National Cancer Registry Ireland **Cancer Trends**

Childhood cancer

Case numbers and histological types

An average of 128 cancers was diagnosed per year in children aged under 15 years between 1994 and 2011 (Table 1). In older teenagers aged between 15 and 19 years, an additional 68 cases were diagnosed per year, or a total of 196 cases under age 20 (Table 1). These figures mostly involve malignant cancers but the International Classification of Childhood Cancer (ICCC)[1], followed in this report, also includes non-malignant tumours of the brain & central nervous system, which made up about 9% of cases tabulated here.

The ICCC subdivides childhood cancers into 12 main diagnostic groups in children, as listed in Table 1. Almost 3 in every 4 cancers in young children were either haematological malignancies (leukaemia, lymphoma and related) or tumours of the brain and nervous system. Although these tumours also represented the main cancers in older teenagers, over 20% of cancers in this group consisted of other epithelial tumour types, including malignant melanoma. *The remainder of this report deals with cancers in children aged under 15 only, the standard age-grouping used for most international analyses.*

Table 1. Annual average number of cancers diagnosed in children and teenagers in Ireland, 1994–2011

	<15 years		15-19 years		*total*
	N	% of all	N	% of all	*N*
all cancers (ICCC definition)#	128		68		*196*
ICCC group#:					
I leukaemias & related	40	31%	8	12%	*48*
II lymphomas & related	13	10%	17	25%	*30*
III brain & CNS*	33	26%	11	17%	*45*
IV neuroblastomas & peripheral nervous system tumours	9	7%	<1	<1%	*9*
V retinoblastoma	3	2%	0	0%	*3*
VI renal tumours	7	5%	<1	<1%	*7*
VII hepatic tumours	1	1%	<1	<1%	*2*
VIII malignant bone tumours	5	4%	4	6%	*10*
IX soft tissue sarcomas	8	6%	4	6%	*12*
X gonadal & germ cell tumours	4	3%	8	11%	*12*
XI other epithelial tumours & melanomas	3	2%	14	21%	*18*
XII other & unspecified	1	1%	<1	<1%	*1*

counts are rounded to the nearest whole number; see ***Appendix*** *(p. 8) for individual years*
 # International Classification of Childhood Cancer, 3rd edition[1]
**central nervous system*

Incidence rates and variation between boys and girls

The world age-standardised rate of childhood cancer in Ireland during 1994-2011 averaged 150 cases per million per year. Incidence was significantly higher (by 14%) in boys than in girls (Table 2). Excluding non-malignant tumours and non-melanoma skin cancers (NMSC), the incidence rate was 136 cases per million per year, similar to incidence rates reported in the UK[2]. About 10 non-malignant tumours of the brain and central nervous system were diagnosed per year.

Table 2. Number of cases diagnosed per year and incidence rates in girls and boys aged under 15, 1994-2011

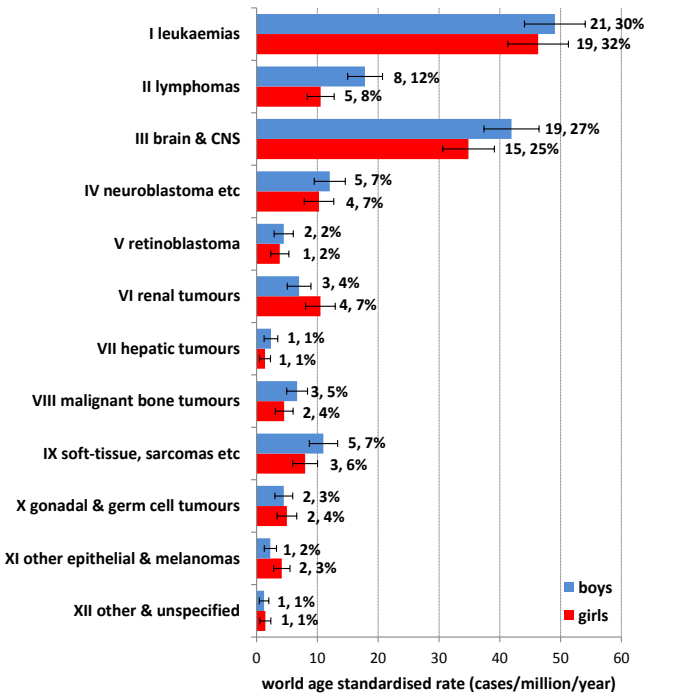
	girls	boys	total
all ICCC I-XII cancers			
cases/year	58	70	128
crude rate	136.6	156.1	146.6
WASR*	140.7	160.3	150.5
(95% CI)	(132.1-149.3)	(151.3-169.2)	(144.3-156.7)
malignant cancers only & excl NMSC#			
cases/year	52	63	115
crude rate	122.7	140.4	131.8
WASR*	127.1	144.9	136.0
(95% CI)	(118.9-135.3)	(136.3-153.4)	(130.1-141.9)
non-malignant brain & CNS			
cases/year	5	5	10
crude rate	10.6	11.9	11.3
WASR*	10.5	11.9	11.2
(95% CI)	(8.2-12.9)	(9.5-14.4)	(5.6-12.9)

**WASR: world age-standardised rate (cases per million per year)*
 # NMSC: non-melanoma skin cancer

Leukaemia represented the cancer group with the highest incidence rate overall (40 children diagnosed annually or an age-standardised rate of 48 cases per million per year), and incidence was slightly higher in boys than in girls (Figure 1). Brain & CNS cancers comprised the second most commonly diagnosed group (38 cases per million per year), again with higher incidence rates in boys. Despite the differences in incidence between the sexes, these two groups combined represented 57% of all cancers in both boys and girls.

An average of 8 boys and 5 girls were diagnosed with lymphoma each year, and incidence rates in boys were statistically significantly higher than in girls. There was no significant difference in incidence rates between the sexes for other cancers, but generally incidence was higher in boys, with the exception of renal, gonadal, germ cell and "other epithelial" tumours, where incidence was higher in girls.

Figure 1. Incidence rates of each cancer type (ICCC I-XII) for girls and boys aged under 15 years, 1994-2011



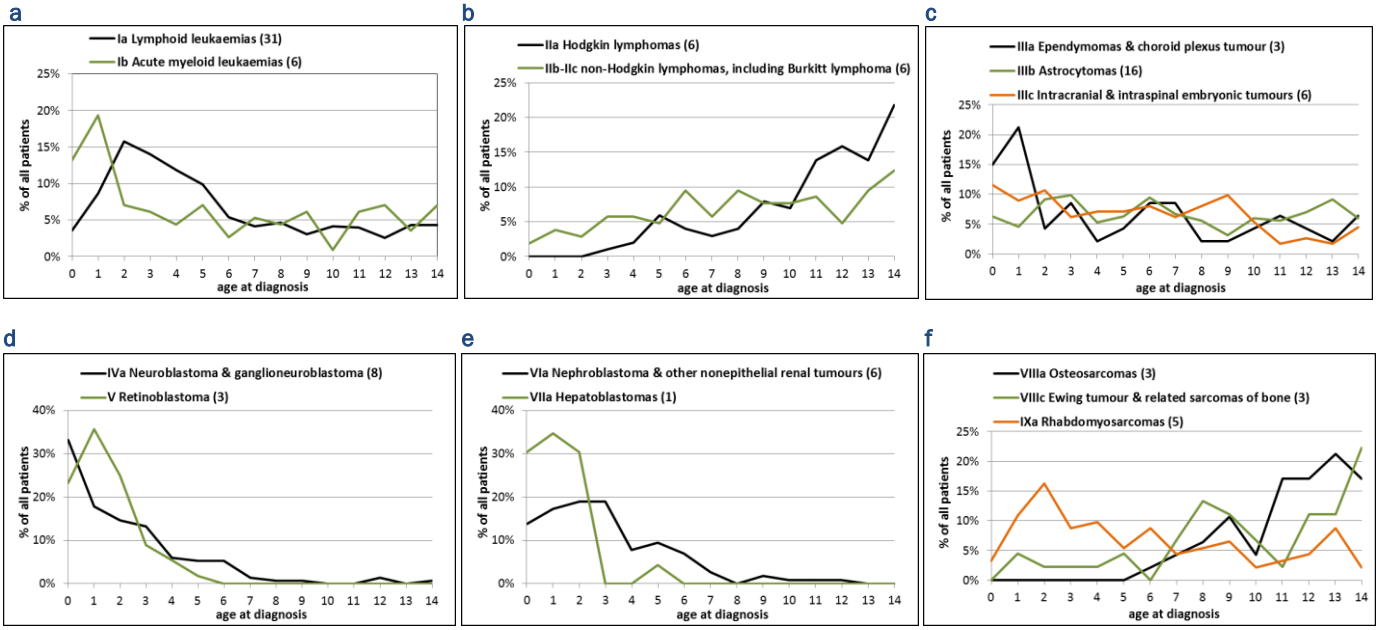
numbers indicate annual average number of cases per year, percentages indicate % composition of all cancers

Age at diagnosis

There was considerable variation between cancer types in the age at which children were diagnosed. Figure 2 illustrates the percentage distribution of the most frequent individual cancer types by individual year of age. Some cancers were more frequent in very young children and rarer in older boys and girls. Neuroblastomas and ganglioneuroblastomas were particularly rare in children aged over 6 years; while almost all retinoblastomas and hepatoblastomas were diagnosed in children aged 4 or less (Figure 2d, e).

Most children diagnosed with lymphoma were older, particularly in the case of Hodgkin lymphoma which was more frequent in children over 10 years (Figure 2b). Hodgkin lymphoma is most frequently diagnosed in children and young adults aged over 15[3]. Osteosarcomas were also much rarer in very young children and most patients were aged over 10 when they were diagnosed (Figure 2f). Leukaemia (Figure 2a) and cancers of the brain and central nervous system (Figure 2c) had a somewhat more even distribution, although acute myeloid leukaemia and ependymomas of the brain were most frequently registered in very young children, aged 2 or younger.

Figure 2. Age at diagnosis for the most frequent childhood cancer subgroups, 1994–2011



**numbers in brackets after titles indicate the annual average number of cases diagnosed per year*

Geographical distribution

Incidence rates of children's cancers varied little between the four health regions in Ireland (Table 3). Incidence rates for all cancers combined and for leukaemia in particular appeared to be highest in the HSE Dublin & Mid-Leinster region, but these patterns were not statistically significant. Incidence of brain & CNS cancer appeared to be highest in the HSE Southern region and in Dublin & Mid Leinster but again this was not significant.

Further analysis showed no significant variation in incidence rates by socio-economic variables (deprivation index at local area level[4]).

Table 3. Incidence rates for all children's cancers (ICCC I-XII, <15 years) by HSE region, 1994–2011

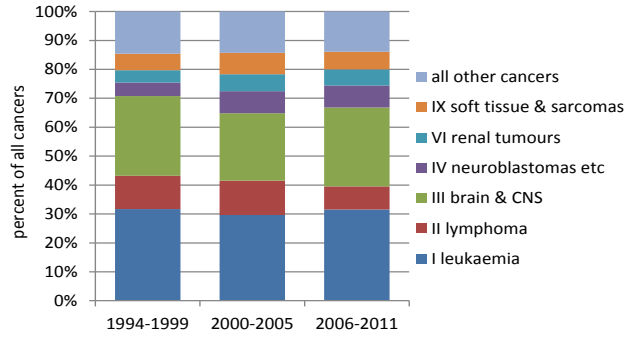
	cases/year	rate (WASR)*	95%CI
all cancers			
Dublin & North East	27	144.6	131.6 – 157.6
Dublin & Mid Leinster	38	158.4	146.5 – 170.3
South	33	150.8	138.5 – 163.1
West	30	145.6	133.2 – 158.1
Ireland total	128	150.5	144.3 – 156.7
I leukaemia			
Dublin & North East	8	44.4	37.1 – 51.6
Dublin & Mid Leinster	12	53.2	46.2 – 60.2
South	10	48.1	41.1 – 55.1
West	9	43.3	36.5 – 50.1
Ireland total	40	47.7	44.2 – 51.2
II lymphoma			
Dublin & North East	3	14.8	10.8 – 18.8
Dublin & Mid Leinster	4	13.5	10.2 – 16.7
South	4	14.9	11.2 – 18.6
West	3	14.0	10.3 – 17.8
Ireland total	13	14.2	12.4 – 16.0
III brain & CNS			
Dublin & North East	7	35.1	28.8 – 41.4
Dublin & Mid Leinster	10	41.2	35.1 – 47.2
South	9	41.4	35.0 – 47.7
West	7	34.9	28.9 – 40.9
Ireland total	33	38.4	35.3 – 41.5

**WASR: world age-standardised rate (cases per million per year)*

Incidence trends over time

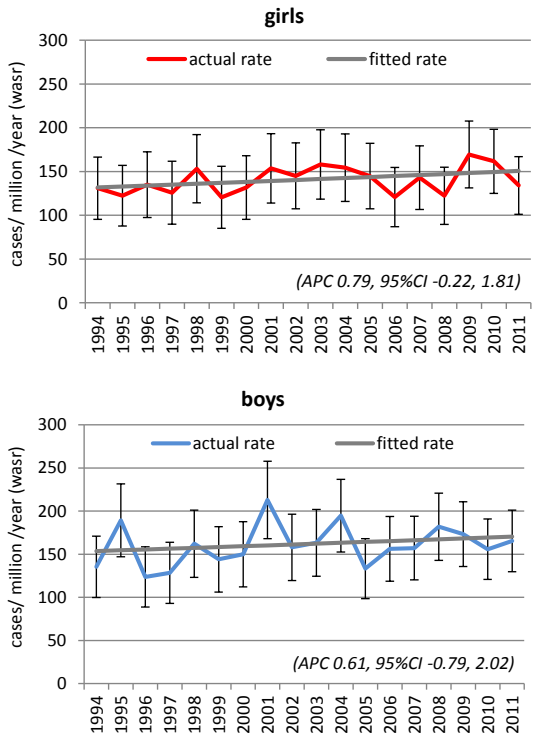
There was relatively minor change in the distribution of cancer types diagnosed over time (Figure 3). Leukaemia has represented just under one-third of all cancers since 1994. There was a slight decline over time in the relative proportion of lymphoma, from representing 12% of all cancers up to 2005 to 8% in 2006-2011. This was more pronounced in boys where there was a decline from an average of 11 boys diagnosed per year in 2000-2005 to 7 per year in 2006-2011. The percentage of brain & CNS tumours declined slightly in 2000-2005, although relative proportions in 2006-2011 were similar to 1994-1999 (27% of all cancers).

Figure 3. Percentage composition of children's cancers (ICCC I-XII, <15 years), 1994–1999, 2000-2005 & 2006-2011



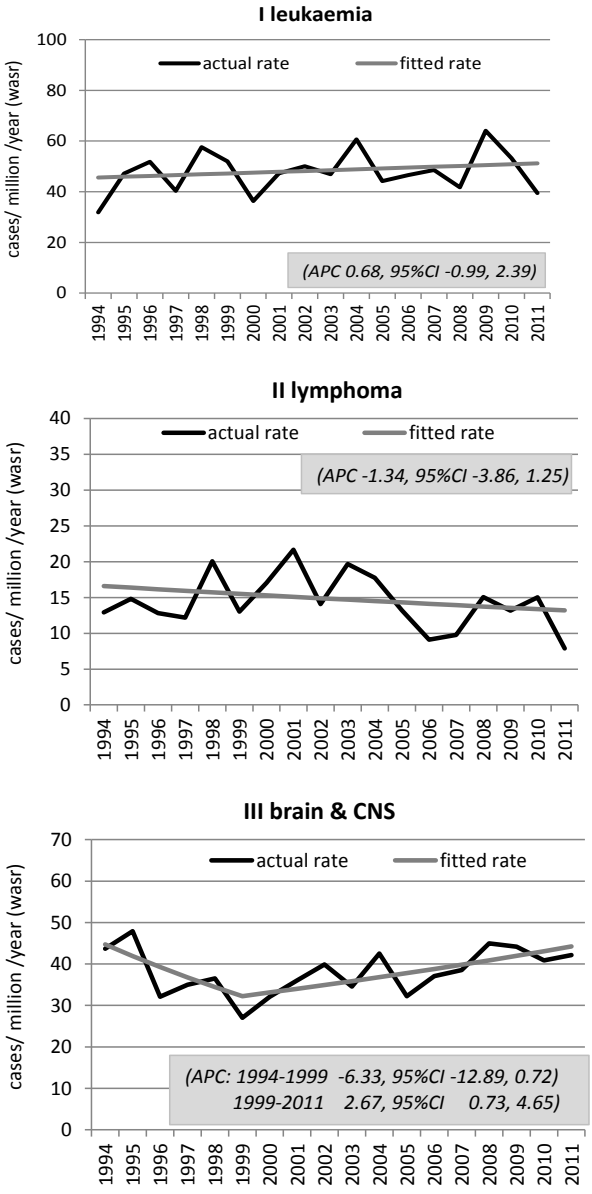
Comparing the earliest and latest periods, 1994-1999 and 2006-2011, incidence rates of all cancers combined increased overall by 10%. However rates fluctuated considerably between years and an overall annual percentage increase of less than 1% was recorded for both boys and girls (Figure 4a). Incidence rates varied from 120 to 169 cases per million per year in girls (between 46 and 76 patients per year) and from 124 to 213 cases per million per year (or 52-88 patients per year) in boys.

Figure 4a. Trends in incidence of all cancers (ICCC I-XII, <15 years), 1994–2011: average annual percentage change (APC) is shown



Incidence trends are described for the 3 most common individual cancer groups (girls and boys combined) in Figure 4b. These individual cancers showed quite different trends. Leukaemia incidence rates varied considerably between years but showed only weak evidence of any longer-term trend, with an annual percentage increase of 0.7% per year. Leukaemia case numbers ranged from 25 patients in 1994 to 58 diagnosed in 2009.

Figure 4b. Trends in incidence of the most frequent childhood cancer groups (<15 years), 1994–2011



Lymphoma incidence rates, while also very variable over time, suggested an average decline by 1.3% per year (Figure 4b), but this was not statistically significant. Numbers peaked at 20 children diagnosed in 2001, compared with just 8 in 2011.

There was an initial decline in incidence rates of paediatric brain & CNS tumours (Figure 4b), with case numbers falling from 40 patients diagnosed in 1994 to 21 patients in 1999. Rates subsequently increased by on average 2.7% per year (statistically significant) and patient numbers in 2011 (42) were similar to those recorded in the mid 1990s.

Tumour-directed treatment

Chemotherapy was the principal treatment for all paediatric cancers combined, either alone or in combination with surgery and/or radiotherapy, and over two-thirds of all patients had chemotherapy (Table 4).

There was fairly little change over time in the relative proportions of treatment categories overall. About 10% of patients apparently did not receive specifically tumour-directed treatment within 12 months of diagnosis. However it should be noted that some patients died before treatment could begin, and a small number of patients were treated after the 12 month cut-off shown here or had other therapies not directed specifically at reducing/removing their cancer.

Treatment varied considerably between the three most common cancers diagnosed (Table 4). Almost all patients diagnosed with leukaemia received chemotherapy and the majority of patients had this treatment alone (or chemotherapy followed by bone marrow or stem cell transplant). Similarly lymphoma patients were treated mostly with chemotherapy alone, although there was a notable increase in the relative proportion of patients receiving chemotherapy in combination with radiotherapy during 2006-2011.

Table 4. Combinations of the main categories of treatment for all children's cancers (ICCC I-XII) and the 3 largest cancer groups diagnosed in 1994-1999, 2000-2005 & 2006-2011

	1994-1999	2000-2005	2006-2011
all cancers (ICCC-I-XII)	***N=685***	***N=766***	***N=840***
surgery only	16%	17%	13%
chemotherapy only	40%	43%	43%
radiotherapy only	3%	4%	5%
surgery & chemotherapy	13%	13%	11%
surgery & radiotherapy	3%	1%	1%
radio- & chemotherapy	7%	9%	10%
all three treatments	5%	7%	5%
no treatment	12%	7%	10%
I leukaemia	***N=217***	***N=230***	***N=265***
surgery only	0%	0%	0%
chemotherapy only	88%	92%	90%
radiotherapy only	0%	0%	0%
surgery & chemotherapy	0%	1%	0%
surgery & radiotherapy	0%	0%	0%
radio- & chemotherapy	5%	3%	2%
all three treatments	0%	0%	0%
no treatment	7%	4%	8%
II lymphoma	***N=79***	***N=92***	***N=67***
surgery only	5%	5%	3%
chemotherapy only	70%	75%	61%
radiotherapy only	5%	4%	0%
surgery & chemotherapy	9%	8%	3%
surgery & radiotherapy	0%	0%	0%
radio- & chemotherapy	9%	3%	28%
all three treatments	0%	0%	1%
no treatment	3%	4%	3%
III brain & CNS	***N=189***	***N=181***	***N=229***
surgery only	35%	41%	29%
chemotherapy only	4%	3%	10%
radiotherapy only	10%	6%	8%
surgery & chemotherapy	6%	11%	8%
surgery & radiotherapy	8%	7%	10%
radio- & chemotherapy	4%	4%	4%
all three treatments	10%	13%	10%
no treatment	23%	15%	21%

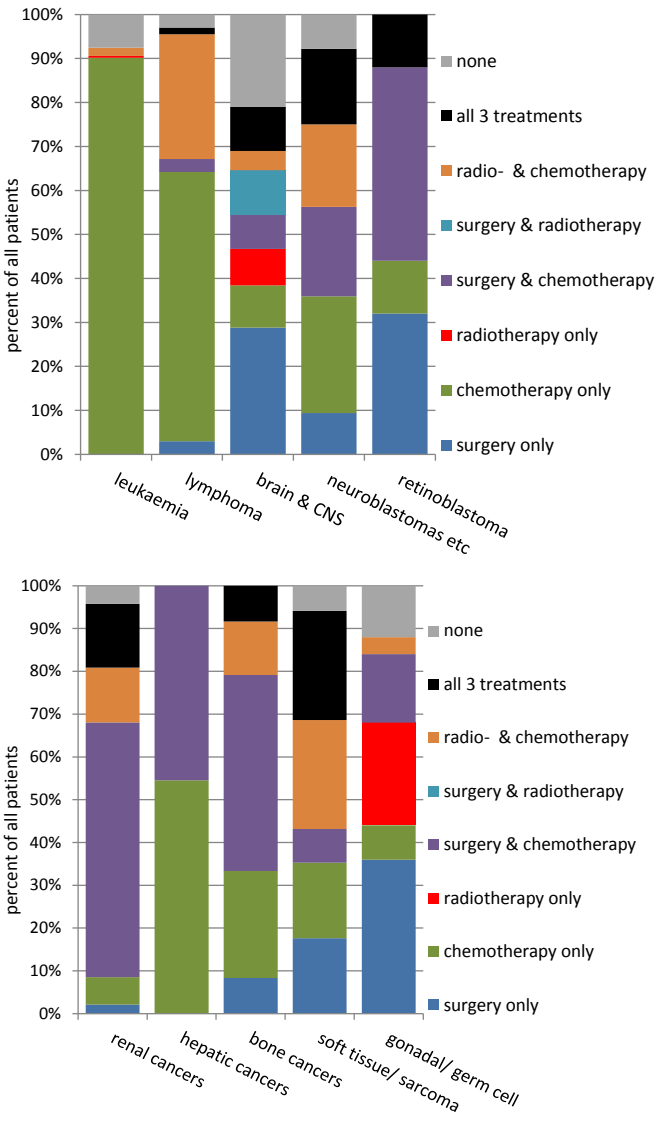
**only treatments received within 12 months of diagnosis are included*

In contrast to the haematological malignancies, the majority of patients with brain & CNS tumours were treated surgically, either alone or together with chemotherapy and radiotherapy. However approximately 1 in 5 patients with brain & CNS tumours had no recorded tumour-directed treatment within 1 year of their diagnosis.

Figure 5 illustrates the treatment combinations received by children diagnosed with the ten main ICCC cancer groups between 2006 and 2011. Along with brain & CNS patients, children diagnosed with retinoblastoma and gonadal/germ cell tumours had the highest proportion of treatment involving surgery only (≥30% of children). Surgery in combination with chemotherapy was the most common treatment for retinoblastoma and for renal, hepatic and bone cancers.

Over 20% of children with germ cell/gonadal tumours had radiotherapy only, but for other cancers radiotherapy was more commonly used in addition to chemotherapy (lymphoma, neuroblastoma and soft tissue sarcoma) or with chemotherapy and surgery (neuroblastoma, retinoblastoma, renal cancers and soft tissue carcinomas).

Figure 5. Combinations of the main categories of treatment for individual cancer groups (ICCC I-XII), 2006-2011



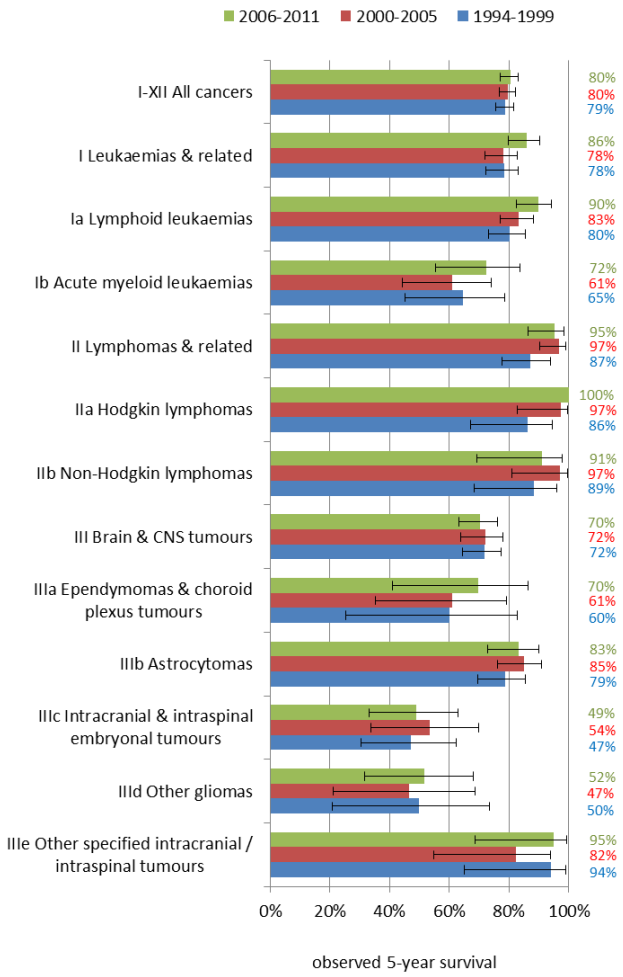
Survival[5]

Five-year observed survival for all childhood cancers combined averaged 80% for cases diagnosed during the most recent period (2006-2011), and has been similarly high throughout 1994-2011 (Figure 6). Five-year survival exceeded 80% during 2006-2011 for leukaemias and related cancers (86%), lymphomas and related (95%), retinoblastoma (100%), renal tumours (89%), hepatic tumours (100%), germ cell and gonadal tumours (100%), and other/unspecified cancers (89%) (Figure 6). Average survival was poorer for patients with brain and other CNS tumours (70%), neuroblastoma & related tumours (63%), bone tumours (71%), and soft-tissue sarcomas (72%) (Figure 6).

Survival figures for some more specific subgroups are also shown in Figure 6, including notably high survival for some subgroups (e.g. Hodgkin lymphoma) but poor survival for others (e.g. gliomas and embryonal tumours of the CNS). Survival variation by gender was relatively minor, and not statistically significant (Figure 7).

Trends in survival were difficult to quantify for individual diagnostic groups or subgroups, given the small numbers of cases and deaths involved. Of the cancers shown in Figure 6, the only significant changes (improvements) in survival, compared with the years 1994-1999, were for lymphoid leukaemias (P=0.008 for 2006-2011, adjusted for age and gender) and for lymphomas (P=0.024 for 2000-2005, adjusted for age, gender and case-mix).

Figure 6. Five-year observed survival by diagnosis period (with 95% confidence intervals) for all cancers combined and for the major diagnostic groups and subgroups, 1994-2011



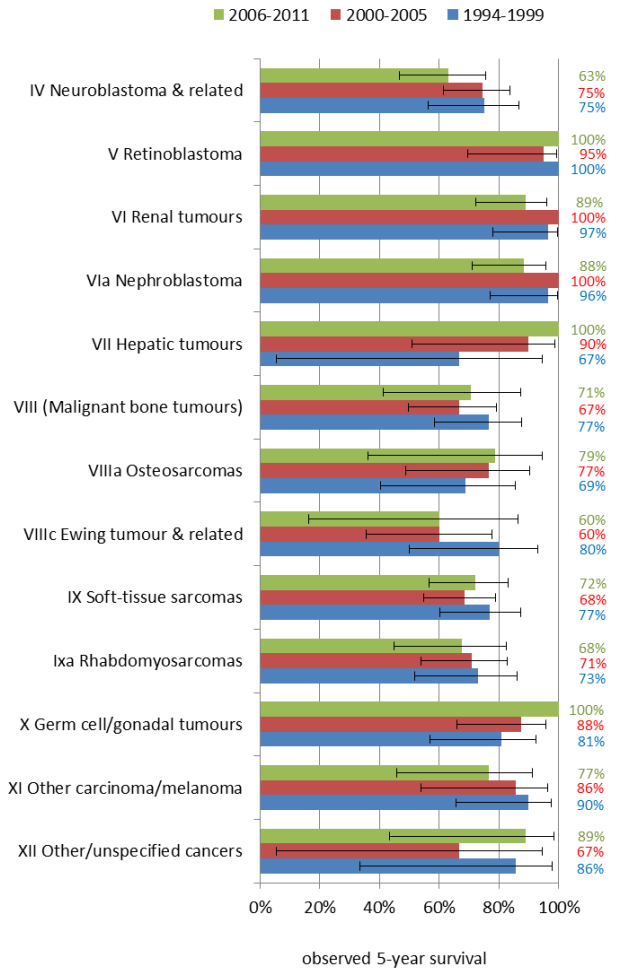
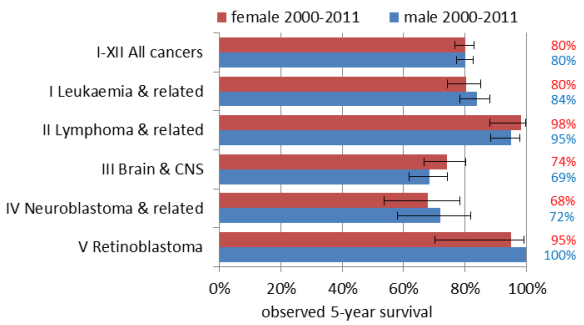
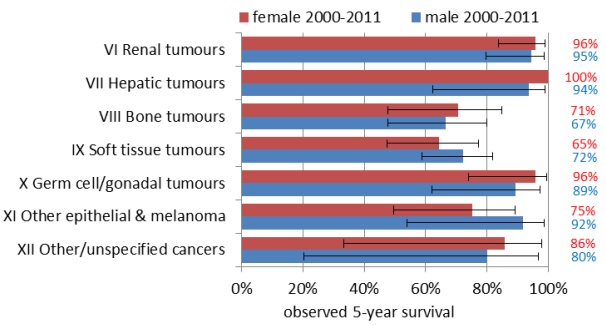


Figure 7. Five-year observed survival by gender, 2000-2011





Long term trends in mortality rates

Overall mortality rates for children's cancers in Ireland were at their highest levels during the late 1950s and 1960s (Figure 8). However mortality rates have since declined substantially, by approximately 2% per year for boys and girls, and mortality rates in the last ten years were about 60-70% lower than during the 1960s. In the most recent decade, on average 9 girls and 12 boys have died from cancer each year, compared to over 50 children per year between the 1950s and 1970s (Table 5). The reduction in mortality was achieved mostly through large improvements in diagnostic and treatment methods since the 1970s.

Throughout the period from the 1950s to the present, the number of cancer deaths among male children has been about 30-35% higher than among females (Table 5).

Table 5. Annual average number of children who died from cancer each decade from the 1950s to 2010[6]

	girls	boys	total
1950s	22	30	52
1960s	26	35	61
1970s	24	32	56
1980s	19	25	44
1990s	10	14	24
2000s	9	12	21

The greatest reduction in childhood cancer deaths has been observed for leukaemia (Table 6). Representing almost half of all childhood cancer deaths in the 1950s and 1960s, numbers of children dying from leukaemia have fallen considerably and in recent years less than 10 children per year have died from this cancer.

Figure 8. Childhood cancer mortality rate (deaths per 100,000 per year, world age standardised) based on all deaths from cancer at ages 0-14 in Ireland 1950–2010[6]

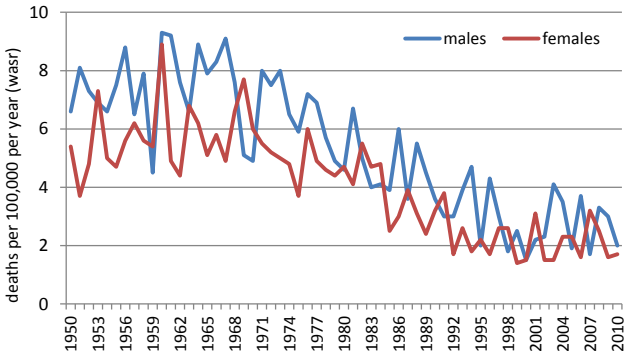


Table 6. Annual average number of childhood deaths for the main cancers each decade from 1950 to 2010[6]

	leukaemias	lymphomas	brain & CNS
1950s	24	5	9
1960s	28	5	13
1970s	21	4	17
1980s	17	4	12
1990s	7	1	9
2000s	7	1	8

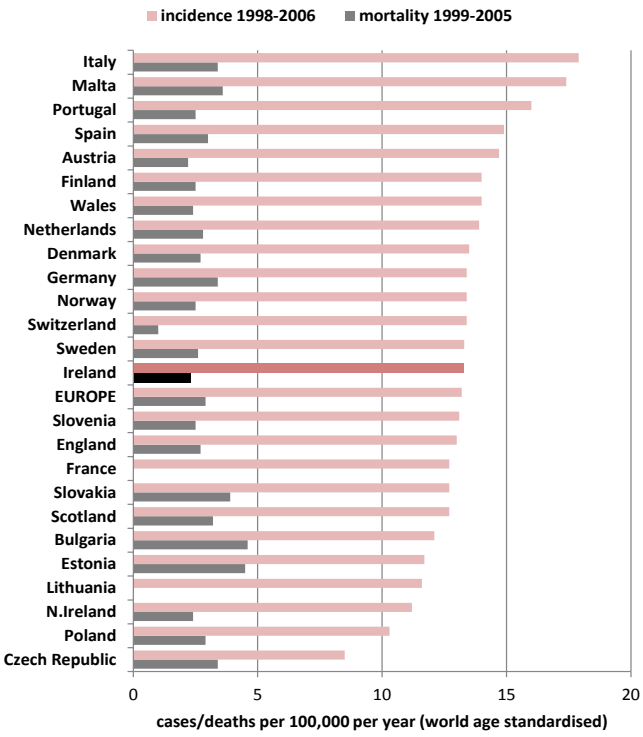
International variation in incidence and mortality[7]

Estimates of childhood cancer incidence and mortality rates for European countries over comparable periods were extracted from the EUREG database[7], which provides data at individual population-based registry level[8].

Irish incidence rates for childhood cancer as a whole ranked 13th of the 25 European countries examined for the period 1998-2006. Incidence rates in Ireland were equal to Swedish rates and similar to those in Germany, Norway and Switzerland, and to the overall European average (Figure 9). Highest incidence rates were observed in Italy, Portugal and Malta. Lowest incidence rates were in the Czech Republic and Poland.

For the period 1999-2005, Ireland had one of the lowest mortality rates for childhood cancers of the European countries examined, with only Switzerland and Austria having lower rates. Mortality rates in Ireland were similar to those in Northern Ireland and Wales and were 21% lower than the European average.

Figure 9. Incidence and mortality rates (cases/deaths per 100,000 per year, world age standardised) for children's cancer* in Europe: 1998-2006 (incidence) and 1999-2005 (mortality)[7 8]



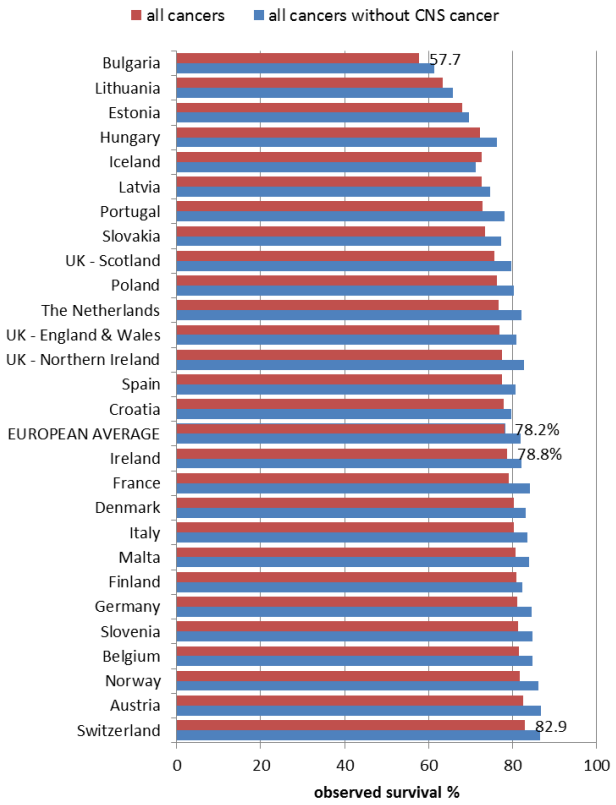
** all invasive cancers, excluding non-melanoma skin cancer*

International variation in survival[9]

The most recent comparable data on childhood cancer survival across Europe have been published by the EUROCARE-5 project.[9] For all cancers combined, 5-year observed survival for Ireland was just under 79%, very close to the European average (Figure 10). Ireland ranked 12th highest of 27 countries included in the analysis (Figure 10). Highest survival was observed in children from Switzerland, Austria and Norway, while poorest survival was seen for children in some of the eastern European countries, particularly Bulgaria, Lithuania and Estonia.

In children, analyses generally include non-malignant tumours of the brain and central nervous system (CNS), but difficulties in differentiating between benign and malignant tumours can sometimes lead to variability in the coding of data between countries. For this reason, EUROCARE-5 also presented survival data where CNS tumours were excluded. Using these figures, Ireland ranked 13th highest of the 27 countries examined.

Figure 10. Five year observed survival for all cancers combined, with and without CNS tumours, diagnosed in 2000-2007 by country in European children (aged 0-14 years).



References and notes

1. Steliarova-Foucher E et al, 2005. International Classification of Childhood Cancer, third edition. Cancer. 103(7):1457-67.
2. Cancer Research UK (CRUK), 2010. Cancer stats: childhood cancer-Great Britain & UK. http://publications.cancerresearchuk.org/downloads/Product/CS_CS_CHILDHOOD.pdf.
3. Hodgkin's lymphoma. Cancer Trends No. 19. NCRI www.ncri.ie/publications/cancer-trends-and-projections/cancer-trends-hodgkins-lymphoma
4. Deprivation Index as per 2002 census. SAHRU (www.sahru.tcd.ie)
5. Cases followed up to 31/12/2012.
6. Source: WHO mortality database http://www-dep.iarc.fr/WHOdb/WHOdb.htm
7. Source: European Cancer Observatory (ECO), EUREG database. http://eco.iarc.fr/EUREG/Default.aspx
8. EUREG *data for France, Germany, Italy, Poland, Portugal, Spain, Switzerland and England represented by groups of individual registries covering various populations/regions within each country. Other countries shown were represented by single registries. Incidence and mortality periods shown in Figure 11 represented the years that data was available for the greatest proportion of registries.*
9. Gatta G. et al 2014. Childhood survival in Europe 1999-2007: results of EUROCARE-5: a population based study (appendix). Lancet Oncol 15(1): 35-47.

Further details of childhood cancer in Ireland:

Annual case numbers for each major cancer type in children aged 0-14 are listed in the *Appendix* overleaf

Appendix. Annual totals of childhood cancers (diagnosed at ages 0-14 years) in Ireland, 1994-2011, by International Classification of Childhood Cancer (ICCC) diagnostic group

Diagnostic group	1994	1995	1996	1997	1998	1999	2000	2001	2002
I-XII. All ICCC-classified cancers	114	132	103	102	131	103	114	147	124
I. Leukaemias, myeloproliferative diseases, & myelodysplastic syndromes	25	39	40	30	45	38	28	37	41
II. Lymphomas & reticuloendothelial neoplasms	12	13	11	12	19	12	15	20	12
III Central nervous system & miscellaneous intracranial/intraspinal neoplasms	40	41	26	30	31	21	27	29	33
IV. Neuroblastomas & other peripheral nervous system tumours	4	7	4	6	4	7	6	13	6
V. Retinoblastoma	3	2	1	2	2	1	5	5	3
VI. Renal tumours	5	3	3	7	5	6	7	12	7
VII. Hepatic tumours			2	2				1	2
VIII. Malignant bone tumours	6	8	6	5	7	2	4	13	6
IX. Soft tissue & other extraosseous sarcomas	8	7	5	5	5	9	11	10	7
X. Germ cell tumours, trophoblastic tumours, & neoplasms of gonads	5	5	2	2	4	6	4	4	3
XI. Other malignant epithelial neoplasms & malignant melanomas	4	4	3	1	7	1	7	2	2
XII. Other & unspecified malignant neoplasms	2	3			2			1	2

Diagnostic group	2003	2004	2005	2006	2007	2008	2009	2010	2011
I-XII. All ICCC-classified cancers	131	145	115	116	130	138	158	151	147
I. Leukaemias, myeloproliferative diseases, & myelodysplastic syndromes	38	50	36	38	42	38	58	50	39
II. Lymphomas & reticuloendothelial neoplasms	17	16	12	8	9	14	13	15	8
III Central nervous system & miscellaneous intracranial/intraspinal neoplasms	30	35	27	32	34	41	41	39	42
IV. Neuroblastomas & other peripheral nervous system tumours	16	11	7	4	13	13	10	12	12
V. Retinoblastoma	2		5	2	3	6	5	4	5
VI. Renal tumours	6	8	6	6	6	9	11	6	9
VII. Hepatic tumours	3	4	1	4		1	3		3
VIII. Malignant bone tumours	2	6	8	5	3	4		4	8
IX. Soft tissue & other extraosseous sarcomas	14	7	8	6	11	4	11	10	9
X. Germ cell tumours, trophoblastic tumours, & neoplasms of gonads	3	5	5	7	3	4	2	2	7
XI. Other malignant epithelial neoplasms & malignant melanomas		3		3	3	3	3	7	3
XII. Other & unspecified malignant neoplasms				1	3	1	1	2	2

