisson approximation, or exactly if less than 30 cases were observed.[9] Variations in incidence between the five European regions were analysed by Poisson regression. Time trends in incidence were modelled using Poisson regression, adjusted for sex and region as appropriate, and expressed as an average annual percentage change (AAPC).

The duration of survival for each case was calculated as the time elapsed between the date of diagnosis and the date of death (if the patient died) or the closing date of the study for the given cancer registry. Survival rates were calculated using the life-table method. DCO cases and those without follow-up were excluded from the survival analyses. The extent of these exclusions can be evaluated from Tables 1 and 2. Variations in survival between groups of patients were tested by log-rank tests.[9] Change in survival between the four periods of diagnosis was tested by the log-rank test for trend,[10] using the complete survival curves. More details on the methods used can be found elsewhere [Steliarova-Foucher, Kaatsch, Lacour and colleagues, this issue].

3. Results

Table 3 presents incidence rates in Europe and the five European regions for each diagnostic group within the ICCC. Total incidence varied widely, from 169 per million in the East to 210 per million in the North. Lymphomas were the most frequent diagnostic group overall and in each region, accounting for around a quarter of all cancers. Epithelial tumours (carcinomas of sites other than kidney, liver and gonadal, together with melanoma) everywhere constituted the second most common group. The next most frequent groups were leukaemia, CNS tumours, and germ-cell and gonadal tumours, though their ordering varied between regions. These were followed by sarcomas of bone and soft tissue. There was substantial inter-regional variation in incidence rates for individual diagnostic groups; for each of the seven most frequent groups, the rate in the region with highest incidence was at least 35% higher than that in the region with lowest incidence. The widest variation was observed for CNS tumours and for germ cell and gonadal tumours. For both of these groups, Northern Europe had the highest incidence; the lowest rate for CNS tumours was in the West, while the British Isles had the lowest rate for germ cell and gonadal tumours.

Fig. 1 shows the relative frequencies of the diagnostic groups among male and female adolescents in Europe as a whole. Lymphomas were most frequent among males, but they were outnumbered by epithelial tumours among females.

The most frequent type of leukaemia was lymphoid, accounting for 56% of all leukaemias. Incidence was lowest in the East and highest in the British Isles and the South. Acute non-lymphocytic leukaemia (ANLL) accounted for 31% of leukaemias. There were no significant departures from the European average in the incidence of ANLL. Recorded incidence rates for unspecified leukaemia were low everywhere, with the highest rate in the South. Two-thirds of lymphomas were Hodgkin's disease, with the remainder being mostly non-Hodgkin's lymphoma (NHL). There was little inter-regional variation in the incidence of Hodgkin's disease, but rather more variation in NHL. The incidence of NHL was highest in the South.

Table 1 – Data-sets included in the analyses of incidence and survival of adolescents (age 15–19 years) with cancer, indicators of coverage, data quality and extent of follow-up (Source: ACCIS)

Region	Registry	Coverage		Cancer cases	NOS	Non-malignant	C.a.	Basis of diagnosis			Closing date	*n*	Follow-up			Notes
		Period	Time-trend					MV	DCO	Unknown			1+ days	5+ years	Median	
				n	%	%	%	%	%	%			%	%	Years	
British Isles	IRELAND, National	1994–1997		231	6	<1	<1	98	0	0	31.12.1998	231	100	0	2.8	
	UNITED KINGDOM, Northern Ireland	1993–1996		115	31	<1	0	84	0	0	31.12.1999	115	100	25	1.5	
	UNITED KINGDOM, Scotland	1978–1997	+	1281	7	–	<1	94	<1	0	31.12.1999	1273	99	84	11.1	
East	ESTONIA, National	1978–1997	+	330	11	–	1	96	<1	0	31.12.1998	323	98	72	8.7	
	SLOVAKIA, National	1978–1997	+	1281	8	<1	<1	94	<1	0	31.12.1997	1192	93	59	6.5	
	GERMANY, NCR (only former East)	1978–1987	+	2262	6	<1	<1	98	0	<1	31.12.1987	2180	96	64	6.3	
North	DENMARK, National	1978–1997	+	1400	9	<1	<1	95	<1	<1	31.12.1997	1366	98	74	9.2	
	FINLAND, National	1978–1997	+	1295	10	<1	5	97	0	<1	31.12.1998	1277	99	71	8.8	
	ICELAND, National	1978–1997	+	82	5	0	0	98	0	0	31.12.2000	81	99	82	8.5	
	NORWAY, National	1978–1997	+	1196	12	<1	0	99	<1	0	1.1.2000	1195	100	81	10.8	
South	ITALY, Ferrara	1991–1995		26	15	–	0	77	<1	0	31.12.1998	24	92	70	6.3	
	ITALY, Latina	1983–1997	+	90	22	–	0	88	<1	<1	31.12.1998	89	99	69	7.1	
	ITALY, Liguria	1988–1995		71	7	<1	1	86	0	0	15.4.2000	71	100	93	7.9	
	ITALY, Lombardy	1978–1997	+	238	3	–	<1	96	<1	0	23.9.1999	233	98	69	7.3	
	ITALY, Macerata	1991–1997		27	4	–	0	89	–	<1	30.9.2000	27	100	71	6.3	
	ITALY, Parma	1978–1995	+	81	5	<1	0	86	0	0	1.4.1999	81	100	83	10.1	
	ITALY, Piedmont general	1988–1997		109	5	–	<1	96	0	0	31.5.2001	109	100	86	9	
	ITALY, Ragusa	1983–1997	+	65	14	–	0	97	0	<1	30.3.2000	65	100	88	9.4	
	ITALY, Sassari	1992–1995		30	13	–	0	87	0	<1	30.12.1999	30	100	72	5.4	
	ITALY, Tuscany	1988–1997		169	17	<1	<1	64	0	0	31.12.1998	169	100	62	5.9	
	ITALY, Umbria	1994–1996		36	8	–	3	92	0	0	31.12.1999	36	100	39	4.6	

	ITALY, Veneto	1990–1996		199	11	–	0	95	<1	0	31.12.1998	195	98	58	5.4	
	MALTA, National	1991–1997		27	4	0	0	96	0	0	31.12.1999	27	100	67	6.4	
	SLOVENIA, National	1978–1997	+	400	5	<1	0	100	0	0	31.12.1999	399	100	73	8.8	
	SPAIN, Albacete	1991–1997		40	8	–	0	95	0	0	15.9.2000	40	100	62	5.8	
	SPAIN, Asturias	1983–1997	+	208	13	<1	<1	96	<1	<1	31.12.1997	200	96	60	6.4	
	SPAIN, Basque Country	1988–1994		210	7	–	<1	97	<1	0	31.12.2000	206	98	100	8.9	
	SPAIN, Canary Islands	1993–1996		81	2	–	0	89	<1	<1	–	–	–	–	–	
	SPAIN, Girona	1994–1997		29	3	–	0	100	0	0	31.12.1997	28	97	0	2.5	
	SPAIN, Mallorca	1988–1995		68	3	–	0	100	0	0	31.12.1998	64	94	76	7.2	
	SPAIN, Navarra	1978–1996	+	144	6	–	0	96	<1	0	31.12.1997	140	97	63	6.7	
	SPAIN, Tarragona	1983–1997	+	124	10	–	<1	94	0	<1	31.12.1998	123	99	63	6	
	SPAIN, Zaragoza	1978–1996	+	161	9	<1	0	90	<1	<1	31.12.1996	151	94	66	6.7	
	TURKEY, Izmir	1993–1996		144	6	–	0	97	–	<1	–	–	–	–	–	
West	FRANCE, Doubs	1978–1996	+	125	6	–	2	42	–	<1	1.6.2001	110	88	35	1.8	
	FRANCE, Herault	1988–1997		100	1	–	0	99	–	0	–	–	–	–	–	
	FRANCE, Isere	1979–1997	+	231	5	<1	0	95	–	<1	–	–	–	–	–	
	FRANCE, Manche	1994–1996		14	7	–	0	93	–	0	31.5.2000	9	100	50	5	S
	FRANCE, Bas-Rhin	1978–1996	+	228	6	–	0	99	–	0	31.12.1997	228	100	71	9.6	
	FRANCE, Haut-Rhin	1988–1997		77	5	–	0	95	–	0	31.12.1995	30	100	71	6.5	S
	FRANCE, Somme	1983–1996	+	79	4	–	1	100	–	0	15.8.2000	79	100	51	5.3	
	FRANCE, Tarn	1983–1997	+	47	0	–	11	100	–	0	–	–	–	–	–	
	NETHERLANDS, National	1989–1995		1360	2	–	6	99	–	0	–	–	–	–	–	S o
	NETHERLANDS, Eindhoven	1978–1997	+	251	3	–	8	98	–	<1	1.7.1999	249	99	68	8.6	o
	SWITZERLAND, Basel	1983–1997	+	84	6	–	2	100	–	0	30.6.2000	84	100	76	7.8	
	SWITZERLAND, Geneva	1978–1997	+	105	2	–	0	99	0	0	31.12.1999	105	100	75	8.3	
	SWITZERLAND, Graubunden & Glarus	1989–1997		30	3	–	0	100	0	0	25.5.2000	30	100	64	5.4	
	SWITZERLAND, St. Gallen Appenzell	1983–1997	+	101	4	<1	0	99	0	0	1.2.2001	101	100	48	5	
	SWITZERLAND, Valais	1989–1997		31	0	–	0	100	0	0	1.12.1998	14	93	92	8.6	S

+, included in time trend analyses; –, not applicable; 1+ days, cases followed-up for 1 or more days, as a percentage of all cases in the registries with follow-up; 5+ years, cases followed-up for 5 or more years, as a percentage of all those not deceased by the closing date; C.a., carcinoid of appendix (C18.1, M-8240); DCO, registrations from death certificate only; MV, microscopically verified cases; *n*, number of cases; NCR, National Cancer Registry of the German Democratic Republic: data contributed only to analyses of time trends for Europe as a whole. For explanation, see Steliarova-Foucher, Kaatsch, Lacour et al. (this issue); Non-malignant, Non-malignant cases, only reported for registries with systematic registration of these cases; NOS, cases with unspecified histology, including the ICCC categories Ie, IIe, IIIf, Vic, VIIc, VIIIe, IXe, XIIb, the morphology codes M-8000 to M-8004 in Xe and topography codes C76 to C80 in XIf; O, overlapping registration areas: the larger of the two data-sets was used in each analysis, according to data availability; S, survival analyses were possible only for a restricted data-set [see Steliarova-Foucher, Kaatsch, Lacour et al., this issue]; Unknown, percentage of registrations with unknown basis of diagnosis.

Table 2 – Numbers of cases, indicators of data quality and extent of follow-up by region and period for time trend analyses of data for adolescents (age 15–19 years) (Source: ACCIS)

Region	Period	Cases			Basis of diagnosis			Follow-up	
		NOS		Non-malignant	MV	DCO	Unknown	1+ days	5+ years
		n	%	%	%	%	%	%	%
Europe[a]	1978–1982	3177	9	1	95	<1	<1	96	98
	1983–1987	3530	8	2	96	<1	<1	98	77
	1988–1992	2541	8	2	96	<1	<1	98	95
	1993–1997	2641	6	3	96	<1	<1	98	23
British Isles	1978–1982	315	8	0	92	<1	0	99	100
	1983–1987	344	8	0	94	0	0	99	100
	1988–1992	320	5	0	94	0	0	100	100
	1993–1997	302	5	0	95	<1	0	99	45
East	1978–1982	340	15	2	89	6	0	90	100
	1983–1987	336	9	1	94	<1	0	94	99
	1988–1992	441	7	2	97	<1	0	97	100
	1993–1997	494	5	2	95	2	0	95	4
North	1978–1982	932	10	3	97	<1	<1	97	99
	1983–1987	984	12	4	96	<1	<1	99	99
	1988–1992	985	10	3	97	<1	<1	99	98
	1993–1997	1072	8	4	97	0	<1	100	26
South	1978–1982	220	8	1	92	3	0	97	93
	1983–1987	404	10	2	95	<1	1	97	99
	1988–1992	444	7	2	97	1	<1	99	94
	1993–1997	443	7	2	95	1	<1	99	18
West	1978–1982	239	7	<1	86	0	1	98	87
	1983–1987	331	2	2	93	0	<1	100	81
	1988–1992	351	5	<1	92	0	<1	97	74
	1993–1997	330	4	<1	98	0	2	98	24

1+ days, cases included in survival analyses, as a percentage of cases in the registries with follow-up data; 5+ years, cases followed-up for 5 or more years, as a percentage of all those not deceased by the closing date; DCO, registrations from death certificate only; MV, microscopically verified cases; *n*, number of cases; NOS, cases with unspecified histology ICCC, including subgroups Ie, IIe, IIIf, VIc, VIIc, VIIIe, IXe, XIIb, Xe (M-8000 to M-8004 only) and XIf (C76 to C80.9 only); Non-malignant, non-malignant tumours located in the CNS, classified in ICCC group III and subgroup Xa.

a Europe includes the data of former GDR, which are not included in any of the regions.

There was almost two-fold variation in incidence of CNS tumours, from 17 per million in the West to 33 per million in the North. The North had a low incidence of astrocytoma, but this was balanced by higher incidence for other gliomas. There was little inter-regional variation in ependymoma or primitive neuroectodermal tumours. Incidence rates for the diverse group of other specified CNS tumours and for unspecified CNS tumours were highest in the North. Total incidence for only the malignant CNS tumours was 20.3 per million, with the lowest rate in the West (16.4 per million) and the highest in the North (25.5 per million); the ranking of regions was the same as for CNS tumours in Table 3. Non-malignant neoplasms represented 14% (152/1057) of all CNS tumours. The incidence rate of non-malignant tumours was 3.4 per million for the overall data-set, ranging from 0.6 in the West to 7.5 in the North. Incidence was higher in the South than in the British Isles (results not shown), but otherwise the ranking of regions was again as in Table 3 for CNS tumours.

The characteristic embryonal tumours of childhood were rare everywhere among adolescents. This was especially true of hepatoblastoma, with no cases registered in the 15–19 year age group, and retinoblastoma with only one registration. Neuroblastoma and Wilms' tumour both had incidence rates below 1 per million. Among renal tumours, carcinomas were twice as frequent as Wilms' tumour.

The most frequent types of bone tumour in all regions were osteosarcoma and Ewing's sarcoma. Incidence rates were low in the North for all bone tumours combined and for Ewing's sarcoma, while the East had a low incidence of osteosarcoma. Incidence of soft tissue sarcomas was below the European average in the East. Fibrosarcoma was the most common subgroup of soft tissue sarcomas in all regions, and Kaposi's sarcoma was rare everywhere.

Incidence of germ-cell and gonadal tumours was relatively high in the North and low in the British Isles and the South. The most frequent site of germ cell tumours was gonadal, for which the same geographical pattern was observed. Other germ cell tumours, however, had higher incidence in the East. There was little geographical variation in the incidence of gonadal carcinomas.

Incidence of the remaining carcinomas and melanomas combined was relatively low in the South and East, and higher than average in the other three regions. There were differences in the geographical patterns according to primary site.

Table 3 – Numbers of cases (*n*), sex ratio (M/F) and annual incidence per million for cancer at age 15–19 years in Europe, 1988–1997 (Source: ACCIS)

	Europe			British Isles		East		North		South		West	
	n	M/F	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate
Leukaemia	1006	1.7	22.6	146	27.9[a]	105	18.9[a]	202	20.6	310	26.9[a]	243	19.7[a]
Lymphoid	562	2.0	12.6	80	15.3	49	8.8[a]	113	11.5	173	15.0[a]	147	11.9
Acute non-lymphocytic	312	1.3	7.0	48	9.2	36	6.5	67	6.8	87	7.5	74	6.0
Chronic myeloid	70	1.7	1.6	9	1.7	9	1.6	17	1.7	21	1.8	14	1.1
Other specified	13	1.2	0.3	2	0.4	3	0.5	1	0.1	4	0.3	3	0.2
Unspecified	49	1.2	1.1	7	1.3	8	1.4	4	0.4[a]	25	2.2[a]	5	0.4[a]
Lymphoma	2027	1.2	45.6	215	41.0	213	38.4[a]	472	48.1	604	52.4[a]	523	42.4
Hodgkin's	1319	1.0	29.7	137	26.1	155	28.0	311	31.7	373	32.3	343	27.8
Non-Hodgkin's	489	2.0	11.0	47	9.0	43	7.8[a]	91	9.3	172	14.9[a]	136	11.0
Burkitt's	68	6.6	1.5	5	1.0	7	1.3	5	0.5[a]	26	2.3	25	2.0
Other	9	3.5	0.2	2	0.4	1	0.2	2	0.2	2	0.2	2	0.2
Unspecified	142	1.2	3.2	24	4.6	7	1.3[a]	63	6.4[a]	31	2.7	17	1.4[a]
CNS	1057	1.3	23.8	128	24.4	152	27.4	324	33.0[a]	243	21.1[a]	210	17.0[a]
Ependymoma	64	1.0	1.4	7	1.3	9	1.6	18	1.8	11	1.0	19	1.5
Astrocytoma	459	1.2	10.3	63	12.0	73	13.2	83	8.5[a]	119	10.3	121	9.8
Primitive neuroectodermal	86	2.2	1.9	11	2.1	10	1.8	25	2.5	24	2.1	16	1.3
Other glioma	185	1.3	4.2	23	4.4	19	3.4	93	9.5[a]	23	2.0	27	2.2[a]
Other specified	105	1.4	2.4	10	1.9	18	3.3	44	4.5[a]	22	1.9	11	0.9
Unspecified	158	1.1	3.6	14	2.7	23	4.1	61	6.2[a]	44	3.8	16	1.3[a]
SNS	69	0.8	1.6	8	1.5	13	2.3	13	1.3	14	1.2	21	1.7
Neuroblastoma	36	1.0	0.8	3	0.6	10	1.8[a]	9	0.9	6	0.5	8	0.6
Other	33	0.7	0.7	5	1.0	3	0.5	4	0.4	8	0.7	13	1.1
Retinoblastoma	1	–	0.0	0	–	0	–	0	–	1	0.1	0	–
Renal	53	0.8	1.2	2	0.4	9	1.6	10	1.0	17	1.5	15	1.2
Wilms' etc.	17	1.4	0.4	1	0.2	4	0.7	3	0.3	3	0.3	6	0.5
Carcinoma	34	0.6	0.8	1	0.2	5	0.9	7	0.7	13	1.1	8	0.6
Unspecified	2	0	0.0	0	–	0	–	0	–	1	0.1	1	0.1
Hepatic	48	1.8	1.1	5	1.0	8	1.4	10	1.0	14	1.2	11	0.9
Carcinoma	43	1.7	1.0	5	1.0	7	1.3	9	0.9	12	1.0	10	0.8
Unspecified	5	4.0	0.1	0	–	1	0.2	1	0.1	2	0.2	1	0.1
Bone	672	1.9	15.1	77	14.7	74	13.3	124	12.6[a]	186	16.1	211	17.1
Osteosarcoma	372	1.9	8.4	38	7.3	32	5.8[a]	86	8.8	96	8.3	120	9.7
Chondrosarcoma	57	1.7	1.3	6	1.1	7	1.3	8	0.8	13	1.1	23	1.9
Ewing's	185	2.0	4.2	27	5.2	30	5.4	22	2.2[a]	58	5.0	48	3.9
Other specified	33	1.4	0.7	3	0.6	2	0.4	2	0.2	10	0.9	16	1.3
Unspecified	25	1.5	0.6	3	0.6	3	0.5	6	0.6	9	0.8	4	0.3
Soft tissue	576	1.2	13.0	60	11.5	52	9.4[a]	143	14.6	149	12.9	172	13.9
Rhabdomyosarcoma	131	1.8	2.9	11	2.1	12	2.2	27	2.8	43	3.7	38	3.1
Fibrosarcoma	212	1.0	4.8	16	3.1	21	3.8	62	6.3	50	4.3	63	5.1
Kaposi's	4	1.0	0.1	0	–	0	–	0	–	2	0.2	2	0.2
Other specified	175	1.0	3.9	25	4.8	15	2.7	41	4.2	37	3.2	57	4.6
Unspecified	54	1.6	1.2	8	1.5	4	0.7	13	1.3	17	1.5	12	1.0
Germ cell and gonadal	1040	2.7	23.4	93	17.7[a]	149	26.9	314	32.0[a]	226	19.6[a]	258	20.9
CNS germ cell	62	5.9	1.4	9	1.7	6	1.1	21	2.1	7	0.6[a]	19	1.5
Other non-gonadal germ-cell	52	2.3	1.2	4	0.8	16	2.9[a]	9	0.9	13	1.1	10	0.8
Gonadal germ-cell	773	5.1	17.4	64	12.2[a]	107	19.3	239	24.4[a]	166	14.4[a]	197	16.0
Gonadal carcinoma	117	0.0	2.6	13	2.5	14	2.5	28	2.9	35	3.0	27	2.2
Other gonadal	36	1.4	0.8	3	0.6	6	1.1	17	1.7[a]	5	0.4	5	0.4
Epithelial	1640	0.6	36.9	213	40.6	153	27.6[a]	428	43.6[a]	356	30.9[a]	490	39.7
Adrenocortical carcinoma	17	0.3	0.4	1	0.2	4	0.7	2	0.2	6	0.5	4	0.3
Thyroid carcinoma	368	0.3	8.3	23	4.4[a]	33	6.0[a]	99	10.1	127	11.0[a]	86	7.0
Nasopharynx carcinoma	55	1.2	1.2	2	0.4	15	2.7[a]	4	0.4	17	1.5	17	1.4
Melanoma	571	0.6	12.8	98	18.7[a]	35	6.3[a]	170	17.3[a]	77	6.7[a]	191	15.5[a]
Skin carcinoma	165	0.8	3.7	42	8.0[a]	17	3.1	26	2.7	48	4.2	32	2.6[a]
Other and unspecified	464	0.8	10.4	47	9.0	49	8.8	127	12.9[a]	81	7.0[a]	160	13.0[a]
Other and unspecified	83	1.4	1.9	21	4.0[a]	7	1.3	17	1.7	33	2.9[a]	5	0.4[a]
Specified	13	0.4	0.3	3	0.6	3	0.5	1	0.1	3	0.3	3	0.2
Unspecified	70	1.8	1.6	18	3.4[a]	4	0.7	16	1.6	30	2.6[a]	2	0.2[a]
Total	8272	1.2	186.0	968	184.7	935	168.6[a]	2057	210.0[a]	2153	186.6	2159	174.8[a]

a 95% confidence interval does not include rate for all European regions combined.

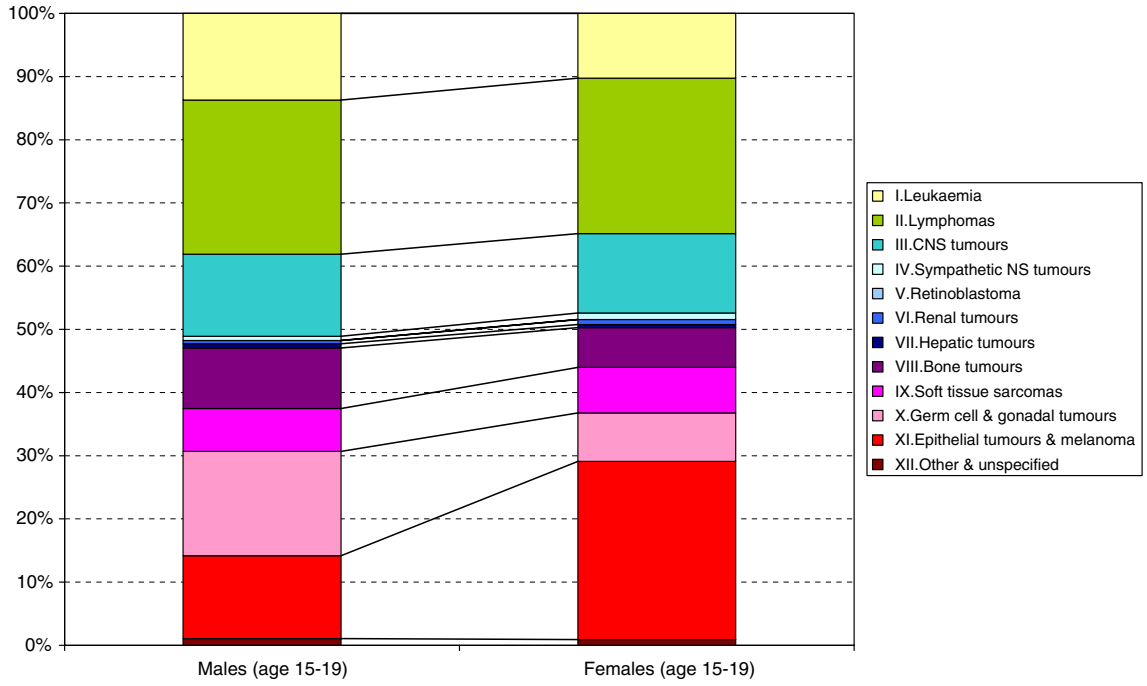

Fig. 1 – Relative frequencies (%) of the 12 diagnostic groups of ICCC among male and female adolescents in Europe, 1988–1997. Source: ACCIS.

Incidence rates were above average for nasopharyngeal carcinoma in the East, for thyroid carcinoma in the North and South, and for skin carcinoma in the British Isles. Table 4 shows incidence rates for the main sites within the heterogeneous subgroup of other and unspecified carcinomas. The most common site was the appendix, followed by large bowel, lung and salivary glands.

Table 5 shows trends in incidence during 1978–1997. Cancer incidence among adolescents increased significantly, at a rate of 2% per year (95% confidence interval 1.7, 2.4, based on 11,889 cases, $P < 0.0001$) overall. There were highly significant increases in all five regions, with the highest rate of increase in the South and the lowest in the West (Table 6). Among the main diagnostic groups, significant increases were

Table 4 – Numbers of cases (*n*), sex ratio (M/F) and annual incidence per million for other and unspecified carcinomas at age 15–19 years in Europe, 1988–1997 (Source: ACCIS)

Tumour site	ICD-O-2 codes	Europe			British Isles		East		North		South		West	
		n	M/F	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate	*n*	Rate
Salivary glands	C07.0–C08.0	34	0.8	0.8	5	1.0	3	0.5	11	1.1	8	0.7	7	0.6
Other head & neck	C00.0–C06.9, C09.0–C09.9, C10.0–C10.9, C12.9–C14.8, C32.0–C32.9	26	1.2	0.6	1	0.2	1	0.2	17	1.7[a]	3	0.3	4	0.3
Stomach	C16.0–C16.9	17	1.4	0.4	1	0.2	3	0.5	3	0.3	7	0.6	3	0.2
Appendix	C18.1	163	0.6	3.7	6	1.1[a]	8	1.4[a]	45	4.6	8	0.7[a]	96	7.8[a]
Large bowel	C18.0, C18.2–C21.8	57	1.0	1.3	8	1.5	12	2.2	14	1.4	12	1.0	11	0.9
Pancreas	C25.0–C25.9	13	0.3	0.3	1	0.2	2	0.4	3	0.3	3	0.3	4	0.3
Lung	C34.0–C34.9	41	0.8	0.9	6	1.1	8	1.4	14	1.4	6	0.5	7	0.6
Thymus	C37.9	6	5.0	0.1	0	0.0	1	0.2	2	0.2	2	0.2	1	0.1
Breast	C50.0–C50.9	5	–	0.1	0	0.0	1	0.2	0	0.0	3	0.3	1	0.1
Cervix/uterus	C53.0–C55.9	15	–	0.3	4	0.8	1	0.2	4	0.4	2	0.2	4	0.3
Bladder	C67.0–C67.9	23	1.6	0.5	4	0.8	4	0.7	2	0.2	6	0.5	7	0.6
Other specified		39	1.2	0.9	5	1.0	3	0.5	9	0.9	17	1.5	5	0.4
Unspecified	C70.0–C72.9, C76.0–C80.9	25	0.9	0.6	6	1.1	2	0.4	3	0.3	4	0.3	10	0.8
Total		464	0.8	10.4	47	9.0	49	8.8	127	12.9[a]	81	7.0[a]	160	13.0[a]
Total, excluding appendix		301	0.7	6.8	41	7.8	41	7.4	82	8.4	73	6.3	64	5.2[a]

There were no registrations for carcinoma of the eye (ICD-0-2 C69.0–C69.9).
a 95% confidence interval does not include rate for all European regions combined.

Table 5 – Trends in the incidence of cancer at age 15–19 years, Europe, 1978–1997 (Source: ACCIS)

	n	AAPC	*P*
Leukaemia	1491	0.6	0.22
Lymphoid	748	1.9	0.008
Acute non-lymphocytic	494	0.4	0.66
Chronic myeloid	125	–0.6	0.74
Unspecified	104	–2.3	0.33
Lymphomas	2801	3.0	<0.0001
Hodgkin's	1911	3.5	<0.0001
Non-Hodgkin	617	1.1	0.15
Burkitt's	63	–2.0	0.44
Unspecified	192	1.9	0.40
CNS	1637	1.7	0.001
Ependymoma	102	0.0	1.0
Astrocytoma	614	2.3	0.005
Primitive neuroectodermal	140	0.7	0.64
Other glioma	291	1.7	0.12
Other specified	220	2.2	0.15
Unspecified	270	0.8	0.50
Sympathetic	103	0.3	0.88
Neuroblastoma	70	0.4	0.88
Renal	71	0.7	0.77
Hepatic	63	–0.7	0.77
Carcinoma	57	–0.6	0.80
Bone	988	0.6	0.38
Osteosarcoma	539	0.7	0.43
Chondrosarcoma	91	0.4	0.87
Ewing's	282	0.3	0.82
Soft-tissue sarcoma	820	0.9	0.19
Rhabdomyosarcoma	162	1.4	0.41
Fibrosarcoma	295	1.5	0.17
Other specified	258	1.4	0.26
Unspecified	101	–0.8	0.72
Germ-cell and gonadal	1702	2.5	<0.0001
CNS germ-cell	81	3.5	0.13
Other non-gonadal germ-cell	102	2.0	0.38
Gonadal germ-cell	1269	2.5	<0.0001
Gonadal carcinoma	157	1.4	0.37
Other gonadal	93	–1.9	0.41
Epithelial	2062	3.1	<0.0001
Thyroid	466	2.5	0.006
Nasopharynx	79	0.2	0.94
Melanoma	677	4.1	<0.0001
Skin carcinoma	198	2.5	0.057
Other carcinoma	626	1.5	0.50
Other & unspecified	150	–0.5	0.74
Unspecified	107	0.2	0.91

Numbers of cases (*n*), average annual percentage change (AAPC) from a model including calendar year, sex and region, and *P*-value from the test for trend. Diagnostic groups and subgroups with fewer than 50 registrations excluded.

Table 6 – Trends in the incidence of cancer at age 15–19 years, Europe, 1978–1997 (Source: ACCIS)

Region	*n*	AAPC	95% CI	*P*
British Isles	1281	2.01	(1.03–2.99)	<0.0001
East	1611	1.79	(0.94–2.65)	<0.0001
North	3973	2.01	(1.45–2.56)	<0.0001
South	1511	2.42	(1.46–3.39)	<0.0001
West	1251	1.70	(0.65–2.77)	0.002

Numbers of cases (*n*) and average annual percentage change (AAPC) from a model including calendar year and sex.

observed for lymphomas, CNS tumours, germ cell and gonadal tumours and epithelial tumours. Among lymphomas, the remarkable increase of 3.5% per year was seen for Hodgkin's disease. Among CNS tumours the main increase occurred for astrocytoma (2.3% per year). Within the group of germ cell and gonadal tumours, there was a significant increase only for gonadal germ cell tumours. Within the group of epithelial tumours, significant increases were observed for carcinomas of thyroid, skin, and other and unspecified sites, and for malignant melanoma. Within the main diagnostic groups that showed no significant change overall, the only subgroup with a significant change in incidence was lymphoid leukaemia (AAPC = 1.9, Table 5).

Table 7 presents 5-year survival rates among adolescents diagnosed during 1988–1997, for all cancers combined and for diagnostic groups and subgroups with at least 100 cases followed up in Europe as a whole. The overall 5-year survival rate for all cancers was 73%. Survival was higher than average in the North, at 78%, and lowest in the East, 57%. The same pattern of lower survival in the East was found in nearly all diagnostic groups and subgroups with sufficient cases for analysis.

Table 8 shows trends in survival during 1978–1997. Results are presented for all cancers combined and for all diagnostic groups with at least 100 cases followed up in Europe as a whole except for the heterogeneous group XII 'Other and unspecified malignant neoplasms'. Overall and in the North European region, survival increased significantly during the 20-year period for all cancers combined and for all diagnostic groups with sufficient registrations for analysis. There were also significant increases in survival for most diagnostic groups analysed in the British Isles and the South. In the West, significant increases were found for lymphomas and epithelial tumours, but not for leukaemias or the group of gonadal and germ cell tumours. There were insufficient numbers of cases for analyses of other diagnostic groups in this region. In the East there were significant increases for the group of germ cell and gonadal tumours and for epithelial tumours and a marginal increase for lymphomas, while for other groups, namely leukaemia, CNS tumours, bone tumours and soft tissue sarcomas, there was virtually no change.

4. Discussion

Cancer incidence among adolescents is more than 50% higher than at age 10–14 years, marking the start of the inexorable rise in incidence through adulthood. There was a distinctive distribution of diagnostic groups, with the most frequent being, in descending order, lymphomas, epithelial tumours, germ cell and gonadal tumours, CNS tumours and leukaemia (Fig. 2). This contrasts with the pattern in childhood, when the most frequent diagnostic group is leukaemia, followed by CNS tumours, lymphomas and sympathetic nervous

Table 7 – Five-year survival (95% CI) of adolescents diagnosed at age 15–19 years during 1988–1997, by diagnostic subgroup and European region (Source: ACCIS)

	Europe		British Isles		East		North		South		West	
	n	Survival %	*n*	Survival %	*n*	Survival %	*n*	Survival %	*n*	Survival %	*n*	Survival %
Leukaemia	811	44 (40–48)	146	50 (41–59)	105	14 (7–22)	202	46 (38–53)	281	49 (43–55)	77	43 (31–54)
Lymphoid	450	50 (44–54)	80	59 (47–70)	49	19 (8–34)	113	48 (38–57)	159	54 (45–62)	49	49 (33,63)
Acute non-lymphocytic	245	35 (29–42)	48	40 (25–54)	36	6 (1–20)	67	39 (26–52)	74	40 (28–51)	20	40 (18,61)
Lymphomas	1597	81 (79–83)	215	82 (76–87)	213	69 (62–76)	472	83 (79–86)	556	83 (79–86)	141	82 (74–88)
Hodgkin's	1045	89 (87–91)	137	90 (83–94)	155	83 (74–88)	311	89 (84–92)	354	91 (87–94)	88	92 (82,97)
Non-Hodgkin's	360	64 (59–69)	47	67 (50–80)	43	37 (20–54)	91	71 (60–79)	146	68 (59–75)	33	55 (34,72)
Unspecified	137	74 (65–81)	24	70 (44–86)	7	–	63	73 (59–82)	29	88 (67–96)	14	76 (43,92)
CNS	866	70 (66–73)	128	68 (59–76)	152	57 (47–66)	324	77 (72–82)	208	67 (60–73)	54	68 (52–80)
Astrocytoma	348	65 (59–70)	63	71 (57–81)	73	52 (37–65)	83	71 (59–80)	96	64 (54–73)	33	64 (43,79)
Other glioma	162	75 (67–81)	23	60 (37–77)	19	74 (43–89)	93	78 (67–85)	18	83 (57–94)	9	–
Unspecified	141	65 (56–73)	14	62 (31–82)	23	22 (3–52)	61	83 (71–91)	43	51 (33–67)	19	–
Bone	486	48 (43–53)	77	58 (45–68)	74	27 (17–38)	124	52 (42–61)	151	48 (39–56)	60	55 (40–67)
Osteosarcoma	271	52 (45–58)	38	62 (42–77)	32	33 (17–50)	86	53 (41–64)	81	53 (41–64)	34	52 (35,68)
Ewing's	144	31 (23–39)	27	43 (23–61)	30	10 (2–28)	22	36 (17–55)	47	30 (17–43)	18	36 (10,63)
Soft tissue	430	67 (62–71)	60	70 (56–81)	52	47 (31–61)	143	72 (64–79)	133	68 (59–75)	42	64 (47–77)
Fibrosarcoma	164	81 (74–86)	16	87 (56–96)	21	57 (31–76)	62	82 (69–89)	46	87 (72–94)	19	84 (58,94)
Other specified	123	74 (64–81)	25	74 (46–89)	15	44 (15–70)	41	78 (61–89)	34	84 (66–93)	8	–
Germ-cell & gonadal	839	87 (84–89)	93	84 (74–90)	149	72 (63–80)	314	92 (88–94)	203	90 (84–93)	80	87 (77–93)
Testicular germ-cell	520	90 (87–92)	54	88 (76–95)	86	76 (64–85)	213	94 (89–96)	120	92 (85–96)	47	90 (76,96)
Epithelial	1245	88 (86–90)	213	85 (79–90)	153	82 (74–88)	428	93 (90–95)	326	85 (81–89)	125	93 (86–97)
Thyroid carcinoma	285	99 (97–100)	23	100 –	33	97 (79–100)	99	99 (93–100)	114	100 –	16	100 –
Melanoma	427	88 (84–91)	98	86 (76–92)	35	75 (56–87)	170	94 (89–97)	71	76 (64–85)	53	96 (84,99)
Skin carcinoma	150	98 (92–100)	42	93 (73–98)	17	100 –	26	100 –	44	100 –	21	100 –
Other carcinoma	331	79 (74–83)	47	69 (53–81)	49	80 (64–90)	127	87 (80–92)	77	71 (59–80)	31	80 (58,92)
Total	6494	73 (71–74)	968	73 (70–76)	935	57 (53–61)	2057	78 (76–80)	1928	73 (71–75)	606	72 (68–76)

n: numbers of cases followed up.

system tumours [Stiller, Marcos-Gragera, Ardanaz and colleagues, this issue]. Within some diagnostic groups, also, there were marked differences between adolescents and children in the relative frequencies of the main subgroups. For example, the ratio of lymphoid leukaemia to ANLL was 1.8:1 in adolescents compared with around 4:1 in children [Coebergh, Reedijk, de Vries and colleagues, this issue].

The female excess of epithelial tumours, already observed in childhood [Stiller, Marcos-Gragera, Ardanaz and colleagues, this issue; Steliarova-Foucher, Stiller, Pukkala and colleagues, this issue; de Vries and colleagues, this issue], increases with age through adolescence and early adulthood.[11] In the USA, epithelial tumours account for more than half of all malignancies among women by the age of 25–29 years, whereas among men they only begin to outnumber non-epithelial cancers around the age of 40 years.[12]

The geographical patterns of incidence showed a mixture of differences and similarities compared with those among children. For leukaemia, incidence was lowest in the East, as was seen in children, but highest in the British Isles, which had the next lowest incidence among children. The highest incidence of lymphomas in both age groups was in the South, but the lowest incidence in adolescents was in the East, which had the second highest rate among children. For CNS tumours, the order of registered incidence rates was identical to that among children with the highest in the North and the lowest in the West. There was little consistency in regional patterns between the two age groups for bone tumours. Soft tissue sarcomas among both children and adolescents had their highest incidence in the North and lowest in the East. Incidence of germ cell and gonadal tumours was also highest in the North for both age ranges, but the next highest rate among adolescents was in the East, which had the lowest childhood incidence. Inter-regional comparisons between age ranges should be treated with some caution since, with the exception of the North, the childhood incidence data included substantial contributions from paediatric cancer registries in areas which were not covered for adolescents. Comparison with published data for England, however, suggests that the results presented here for the British Isles, based on data from Scotland, Northern Ireland and the Republic of Ireland, are representative. In England, the incidence rates in 1988–1997[13] were generally similar to those reported here for the British Isles; the only notable exceptions were that incidence was lower in England for leukaemias, CNS tumours and melanoma. Incidence rates in the west European region, represented in this study by France, the Netherlands and Switzerland, were generally similar to those already reported for France alone.[14] The divergence of geographical patterns of incidence between adolescents and children for many diagnostic groups suggests that some of the variations are real. For CNS tumours, however, where there

Table 8 – Five-year survival (95% CI) of adolescents diagnosed at age 15–19 years during 1978–1997 by diagnostic group and European region (Source: ACCIS)

		1978–1982		1983–1987		1988–1992		1993–1997		
		n	Survival %	*n*	Survival %	*n*	Survival %	*n*	Survival %	*P*
Europe	Leukaemia	416	21 (17–25)	394	28 (24–33)	303	43 (37–48)	275	44 (37–51)	<0.0001
	Lymphoma	669	66 (62–69)	832	72 (69–75)	569	80 (76–83)	631	83 (79–86)	<0.0001
	CNS	382	62 (57–67)	474	69 (65–73)	323	68 (62–73)	330	73 (66–78)	0.0020
	Bone	286	34 (28–39)	295	42 (36–47)	181	46 (38–53)	186	51 (43–59)	0.0002
	Soft-tissue	201	57 (50–64)	264	51 (45–57)	171	64 (56–71)	155	74 (66–80)	0.0004
	Germ-cell & gonadal	456	64 (60–69)	502	76 (71–79)	336	83 (79–87)	346	90 (85–93)	<0.0001
	Epithelial	489	79 (75–83)	520	81 (78–85)	467	88 (84–90)	518	90 (87–93)	<0.0001
	Total	3002	57 (55–58)	3380	63 (62–65)	2420	71 (69–73)	2522	76 (74–77)	<0.0001
British Isles	Leukaemia	38	24 (12–38)	39	41 (26–56)	45	53 (38–67)	44	65 (48–77)	<0.0001
	Lymphoma	73	75 (64–84)	83	72 (61–81)	69	86 (75–92)	72	84 (72–91)	0.0635
	CNS	31	45 (27–61)	35	57 (39–72)	42	67 (50–79)	26	77 (55–89)	0.0101
	Bone	37	35 (20–50)	32	41 (24–57)	26	65 (44–80)	16	65 (35–84)	0.0038
	Germ-cell & gonadal	43	63 (47–75)	43	74 (59–85)	34	76 (58–87)	29	90 (71–97)	0.0130
	Epithelial	58	83 (70–90)	66	85 (74–92)	78	82 (72–89)	83	91 (81–96)	0.3854
	Total	312	60 (54–65)	342	63 (58–68)	319	73 (68–78)	300	80 (74–84)	<0.0001
East	Leukaemia	42	10 (3–21)	33	21 (10–36)	49	14 (6–25)	45	14 (3–32)	0.6567
	Lymphoma	86	59 (48–69)	96	60 (50–69)	100	69 (59–77)	109	69 (54–80)	0.0795
	CNS	27	59 (39–75)	46	54 (39–67)	70	53 (41–64)	66	53 (29–73)	0.5871
	Bone	30	23 (10–39)	18	39 (17–60)	32	19 (8–34)	42	36 (20–51)	0.7478
	Soft-tissue	26	50 (30–67)	25	44 (24–62)	26	42 (23–60)	25	54 (27–75)	0.9455
	Germ-cell & gonadal	36	58 (41–72)	48	73 (58–83)	65	65 (52–75)	81	83 (71–91)	0.0093
	Epithelial	47	64 (48–76)	41	73 (57–84)	69	80 (68–87)	82	84 (71–92)	0.0038
	Total	305	47 (41–52)	316	56 (50–61)	427	55 (50–59)	467	59 (52–65)	0.0002
North	Leukaemia	124	25 (18–33)	115	34 (25–43)	101	46 (36–55)	94	42 (29–55)	0.0005
	Lymphoma	147	66 (57–73)	172	74 (67–80)	213	80 (74–85)	258	84 (78–89)	<0.0001
	CNS	144	65 (56–72)	172	80 (73–85)	140	75 (67–81)	181	79 (71–84)	0.0236
	Bone	82	38 (27–48)	78	49 (37–59)	61	51 (38–63)	63	53 (38–66)	0.0482
	Soft-tissue	63	59 (46–70)	77	53 (42–64)	75	71 (59–80)	66	74 (61–84)	0.0151
	Germ-cell & gonadal	131	84 (76–89)	138	83 (76–88)	159	91 (85–94)	155	93 (85–97)	0.0010
	Epithelial	176	85 (79–90)	184	86 (80–90)	204	94 (90–97)	223	91 (86–95)	0.0287
	Total	905	63 (59–66)	971	69 (66–72)	976	77 (74–79)	1067	79 (76–82)	<0.0001
South	Leukaemia	40	30 (17–44)	60	35 (23–47)	70	49 (36–60)	66	52 (38–64)	0.0118
	Lymphoma	53	63 (48–75)	100	76 (66–83)	128	84 (77–90)	126	88 (81–93)	0.0002
	CNS	19	67 (41–84)	55	69 (55–80)	48	64 (48–76)	38	65 (46–79)	0.8712
	Bone	18	33 (14–55)	30	37 (20–53)	34	42 (26–58)	41	56 (38–71)	0.2933
	Soft-tissue	20	45 (23–65)	37	66 (48–79)	31	71 (51–84)	28	81 (60–92)	0.0178
	Germ-cell & gonadal	23	61 (38–77)	40	80 (64–89)	45	89 (75–95)	44	92 (78–98)	0.0006
	Epithelial	32	70 (50–83)	61	75 (63–84)	73	78 (67–86)	75	90 (77–95)	0.0162
	Total	213	52 (45–58)	392	64 (59–68)	438	71 (67–75)	438	77 (72–81)	<0.0001
West	Leukaemia	23	24 (9–43)	30	29 (14–46)	38	46 (29–61)	26	25 (8–47)	0.4169
	Lymphoma	54	70 (56–81)	67	78 (66–87)	59	81 (68–89)	66	86 (74–93)	0.0101
	Germ-cell & gonadal	23	74 (51–87)	27	88 (68–96)	33	87 (69–95)	37	86 (67–95)	0.2071
	Epithelial	33	77 (58–88)	46	78 (62–88)	43	98 (84–100)	55	92 (81–97)	0.0102
	Total	189	60 (53–67)	257	66 (60–72)	260	72 (65–77)	250	75 (69–81)	0.0004

n, numbers of cases followed up. *P*, *P*-value from log-rank test for trend.

was striking consistency in geographical patterns across the age range, it seems likely that at least the high incidence in the North is partly a reflection of differences in diagnosis and registration [Peris-Bonet and colleagues, this issue]. Among skin carcinomas in adolescents, basal cell carcinoma (BCC) was registered with five times the frequency of squamous cell [de Vries and colleagues, this issue]. While only a few registries did not claim to register skin carcinomas systematically, it remains possible that much of the inter-regional variation in incidence rates is due to variable ascertainment levels for BCC. Much of the inter-regional variation in incidence of other and unspecified carcinomas (ICCC XIf) was due to differences in the rates for carcinoid tumours of the appendix, which made the largest contribution of any site to the rates for this subgroup in the North and West regions and in Europe as a whole [Steliarova-Foucher, Kaatsch, Lacour and colleagues, this issue].

The incidence rate for all cancers of 186 per million during 1988–1997 in Europe as a whole was somewhat lower than the 202 per million during 1986–1995 in the SEER registries of the United States of America (USA).[15] Incidence rates for most diagnostic groups were similar in the two studies. The overall

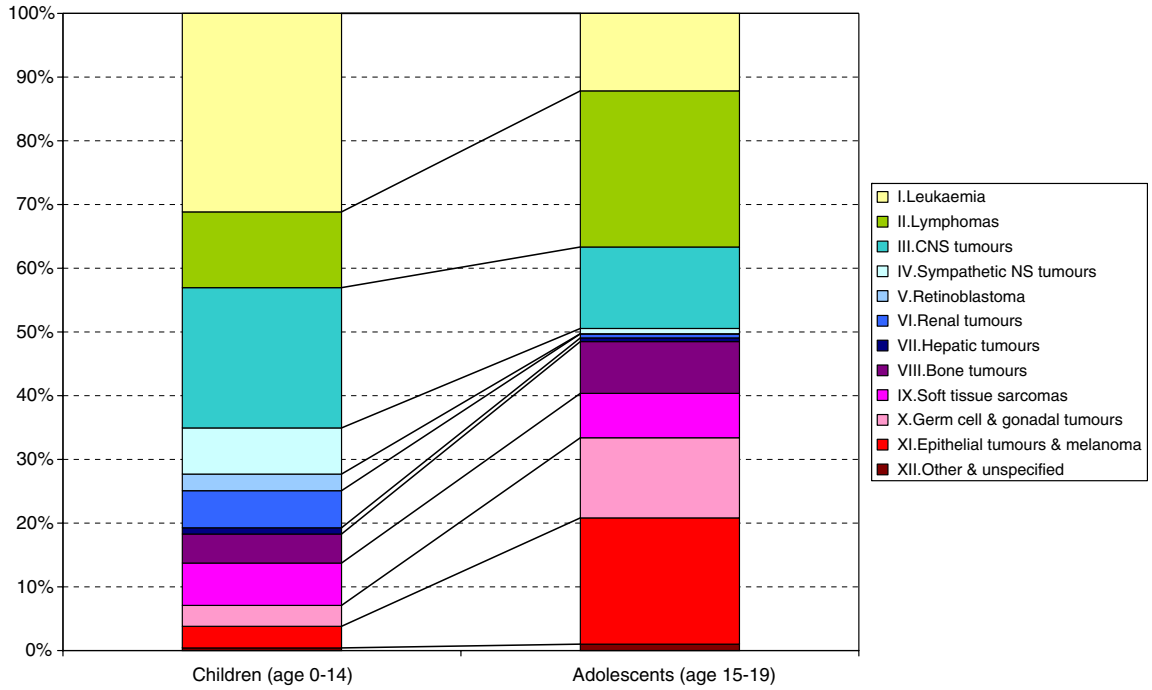

Fig. 2 – Relative frequencies (%) of the 12 diagnostic groups of ICCC among children and adolescents in Europe, 1988–1997. Source: ACCIS.

deficit in Europe was largely attributable to lower rates for soft tissue sarcomas, germ cell and gonadal tumours, and thyroid carcinoma. The higher rate for CNS tumours in Europe can probably be explained by the inclusion of non-malignant CNS tumours in many of the European registries, since the rate of malignant CNS tumours in Europe (20.3 per million) was the same as in the SEER data (20.2 per million).[15] It has been estimated that inclusion of non-malignant tumours would increase the total incidence of CNS tumours among adolescents in the USA by as much as 57%.[16] In the ACCIS study, the inclusion of non-malignant neoplasms increased the total rate of CNS tumours by 17% above that of malignant tumours alone in the overall data-set and by 30% in the North, the region with the highest proportion of non-malignant tumours and the only region in which all registries included them.

Overall, cancer incidence among adolescents increased at a rate of 2% per year, compared with 1.1% among children of all ages and 1.3% among those aged 10–14 years [Kaatsch and colleagues, this issue]. The rate of increase was higher in adolescents than in children aged 0–14 years for lymphoid leukaemia (1.9% versus 0.8% per year respectively), lymphomas (2.8% per year in adolescents and 1.3% per year in children aged 10–14) and epithelial tumours (3.2% per year in adolescents and 2.2% per year in children aged 10–14). Incidence also increased faster in adolescents than in children for the overall group of germ cell and gonadal tumours (2.6% in adolescents and 1.6% in children aged 0–14). In adolescents the increase was seen for gonadal germ cell tumours whereas in children it was for germ cell tumours of the CNS and other extra-gonadal sites. The rate of increase was similar in adolescents and children for CNS tumours (overall and astrocytoma) [Peris-Bonet and colleagues, this issue]. In some diagnostic groups a significant increase was observed in children but not in adolescents: tumours of the sympathetic nervous system, renal tumours and soft tissue sarcomas [Kaatsch and colleagues, this issue]. The incidence trends for adolescents and children were calculated for populations from partly different geographical areas. Within a single region, trends can vary markedly between countries, as has been shown for testicular cancer in Northern Europe.[17] The differences in the size of temporal trends between adolescents and children are therefore not necessarily representative of the true patterns.

While there was no consistency in the ranking of the five European regions by AAPC for total cancer incidence among adolescents and children, for every region the AAPC was higher in adolescents. The rate of increase among European adolescents was also greater than in the USA over a similar period. In the SEER registries, total incidence increased from 183 per million in 1975–1979 to 203.8 per million in 1990–1995; the AAPC was 0.70%, slightly less than the AAPC of 0.77% among children.[15] The increase in the US was concentrated in ALL, osteosarcoma and germ cell and gonadal tumours. Some of the increase in the last of these groups was an artefact of increased registration for epithelial ovarian tumours of borderline malignancy. It is unknown how much of the increase for ALL and osteosarcoma was real, since trends were not reported for leukaemias or bone tumours of unspecified cell type.

The 5-year survival rate for all cancers combined in Europe as a whole was 73%, very similar to the 72% for children [Sankila and colleagues, this issue]. The similarity of survival rates was mainly attributable to the higher proportion of

tumours with favourable prognosis (such as Hodgkin's disease and epithelial tumours) in adolescents than in children, while there were important differences in outcome between adolescents and children for diagnostic groups with somewhat lower survival. Adolescents had substantially lower survival than children for leukaemia (44% versus 73%) and bone tumours (48% versus 61%), but somewhat higher survival for CNS tumours (70% versus 64%). There is debate as to whether adolescents with cancer should be treated as old children rather than young adults, at least for those whose disease is biologically similar to that found in children. Adolescents with acute lymphoblastic leukaemia (ALL) have been found to have higher survival when treated on protocols developed for children rather than adults.[18]

The pattern of lowest survival rates in the East and highest in the North overall and for many diagnostic groups was similar to that found previously for patients aged 15–24 years in the EUROCARE study,[6] though different countries and registries were represented in the two studies. This pattern is also similar to that among both children[3] [Sankila and colleagues, this issue] and adults,[19] presumably reflecting similar influences of variations in healthcare systems and resources. Survival may also vary between countries within the same region,[6] though the survival rates reported for France[20] are broadly similar to those for the West region in the present study.

Survival rates for adolescents in Europe during 1988–1997 were comparable with those in the SEER registries for most major diagnostic groups and subgroups.[15] The most striking exception was Ewing's sarcoma, for which 5-year survival was 31% in Europe as a whole, and below 45% in each European region, compared with 56% in the USA. The reasons for this difference are unknown, though it seems unlikely to be due to misclassification since survival of adolescents with osteosarcoma was also higher in the USA than in Europe, but by a much smaller margin (59% compared with 52%), and the ratio of incidence rates for osteosarcoma to Ewing's sarcoma was similar in the two studies.

In the analysis of survival trends, for all cancers combined in Europe as a whole the 5-year survival rate rose between 1978–1982 and 1993–1997 from 57% to 76%, equivalent to a 44% reduction in the probability of death within 5 years of diagnosis. This was very similar to the 45% reduction among children over the same period [Magnani and colleagues, this issue]. The largest reduction in the death rate, 72%, was for germ-cell and gonadal tumours, presumably reflecting the increased efficacy of chemotherapy for these cancers. The risk of death within 5 years was reduced by around 50% for lymphomas and epithelial tumours, by 40% for soft tissue sarcomas, and by 26–29% for leukaemias, CNS tumours and bone tumours. In the USA, the much smaller improvement in survival of young adults with sarcomas of bone and soft tissue compared with children has been linked to lower participation in clinical trials.[21] In Europe, however, while the reduction in probability of death for bone tumours was greater among children (42%) [Magnani and colleagues, this issue] than among adolescents, for soft tissue sarcoma the reduction among children (25%) was considerably smaller than among adolescents.

In the five European regions, the probability of death within 5 years of diagnosis was reduced by around 50% in the British Isles and the South, 43% in the North, 37% in the West and 23% in the East. The net effect was that, outside the Eastern region, the amount of inter-regional variation in survival was reduced over the course of the study period. Survival in the East was lower than in the other regions throughout, and the gap increased in more recent years. Between 1965–1969 and 1995–1998, cancer mortality at 15–24 years of age fell by 43% in EU countries and by between 11% and 33% in four Eastern European countries.[22] Assuming that incidence trends did not vary markedly between regions, the smaller reduction in mortality in the East is consistent with the smaller increase in survival, though the four Eastern countries in the mortality study, Bulgaria, Hungary, Poland and Romania, did not contribute data to this study.

Adolescents have a distinctive pattern of cancer incidence, which differs from those found in younger and older age groups. This study has revealed inter-regional differences in patterns of cancer incidence and survival among adolescents in Europe. Incidence increased over the 20-year study period. Survival rates varied widely between regions and, within the same diagnostic groups, tended to be lower than in children. During 1978–1997, survival increased in all regions, but at a slower rate in the East than elsewhere. Extension of the ACCIS database will provide the opportunity to study these variations in greater detail and to monitor trends in both incidence and survival over more recent years.

Conflict of interest statement

None declared.

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