5 Childhood cancer

Studies of the incidence of cancer in childhood in Africa are even more difficult than those of adults. Because of the relative rarity of cancer in this age group, population-based studies must involve rather large populations (or long time periods) in order that sufficient cases be assembled to permit calculation of valid rates. For this reason, most African studies have been of case series, with inevitable difficulties in interpretation.

The rather special nature of the tumours affecting children requires the use of a classification system other than the familiar ICD, which is based upon cancer site (and designed primarily for the study of epithelial neoplasms, which comprise only a small proportion of childhood cancers). Childhood cancers, in contrast, are histologically very diverse and some types can occur in many different sites. A classification based principally on histological type is therefore more appropriate. The current standard is the International Classification of Childhood Cancer (ICCC: Kramárová *et al.*, 1996) that was used for the IARC monograph *International Incidence of Childhood Cancer*, Volume II (IICC-2: Parkin *et al.*, 1998). An earlier version (Birch & Marsden, 1987) was used for the first volume of *International Incidence of Childhood Cancer* (IICC-1: Parkin *et al.*, 1988). There are 12 main diagnostic groups, as follows: leukaemia; lymphomas and reticuloendothelial neoplasms; central nervous system (CNS) and miscellaneous intracranial and intraspinal neoplasms; sympathetic nervous system tumours; retinoblastoma; renal tumours; hepatic tumours; malignant bone tumours; soft-tissue sarcomas; germ-cell, trophoblastic and other gonadal neoplasms; carcinomas and other malignant epithelial neoplasms; other and unspecified malignant neoplasms. All except retinoblastoma are divided into a number of subgroups. In this chapter, geographical and ethnic patterns of incidence will be considered for each major diagnostic group in turn. A series of tables summarizes the data on childhood cancers from the cancer registries contributing to this volume.

Leukaemia

In white populations of Europe, the Americas and Oceania, and also in much of eastern Asia, around a third of all childhood cancers are leukaemias, with age-standardized incidence rates (ASR) of 35–50 per million. Acute lymphoblastic leukaemia (ALL) comprises 75–80% of the total in these populations, with ASRs generally in the range 25–40 per million, and a marked peak in incidence at age 2–3 years. In black children in the United States, leukaemia accounts for about a quarter of all childhood cancer; the incidence of ALL is only half that among whites, largely because of a much reduced early childhood peak. In the United Kingdom, however, the incidence among children of West Indian origin is only slightly less than that among whites (Stiller *et al.*, 1991).

In North Africa, although data are relatively sparse, it appears that the incidence of leukaemia is not far below that in Europe, with a similar distribution by subtype, and a peak in incidence of ALL in young children. In a case series from the National Cancer Institute, Cairo, (El Bolkainy *et al.*, 1984), 87% of 123 childhood leukaemias were ALL, with a modest peak in frequency at ages 3–6 years.

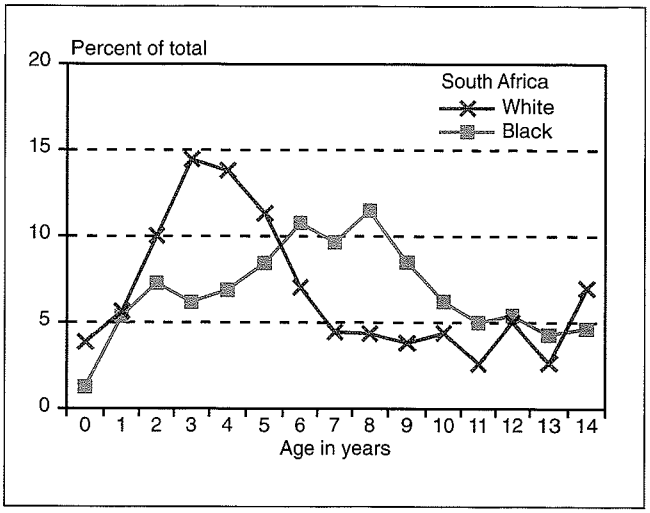

Figure 1. Age distribution of childhood lymphoid leukaemia

In sub-Saharan Africa, recorded incidence rates of leukaemia are considerably lower (Table 1). The incidence of ALL is especially low (Table 2), with little or no sign of a peak in the age–incidence curve (Figure 1).

This low incidence is partly a consequence of underdiagnosis and underreporting (Davies, 1973; Fleming, 1993). Cancer registries in Africa may have less efficient methods of detecting cases diagnosed by blood smears or cytology. Diagnosis may be missed because the common clinical presentation of childhood leukaemia—fever, lymphadenopathy and anaemia—is easy to confuse with other common conditions in paediatric practice in the tropics. The diagnosis may be missed on examination of blood smears, where blast cells may be mistaken for the activated lymphocytes common in children with malaria. Finally, children with the above symptoms (particularly the very young) may not be brought to medical attention before the rapid evolution of the disease has caused death.

An additional problem in interpreting epidemiological patterns of childhood leukaemia has been the reliance upon clinical series and relative proportions of cases of leukaemia of different cell types, and in different age groups, to infer differences in occurrence.

However, even taking these factors into account, all data are consistent in suggesting that incidence rates are low in African children (although this was disputed, on the basis of hospital admissions to paediatric wards in Kampala, Uganda in 1966, by Vanier & Pike, 1967).

Among cases of lymphoid leukaemia, the common ALL immunophenotype accounts for around 70% of classifiable cases among most white populations, including those in less developed countries, and the early childhood peak in the incidence of ALL is due to the even more marked peak for this subtype (Greaves, 1984). Common ALL accounts for only a minority of cases among

Table 1. Childhood cancer: age-standardized (world) incidence per million

Leukaemia

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	108	**25.6**	63	**16.0**	171	1.7	**20.9**
*Egypt, Alexandria (1980-1989)	162	**24.5**	97	**15.3**	259	1.7	**20.0**
Tunisia, 3 registries	32	**26.6**	33	**29.0**	65	1.0	**27.8**
Africa, West							
The Gambia (1988-1998)	8	**3.4**	5	**2.1**	13	1.6	**2.7**
Guinea, Conakry (1993-1999)	7	**4.4**	4	**2.5**	11	1.8	**3.5**
Mali, Bamako (1988-1997)	1	**0.6**	5	**2.8**	6	0.2	**1.8**
Niger, Niamey (1993-1999)	4	**5.1**	6	**6.9**	10	0.7	**6.0**
Nigeria, Ibadan (1993-1999)	3	**4.8**	2	**2.1**	5	1.5	**3.0**
Africa, Central							
Congo, Brazzaville (1996-1999)	6	**11.3**	-	**-**	6	-	**5.8**
Africa, East							
France, La Reunion (1988-1994)	17	**30.4**	17	**29.7**	34	1.0	**30.1**
Kenya, Eldoret (1998-2000)	11	**26.9**	6	**14.5**	17	1.8	**20.7**
Malawi, Blantyre (1991-2001)	3	**1.6**	6	**3.2**	9	0.5	**2.5**
Uganda, Kyadondo County (1993-1997)	9	**8.7**	9	**7.2**	18	1.0	**7.9**
Zimbabwe, Harare: African (1990-1997)	41	**24.4**	34	**19.0**	75	1.2	**21.6**
Africa, South							
*Namibia (1983-1992)	17	**6.3**	16	**6.0**	33	1.1	**6.2**
South Africa: Black (1989-1992)	*259*	**11.8**	*191*	**8.9**	*450*	*1.4*	**10.4**
South Africa: Indian (1989-1992)	*41*	**67.5**	*21*	**34.1**	*62*	*2.0*	**51.0**
South Africa: Mixed race (1989-1992)	*40*	**18.8**	*25*	**11.5**	*65*	*1.6*	**15.2**
South Africa: White (1989-1992)	*111*	**50.4**	*84*	**42.5**	*195*	*1.3*	**46.5**
Swaziland (1996-1999)	6	**6.7**	5	**6.5**	11	1.2	**6.6**
Europe/USA							
USA, SEER: White (1993-1997)	492	**49.3**	402	**42.4**	894	1.2	**45.9**
USA, SEER: Black (1993-1997)	65	**36.0**	46	**26.2**	111	1.4	**31.2**
France, 8 registries (1993-1997)	122	**45.7**	86	**33.4**	208	1.4	**39.7**
The Netherlands (1993-1997)	342	**49.2**	231	**34.8**	573	1.5	**42.2**
UK, England (1993-1997)	1057	**45.5**	835	**37.2**	1892	1.3	**41.4**

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South African blacks (MacDougall, 1985), in Nigeria (Williams, 1985) and Kenya (Dearden, 1985), so that T-cell ALL (the incidence of which is relatively constant throughout childhood) accounts for a correspondingly larger proportion.

The peak of ALL at age 2–3 years began to emerge in mortality data in England and Wales in the 1920s and it was well established among whites in the United States by the early 1940s, the earliest period for which rates could be reliably calculated (Court Brown & Doll, 1961). The more moderate peak among American blacks emerged later (Miller, 1977). In the black population of South Africa, although the incidence of 'common' acute lymphocytic leukaemia (cALL) is low, this subtype still occurs with a peak incidence at around ages 2–5 years (Greaves *et al.*, 1993). It has been suggested that the frequency of diagnosis of cALL in clinical series has increased in recent years, for example in Nigeria, South Africa, and Zimbabwe (Paul *et al.*, 1992; Fleming, 1993).

A number of studies have found that residence in areas of higher socioeconomic status is associated with increased risk of childhood ALL (McWhirter, 1982, Alexander *et al.*, 1990; Draper *et al.*, 1991). In Ibadan, Williams (1985) observed that a higher percentage of childhood cases of ALL were of higher socioeconomic status (27%), compared with cases of acute myeloid leukaemia (AML) (6%) or Burkitt lymphoma (3.3%).

It seems likely that infection is an important factor in the etiology of childhood ALL, and several models have been proposed. According to the hypothesis of Greaves (1988), the association of high incidence of common ALL at age 2–3 years with higher levels of socioeconomic development may be explained by relatively late exposure to an infectious agent in more affluent societies. In these circumstances, a pre-malignant clone of B-cells in bone marrow will have had some time to proliferate in infancy, so that there are numerous cells in which a second mutation can occur under the promoting effect of antigenic challenge.

In the United States and Japan, improvements in public hygiene, as indicated by decreases in prevalence of hepatitis A infection, were followed by increases in childhood leukaemia incidence. This could have come about by an increase in the number of children susceptible to a putative leukaemia-inducing infectious agent also linked to public hygiene, consequent on an increase in the proportion of mothers who were seronegative for that agent (Smith *et al.*, 1998b).

Williams *et al.* (1984), comparing admissions to University College Hospital, Ibadan, for childhood leukaemia in 1978–82 with those in 1958–68, suggested that there had been an increase in incidence rates. However, the estimated rates for the second period (5.5–19 per million), from Williams and Bamgboye (1983), seem no

Table 2. Childhood cancer: age-standardized (world) incidence per million

Acute lymphoid leukaemia

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	71	**17.0**	40	**10.3**	111	1.8	**13.7**
*Egypt, Alexandria (1980-1989)	50	**7.5**	31	**4.8**	81	1.6	**6.2**
Tunisia, 3 registries	26	**21.9**	21	**18.6**	47	1.2	**20.3**
Africa, West							
The Gambia (1988-1998)	3	**1.3**	2	**0.8**	5	1.5	**1.1**
Guinea, Conakry (1993-1999)	3	**1.9**	3	**1.7**	6	1.0	**1.8**
Mali, Bamako (1988-1997)	-	-	-	-	-	-	-
Niger, Niamey (1993-1999)	4	**5.1**	2	**2.4**	6	2.0	**3.7**
Nigeria, Ibadan (1993-1999)	-	-	-	-	-	-	-
Africa, Central							
Congo, Brazzaville (1996-1999)	5	**9.4**	-	-	5	-	**4.8**
Africa, East							
France, La Reunion (1988-1994)	12	**21.4**	13	**22.7**	25	0.9	**22.0**
Kenya, Eldoret (1998-2000)	6	**14.6**	1	**2.5**	7	6.0	**8.6**
Malawi, Blantyre (1991-2001)	1	**0.5**	1	**0.5**	2	1.0	**0.5**
Uganda, Kyadondo County (1993-1997)	2	**1.9**	4	**3.2**	6	0.5	**2.6**
Zimbabwe, Harare: African (1990-1997)	26	**15.3**	15	**8.4**	41	1.7	**11.8**
Africa, South							
*Namibia (1983-1992)	11	**4.2**	13	**4.9**	24	0.8	**4.5**
South Africa: Black (1989-1992)	*125*	**5.7**	*106*	**5.0**	*231*	*1.2*	**5.3**
South Africa: Indian (1989-1992)	*24*	**39.2**	*12*	**18.8**	*36*	*2.0*	**29.1**
South Africa: Mixed race (1989-1992)	*29*	**13.8**	*15*	**7.0**	*44*	*1.9*	**10.4**
South Africa: White (1989-1992)	*71*	**32.7**	*54*	**26.9**	*125*	*1.3*	**29.8**
Swaziland (1996-1999)	1	**1.2**	2	**2.6**	3	0.5	**1.9**
Europe/USA							
USA, SEER: White (1993-1997)	408	**41.1**	328	**34.7**	736	1.2	**38.0**
USA, SEER: Black (1993-1997)	47	**26.0**	30	**17.1**	77	1.6	**21.6**
France, 8 registries (1993-1997)	92	**34.8**	66	**25.8**	158	1.4	**30.4**
The Netherlands (1993-1997)	268	**38.6**	193	**29.1**	461	1.4	**34.0**
UK, England (1993-1997)	827	**35.8**	650	**29.0**	1477	1.3	**32.4**

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different from those recorded by the Ibadan Cancer Registry in 1960–69: 11.8 per million (Junaid & Babalola, 1988). In Kampala, Uganda, there is no evidence for an increase in incidence of childhood leukaemias: the incidence fell from 18.7 per million in 1960–71 to 8.6 per million in 1991–97 (Wabinga *et al.*, 2000).

Apart from ALL, most childhood leukaemias are acute non-lymphocytic leukaemia (ANLL). In Europe and North America, the ASR is typically in the range 4–9 per million, with incidence highest in the first two years of life and relatively constant thereafter. ANLL (or acute myeloid leukaemia, AML) appears to be relatively common in series from Africa. However, this is most likely because of the deficit of cases of ALL, rather than a particularly high incidence of AML. Fleming (1993) considered that the incidence of AML in childhood may be increased in Africa, especially in boys aged 5–14 years. The basis for this speculation is not clear; although the rates estimated for Ibadan in 1978–82 were indeed high (Williams & Bamgboye, 1983), the numbers on which the calculation was based must have been small (and the population denominator very uncertain). None of the other reports from Ibadan have suggested a high incidence (Parkin *et al.*, 1988, 1998), and in Cape Province, South Africa, the incidence in black children was no higher than in whites (Sayers *et al.*, 1992).

Chloromas (solid leukaemic masses) have been reported to complicate about 10% of childhood cases of acute myeloid leukaemia in Nigeria (Fleming & Peter, 1982; Williams *et al.*, 1982) and an even higher proportion in Uganda (Davies & Owor, 1965; Barr *et al.*, 1972; Owor, 1984) and South Africa (MacDougall *et al.*, 1986).

Lymphoma

The epidemiology of lymphomas in Africa, including Burkitt lymphoma, has been described in Chapter 4.10. This section is confined to features specific to lymphoma in the childhood age range (Table 3).

Hodgkin disease

Stiller and Parkin (1990) observed that, although it was not possible to estimate incidence of childhood Hodgkin disease in Africa, most published series of childhood cancers contained "considerable numbers" of cases. Table 4 suggests that the incidence in sub-Saharan Africa is indeed similar to that in populations of the developed countries of Europe and North America, and that in North Africa, it may even be higher. The contrast between the pattern of incidence of childhood Hodgkin disease in western industrialized countries, where incidence rises steeply with age, and in some developing countries, where the increase in early adolescence is much gentler and there is sometimes even a modest peak at age 5–9 years, is described in Chapter 4.10. Figure 2 shows age-specific incidence in age groups 0–4, 5–9 and 10–14 years in

Table 3. Childhood cancer: age-standardized (world) incidence per million

Lymphoma

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	124	**29.8**	57	**13.9**	181	2.2	**22.0**
*Egypt, Alexandria (1980-1989)	269	**40.9**	131	**20.7**	400	2.1	**30.8**
Tunisia, 3 registries	24	**18.7**	12	**10.4**	36	2.0	**14.7**
Africa, West							
The Gambia (1988-1998)	40	**16.8**	25	**10.6**	65	1.6	**13.7**
Guinea, Conakry (1993-1999)	34	**22.6**	30	**22.0**	64	1.1	**22.3**
Mali, Bamako (1988-1997)	22	**13.7**	10	**5.7**	32	2.2	**9.5**
Niger, Niamey (1993-1999)	20	**26.2**	12	**14.3**	32	1.7	**20.1**
Nigeria, Ibadan (1993-1999)	37	**62.9**	22	**20.1**	59	1.7	**34.7**
Africa, Central							
Congo, Brazzaville (1996-1999)	8	**15.2**	10	**20.2**	18	0.8	**17.6**
Africa, East							
France, La Reunion (1988-1994)	14	**22.7**	6	**10.6**	20	2.3	**16.7**
Kenya, Eldoret (1998-2000)	19	**46.4**	15	**37.1**	34	1.3	**41.7**
Malawi, Blantyre (1991-2001)	86	**47.9**	43	**23.2**	129	2.0	**35.2**
Uganda, Kyadondo County (1993-1997)	89	**79.1**	65	**52.8**	154	1.4	**65.3**
Zimbabwe, Harare: African (1990-1997)	33	**19.5**	15	**8.4**	48	2.2	**13.8**
Africa, South							
*Namibia (1983-1992)	22	**8.2**	9	**3.4**	31	2.4	**5.8**
South Africa: Black (1989-1992)	*198*	**9.0**	*90*	**4.1**	*288*	2.2	**6.6**
South Africa: Indian (1989-1992)	*10*	**15.5**	*6*	**9.6**	*16*	*1.7*	**12.6**
South Africa: Mixed race (1989-1992)	*29*	**13.0**	*10*	**4.7**	*39*	*2.9*	**8.9**
South Africa: White (1989-1992)	*67*	**28.6**	*34*	**15.5**	*101*	*2.0*	**22.2**
Swaziland (1996-1999)	12	**15.6**	10	**12.5**	22	1.2	**14.0**
Europe/USA							
USA, SEER: White (1993-1997)	187	**17.0**	117	**11.1**	304	1.6	**14.1**
USA, SEER: Black (1993-1997)	28	**14.8**	16	**8.5**	44	1.8	**11.7**
France, 8 registries (1993-1997)	84	**27.7**	42	**14.4**	126	2.0	**21.2**
The Netherlands (1993-1997)	154	**20.6**	84	**11.8**	238	1.8	**16.3**
UK, England (1993-1997)	446	**17.8**	193	**7.9**	639	2.3	**12.9**

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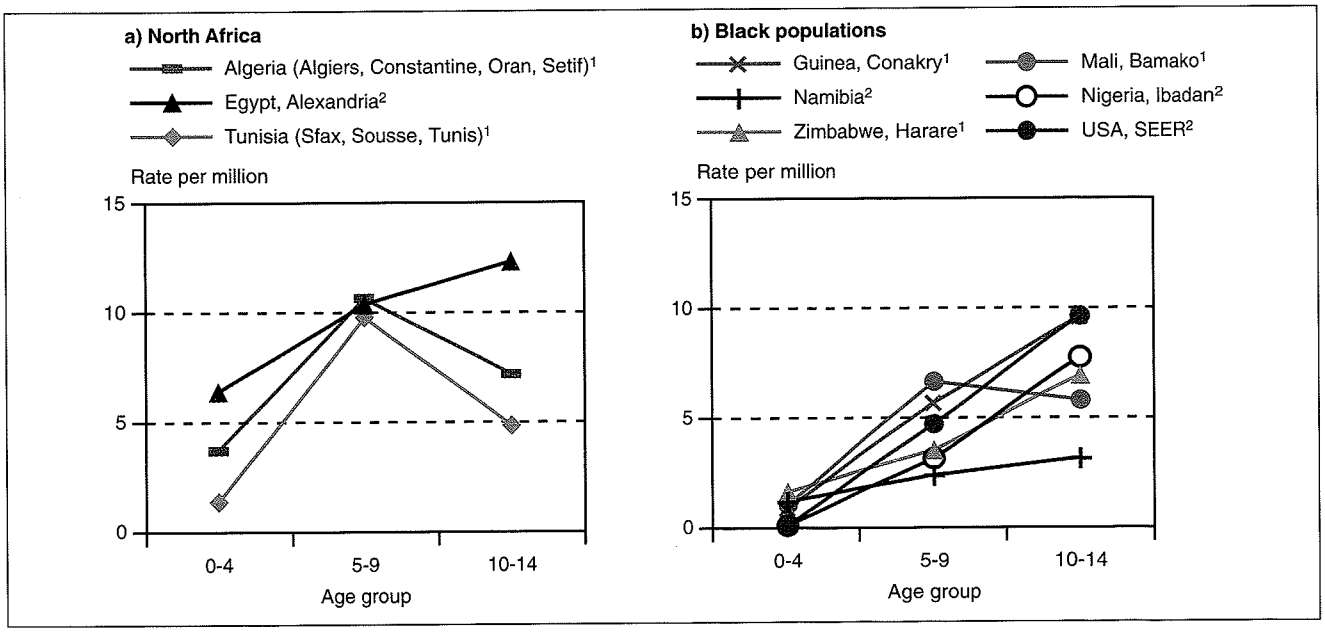

Figure 2. Hodgkin disease in children (Sources: 1 this volume; 2 *International Incidence of Childhood Cancer*, Vol. II)

Table 4. Childhood cancer: age-standardized (world) incidence per million

Hodgkin disease

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	39	**9.0**	19	**4.5**	58	2.1	**6.8**
*Egypt, Alexandria (1980-1989)	82	**12.5**	44	**6.7**	126	1.9	**9.5**
Tunisia, 3 registries	9	**6.7**	4	**3.4**	13	2.3	**5.1**
Africa, West							
The Gambia (1988-1998)	7	**2.9**	2	**0.9**	9	3.5	**1.9**
Guinea, Conakry (1993-1999)	11	**7.7**	3	**2.0**	14	3.7	**4.9**
Mali, Bamako (1988-1997)	11	**6.8**	3	**1.6**	14	3.7	**4.1**
Niger, Niamey (1993-1999)	4	**6.0**	-	-	4	-	**2.8**
Nigeria, Ibadan (1993-1999)	5	**7.9**	-	-	5	-	**2.7**
Africa, Central							
Congo, Brazzaville (1996-1999)	-	-	-	-	-	-	-
Africa, East							
France, La Reunion (1988-1994)	3	**5.4**	-	-	3	-	**2.7**
Kenya, Eldoret (1998-2000)	3	**7.2**	1	**2.5**	4	3.0	**4.9**
Malawi, Blantyre (1991-2001)	9	**5.0**	1	**0.5**	10	9.0	**2.7**
Uganda, Kyadondo County (1993-1997)	5	**4.4**	4	**3.2**	9	1.3	**3.8**
Zimbabwe, Harare: African (1990-1997)	9	**5.4**	4	**2.3**	13	2.3	**3.8**
Africa, South							
*Namibia (1983-1992)	8	**2.9**	3	**1.1**	11	2.7	**2.0**
South Africa: Black (1989-1992)	*86*	**3.9**	*24*	**1.1**	*110*	*3.6*	**2.5**
South Africa: Indian (1989-1992)	*3*	**4.5**	*1*	**1.5**	*4*	*3.0*	**3.1**
South Africa: Mixed race (1989-1992)	*17*	**7.4**	*2*	**0.9**	*19*	*8.5*	**4.1**
South Africa: White (1989-1992)	*18*	**7.5**	*6*	**2.4**	*24*	*3.0*	**5.0**
Swaziland (1996-1999)	4	**4.6**	1	**1.0**	5	4.0	**2.8**
Europe/USA							
USA, SEER: White (1993-1997)	60	**5.3**	61	**5.5**	121	1.0	**5.4**
USA, SEER: Black (1993-1997)	7	**3.5**	8	**4.1**	15	0.9	**3.8**
France, 8 registries (1993-1997)	26	**8.0**	16	**5.1**	42	1.6	**6.6**
The Netherlands (1993-1997)	37	**4.8**	32	**4.2**	69	1.2	**4.5**
UK, England (1993-1997)	169	**6.6**	87	**3.4**	256	1.9	**5.0**

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selected populations. In several countries where Burkitt lymphoma is endemic, the incidence or relative frequency of Hodgkin disease is substantially higher at age 10–14 years than at 5–9 years, indicating an age–incidence pattern different from that which is typical of developing countries elsewhere.

The relative frequencies of histological subtypes of childhood Hodgkin disease vary considerably. Throughout North America and western Europe, nodular sclerosis is usually the most frequent, nearly always accounting for more than half the cases of known subtype. Lymphocyte predominance seldom accounts for more than 20% of cases, and lymphocyte-depleted Hodgkin disease is very rare. Case series from Africa with adequate detail on histological subtype are rather few (Levy, 1988; Wright, 1973; Edington *et al.*, 1973; Cohen & Hamilton, 1980). African children have an excess of mixed cellularity (MC) subtype and a marked deficit of nodular sclerosing (NS) cases, while lymphocyte-depleted (LD) cases may comprise up to 30% in some series. Positivity for Epstein–Barr virus (EBV) in malignant cells is more common in childhood Hodgkin disease than in adults, in the MC subtype and in cases from developing countries (Glaser *et al.*, 1997). There is a higher prevalence of EBV in Hodgkin disease cases from Kenya than in European countries, with almost all paediatric cases from Kenya being EBV-positive (Leoncini *et al.*, 1996; Weinreb *et al.*, 1996).

Non-Hodgkin lymphoma

Non-Hodgkin lymphoma in childhood is nearly always high-grade. The epidemiology of Burkitt lymphoma in Africa has been described in Chapter 4.10. Other types of non-Hodgkin lymphoma usually have a total ASR of 5–9 per million, though incidence rates may be a little higher than this in North Africa. In the United States, blacks have a lower rate than whites. Though these geographical patterns are assumed to be related to environmental exposures, the high incidence in young Jewish migrants to Israel from North Africa is retained in their Israeli-born offspring, indicating that genetic susceptibility may also be involved (Iscovich & Parkin, 1997).

Brain and spinal tumours

In developed countries, brain and spinal tumours typically account for 20–25% of all childhood cancer, with an ASR of 25–40 per million. The most common subgroup is astrocytoma, which covers a wide spectrum of histological types from the relatively benign juvenile astrocytoma (including optic nerve glioma) to the aggressive anaplastic astrocytoma and glioblastoma multiforme. The second most common category comprises primitive neuroectodermal tumours, most of which are cerebellar medulloblastoma. Ependymomas (including choroid plexus tumours) are relatively rare and, like astrocytomas, this category encompasses a wide range of degrees of malignancy.

Table 5. Childhood cancer: age-standardized (world) incidence per million
Brain and spinal neoplasms

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	44	**10.2**	21	**5.2**	65	2.1	**7.7**
*Egypt, Alexandria (1980-1989)	136	**20.5**	115	**18.0**	251	1.2	**19.1**
Tunisia, 3 registries	11	**9.5**	12	**10.5**	23	0.9	**10.0**
Africa, West							
The Gambia (1988-1998)	1	**0.4**	-	-	1	-	**0.2**
Guinea, Conakry (1993-1999)	-	-	1	**0.8**	1	0.0	**0.4**
Mali, Bamako (1988-1997)	-	-	2	**1.2**	2	0.0	**0.6**
Niger, Niamey (1993-1999)	2	**2.1**	1	**1.4**	3	2.0	**1.8**
Nigeria, Ibadan (1993-1999)	13	**24.4**	5	**4.9**	18	2.6	**11.6**
Africa, Central							
Congo, Brazzaville (1996-1999)	-	-	-	-	-	-	-
Africa, East							
France, La Reunion (1988-1994)	8	**15.1**	6	**9.0**	14	1.3	**12.1**
Kenya, Eldoret (1998-2000)	6	**14.6**	5	**12.1**	11	1.2	**13.3**
Malawi, Blantyre (1991-2001)	-	-	1	**0.5**	1	0.0	**0.3**
Uganda, Kyadondo County (1993-1997)	3	**2.9**	1	**0.8**	4	3.0	**1.8**
Zimbabwe, Harare: African (1990-1997)	22	**13.3**	19	**10.7**	41	1.2	**11.9**
Africa, South							
*Namibia (1983-1992)	18	**6.8**	16	**6.0**	34	1.1	**6.4**
South Africa: Black (1989-1992)	*111*	**5.1**	*71*	**3.3**	*182*	*1.6*	**4.2**
South Africa: Indian (1989-1992)	*7*	**11.4**	*4*	**6.1**	*11*	*1.8*	**8.8**
South Africa: Mixed race (1989-1992)	*18*	**8.6**	*19*	**8.6**	*37*	*0.9*	**8.6**
South Africa: White (1989-1992)	*40*	**17.4**	*48*	**21.4**	*88*	*0.8*	**19.3**
Swaziland (1996-1999)	-	-	-	-	-	-	-
Europe/USA							
USA, SEER: White (1993-1997)	387	**37.6**	284	**28.7**	671	1.4	**33.2**
USA, SEER: Black (1993-1997)	46	**25.6**	43	**24.2**	89	1.1	**24.9**
France, 8 registries (1993-1997)	83	**29.0**	51	**19.0**	134	1.6	**24.1**
The Netherlands (1993-1997)	188	**26.0**	194	**28.4**	382	1.0	**27.2**
UK, England (1993-1997)	646	**27.0**	594	**25.5**	1240	1.1	**26.3**

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In developing countries, brain and spinal tumours are usually outnumbered not only by leukaemias but also by lymphomas, and recorded incidence is lower than in developed countries. In Africa, rates are very variable, but in general very low, rarely exceeding 15 per million (Table 5). There is almost certainly considerable under-ascertainment, because of deficiencies in diagnostic facilities. The registries that collect cases mainly from pathology departments will also suffer a deficit if autopsies are rarely performed. There is some evidence, however, from comparisons of incidence rates within the same country that risk may vary between ethnic groups. Black children in the United States have a lower ASR than whites, while children of West Indian descent in the United Kingdom have a low frequency of brain tumours (Stiller *et al.*, 1991). The lower recorded incidence in black children than in white in South Africa probably is largely related to differential biopsy rates.

Neuroblastoma

In the predominantly white populations of Europe, North America and Oceania, and also in Japan and Israel, the ASR is generally in the range 7–12 per million, and 6–10% of all childhood cancers are neuroblastomas (Stiller & Parkin, 1992). Rates are highest (25–50 per million) in the first year of life, when this is the commonest of all cancers. In the United States, blacks had a lower incidence than whites in infancy, but similar rates thereafter, whereas in the United Kingdom, there is no sign of variation between ethnic groups (Stiller *et al.*, 1991; Powell *et al.*, 1994).

Although the highest recorded incidence rates for neuroblastoma have long been in industrialized countries with a high material standard of living, studies in Denmark and the United States found that it was more common among less affluent groups (Carlsen, 1986; Davis *et al.*, 1987). This might be because children from families of lower socioeconomic status are generally more likely to be seen by doctors, giving greater opportunity for tumours to be detected. This explanation would not, however, account for the lower incidence among blacks in the United States, who are generally of lower socioeconomic status than whites. It seems likely that at least some of the deficit in developing countries compared with industrialized countries is due to underdiagnosis (Stiller & Parkin, 1992).

In North Africa, incidence rates of neuroblastoma are not much lower than in Europe and North America (Table 6). In southern Africa, there is some variability. Rates in black children in South Africa are considerably lower than rates in whites; since these data are histology-based, this may reflect different rates of investigation. In Zimbabwe, incidence in Harare is rather low, but the older series from Bulawayo (1963–77) did not suggest a particularly low incidence.

In West and East Africa, however, the rates are very low indeed, and neuroblastoma appears to be a rare cancer.

Table 6. Childhood cancer: age-standardized (world) incidence per million

Neuroblastoma

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	38	**9.7**	15	**4.0**	53	2.5	**6.9**
*Egypt, Alexandria (1980-1989)	42	**6.6**	24	**4.0**	66	1.8	**5.4**
Tunisia, 3 registries	9	**9.0**	11	**11.3**	20	0.8	**10.1**
Africa, West							
The Gambia (1988-1998)	1	**0.4**	1	**0.5**	2	1.0	**0.5**
Guinea, Conakry (1993-1999)	-	-	-	-	-	-	-
Mali, Bamako (1988-1997)	-	-	-	-	-	-	-
Niger, Niamey (1993-1999)	2	**2.6**	-	-	2	-	**1.2**
Nigeria, Ibadan (1993-1999)	2	**4.0**	1	**1.2**	3	2.0	**2.1**
Africa, Central							
Congo, Brazzaville (1996-1999)	-	-	-	-	-	-	-
Africa, East							
France, La Reunion (1988-1994)	2	**4.1**	5	**9.9**	7	0.4	**7.0**
Kenya, Eldoret (1998-2000)	-	-	-	-	-	-	-
Malawi, Blantyre (1991-2001)	1	**0.5**	-	-	1	-	**0.3**
Uganda, Kyadondo County (1993-1997)	-	-	-	-	-	-	-
Zimbabwe, Harare: African (1990-1997)	7	**4.1**	5	**2.8**	12	1.4	**3.4**
Africa, South							
*Namibia (1983-1992)	9	**3.6**	9	**3.6**	18	1.0	**3.6**
South Africa: Black (1989-1992)	*58*	**2.7**	*36*	**1.7**	*94*	*1.6*	**2.2**
South Africa: Indian (1989-1992)	-	-	-	-	-	-	-
South Africa: Mixed race (1989-1992)	*13*	**6.6**	*12*	**6.0**	*25*	*1.1*	**6.3**
South Africa: White (1989-1992)	*26*	**13.0**	*23*	**11.5**	*49*	*1.1*	**12.2**
Swaziland (1996-1999)	1	**1.4**	1	**1.4**	2	1.0	**1.4**
Europe/USA							
USA, SEER: White (1993-1997)	139	**14.9**	108	**12.1**	247	1.3	**13.5**
USA, SEER: Black (1993-1997)	25	**15.1**	17	**10.4**	42	1.5	**12.8**
France, 8 registries (1993-1997)	35	**14.0**	22	**9.5**	57	1.6	**11.8**
The Netherlands (1993-1997)	54	**8.2**	46	**7.3**	100	1.2	**7.8**
UK, England (1993-1997)	200	**9.2**	166	**7.8**	366	1.2	**8.5**

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A low frequency of neuroblastoma has been reported in numerous other series from tropical Africa (O'Conor & Davies, 1960). Miller (1977) noted that neuroblastoma cases were infrequent in series from East Africa (Kenya, Tanzania, Malawi, Zambia); in the data from Uganda, and from West Africa (Dakar and Ibadan), the relative frequency was higher, but the ratio of neuroblastoma cases to Wilms tumour cases was less than half of that in blacks in the United States. In a series of 1522 histologically diagnosed solid tumours of children in Kenya, Kung'u (1984) observed only two cases of neuroblastoma (although there were many "unspecified small round-cell sarcomas" of young children in the series) and more recent series (Makata *et al.*, 1996; Mwanda, 1999) have reported similarly low relative frequencies (0.5% and 0%, respectively). Miller(1989) drew upon relative frequency data cited above (Miller, 1977) and data in *International Incidence of Childhood Cancer* (Parkin *et al.*, 1988) to draw attention to the very low frequency (<1% of childhood cancers) in Kenya, Malawi, Tanzania, Uganda, Zaire and Zambia. Figure 3 shows an updated version of the map of Miller (1989), drawing upon data in this volume, as well as the original series.

The low rates of neuroblastoma in Ibadan, Nigeria, reported in Table 6 echo the rather modest frequency of this cancer in series for the same centre in 1960–72 (2.6%) (Williams, 1975) and 1960–84 (4.3%) (Parkin *et al.*, 1988).

Wessels and Hesseling (1996) calculated minimum incidence rates for the population of Namibia to be 7.6 per million for urban areas and 3.5 for rural dwellers.

Retinoblastoma

In most developed countries, retinoblastoma has an ASR of 3–5 per million and accounts for 2.5–4% of all childhood cancers. It is predominantly a tumour of early childhood, though the proportion of cases occurring among infants aged under one year is rather less than for neuroblastoma. In the United States, incidence among blacks (5.3 per million) is somewhat higher than among whites (4.9 per million) (Parkin *et al.*, 1998).

The data from Africa (Table 7) suggest that, in many of the populations of sub-Saharan Africa, rates are rather higher than in Europe and the United States, with several countries having rates in the range 5–11. The explanation for the very low recorded rate in Alexandria (Egypt) is unknown.

High relative frequencies of retinoblastomas have been reported in several clinical or pathology series (although the latter are often restricted to solid tumours), e.g. from Nigeria (Kodilinye, 1967; Williams, 1975; Obioha *et al.*, 1989), Sudan (Hussan *et al.*, 1988;

Table 7a. Childhood cancer: age-standardized (world) incidence per million

Retinoblastoma

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	22	**5.9**	18	**5.2**	40	1.2	**5.5**
*Egypt, Alexandria (1980-1989)	3	**0.5**	5	**0.8**	8	0.6	**0.7**
Tunisia, 3 registries	3	**2.8**	3	**3.1**	6	1.0	**3.0**
Africa, West							
The Gambia (1988-1998)	6	**2.6**	7	**3.0**	13	0.9	**2.8**
Guinea, Conakry (1993-1999)	21	**11.6**	10	**5.6**	31	2.1	**8.6**
Mali, Bamako (1988-1997)	13	**7.8**	13	**7.6**	26	1.0	**7.7**
Niger, Niamey (1993-1999)	6	**6.4**	4	**4.3**	10	1.5	**5.3**
Nigeria, Ibadan (1993-1999)	15	**33.5**	10	**11.3**	25	1.5	**19.0**
Africa, Central							
Congo, Brazzaville (1996-1999)	1	**1.9**	2	**4.0**	3	0.5	**3.0**
Africa, East							
France, La Reunion (1988-1994)	1	**2.1**	4	**8.4**	5	0.3	**5.2**
Kenya, Eldoret (1998-2000)	2	**5.0**	1	**2.5**	3	2.0	**3.8**
Malawi, Blantyre (1991-2001)	10	**6.1**	13	**7.4**	23	0.8	**6.8**
Uganda, Kyadondo County (1993-1997)	12	**9.5**	8	**6.0**	20	1.5	**7.7**
Zimbabwe, Harare: African (1990-1997)	24	**14.0**	13	**7.3**	37	1.8	**10.6**
Africa, South							
*Namibia (1983-1992)	10	**4.1**	12	**4.9**	22	0.8	**4.5**
South Africa: Black (1989-1992)	*66*	**3.2**	*56*	**2.8**	*122*	*1.2*	**3.0**
South Africa: Indian (1989-1992)	*4*	**7.4**	*1*	**1.6**	*5*	*4.0*	**4.5**
South Africa: Mixed race (1989-1992)	*8*	**4.1**	*9*	**4.6**	*17*	*0.9*	**4.4**
South Africa: White (1989-1992)	*6*	**3.1**	*6*	**3.4**	*12*	*1.0*	**3.3**
Swaziland (1996-1999)	1	**1.4**	2	**2.6**	3	0.5	**2.0**
Europe/USA							
USA, SEER: White (1993-1997)	43	**4.6**	41	**4.6**	84	1.0	**4.6**
USA, SEER: Black (1993-1997)	8	**4.9**	8	**5.0**	16	1.0	**5.0**
France, 8 registries (1993-1997)	13	**5.5**	3	**1.3**	16	4.3	**3.5**
The Netherlands (1993-1997)	33	**5.0**	35	**5.6**	68	0.9	**5.3**
UK, England (1993-1997)	92	**4.3**	92	**4.4**	184	1.0	**4.4**

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Parkin *et al.*, 1988), Congo (Democratic Republic) (Massabi *et al.*, 1989) and Kenya (Kung'u 1984). However, care must be taken when interpreting comparisons of relative frequencies. It is likely that retinoblastoma—a relatively easily diagnosed cancer—will be more often correctly diagnosed in Africa than other deep-seated cancers.

It is generally considered that there is less variation in incidence between populations for bilateral tumours (all of which represent the heritable form of the disease, with a genetic etiology) than for unilateral cases, most of which are sporadic (Draper *et al.*, 1992). In Europe, the percentages of bilateral cases are 21% in France, 29% in Germany and 37% in England and Wales (Parkin *et al.*, 1998). In the United States SEER registries, the percentage of bilateral cases (1983–92) was 29% in whites and 44% in blacks. The numbers of cases in the individual series from Africa in this volume are generally too small (or laterality is not recorded) to allow any clear analysis of this feature. In the larger series in Table 7, for which laterality was recorded, bilateral cases were 0/27 cases in Ibadan and 4/22 in Namibia. In the national histopathology series from Malawi (1991–95), there were five bilateral tumours in a total of 32 registrations (Parkin *et al.*, 1998). The percentage of bilateral cases in a 20-year clinical series from Johannesburg was 18% (Freedman & Goldberg, 1976), while in a long case series from Congo (Democratic Republic), Kayembi-Lubeji (1990) reported 33% of cases to be bilateral. A deficit of bilateral tumours may represent a higher relative incidence of

Table 7(b) Retinoblastoma. Mean age at diagnosis

	Mean age (years)
Algeria, 4 registries (1993–97)	3.0
Tunisia, 3 registries (1993–97)	3.7
Guinea, Conakry (1996–98)	3.3
Mali, Bamako (1988–97)	3.4
Nigeria, Ibadan (1985–92)	3.4
Uganda, Kyadondo (1993–97)	3.1
South Africa: Black (1989–92)	2.8
South Africa: White (1989–92)	2.9
Zimbabwe,Harare: African (1990–97)	2.4
USA, SEER: White (1993–97)	1.3
USA, SEER: Black (1993–97)	0.9
France, 8 registries (1993–97)	1.3
The Netherlands (1993–97)	1.3
UK, England (1993–97)	1.3

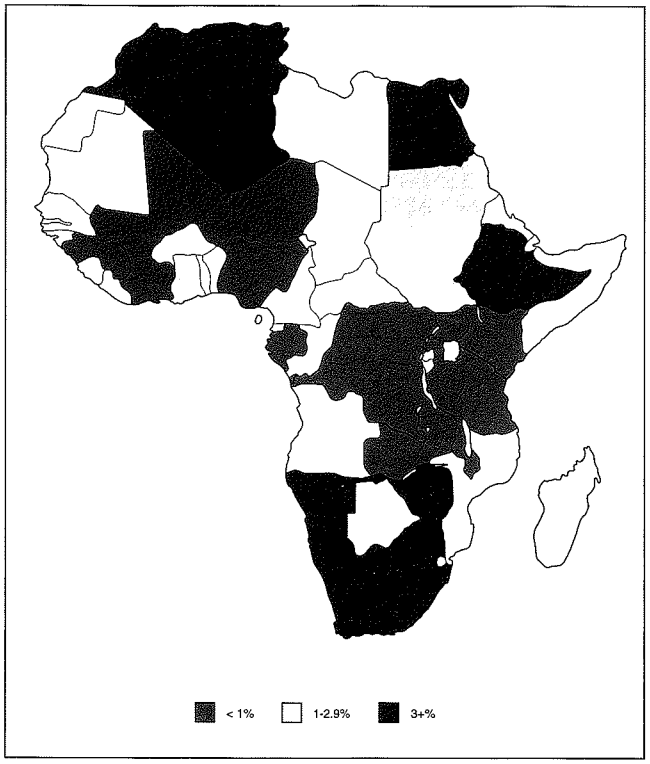

Figure 3. Frequency of neuroblastoma among childhood cancers (excluding Kaposi sarcoma and Burkitt lymphoma)

sporadic, as opposed to heritable cases, but it could also be a consequence of poor survival from the first tumour, or simply failures of recording.

Most case series have noted the rather higher age at diagnosis of cases in Africa than in Europe or North America. The mean age of the cases in the registry series in Table 7 is shown in Table 7(b). The older age at diagnosis in African children relates to the lower frequency of bilateral tumours (which have an earlier age of onset than sporadic, unilateral cases) and probably also to the relatively advanced stage at which tumours present in clinical practice in Africa (Wessels & Hesseling, 1995).

Renal tumours

The great majority of childhood renal tumours are Wilms tumours. It has long been noted that, worldwide, the highest incidence rates of Wilms tumour are observed among black populations, both in Africa and in series from the United States (Stiller & Parkin, 1990). However, recent data from the SEER program (1983–92) do not suggest a higher incidence in black children (ASR 8.8 per million) than in white children (ASR 10.0 per million). In the United Kingdom, children of West Indian descent also have a relatively high frequency of Wilms tumour (Stiller *et al.*, 1991).

Among white populations, Wilms tumour usually has an ASR of 6–10 per million and accounts for 5–7% of all childhood cancers, though higher rates have been recorded in several Nordic countries, Estonia and New Zealand. The age distributions in white and black populations are similar, with the highest incidence occurring in the second year of life.

The results from the African registries in this volume are varied (Table 8). Several incidence rates in southern and eastern Africa (e.g., in Kenya, Reunion, Uganda and Zimbabwe) are relatively high; the registries in West Africa report moderate incidence (with the exception of Conakry, Guinea).

Since incidence of Wilms tumour apparently varies along ethnic rather than geographical lines, it is possible that there is a strong element of genetic predisposition in its etiology, despite the fact that very few cases can be identified as directly hereditary.

Liver tumours

Most malignant liver tumours of childhood are either hepatoblastomas or hepatocellular carcinomas.

Hepatoblastoma is one of the rarer embryonal tumours. Nearly all cases are diagnosed in the first few years of life and incidence is highest in infancy. There is apparently very little geographical variation, with ASRs around 1–2 per million worldwide.

Hepatocellular carcinoma shows much more geographical variation, though everywhere most cases are in older children (10–14 years). In Europe and North America, it is rare in childhood, occurring with well under half the frequency of hepatoblastoma. It is much more common, however, in regions of the world with high rates of adult liver cancer (sub-Saharan Africa, East and South-East Asia and Melanesia). Most childhood cases of liver cancer in these areas occur in chronic carriers of hepatitis B (Cameron & Warwick, 1977; Moore *et al.*, 1997).

Bone tumours

In most childhood cancer registries, bone tumours (Table 9) comprise about 5% of all childhood cancers, compared with less than 1% in adults. Almost all are either osteosarcoma or Ewing sarcoma, with fewer than 10% being of other types.

The risk of osteosarcoma shows a bimodal distribution throughout life, with the first peak at age 15–19 years, so that incidence within childhood increases with age and more than 70% occurs at age 10–14 years. In the United States, the incidence was formerly somewhat higher in the black population than among whites (Parkin *et al.*, 1988), but during the l980s rates were very similar for the two ethnic groups (Parkin *et al.*, 1998). A link between the risk of osteosarcoma and bone growth has long been suspected (Johnson, 1953). More than three quarters of tumours arise in the long bones of the legs and there is an excess in girls before age 13 years and in boys thereafter, corresponding to their relative rates of growth.

The data from Africa are very sparse, as many bone tumours do not have adequate histological examination. In *International Incidence of Childhood Cancer*, Vol. II (Parkin et al, 1998), incidence rates were presented for just two centres with more than five cases of osteosarcoma registered: Harare, Zimbabwe (ASR 4.3 per million, based on eight cases), and Namibia, 1983–92 (ASR 2.7 per million, histology-only cases).

There is considerably more variation in risk between populations for Ewing sarcoma, with particularly low incidence in black populations. This was first noted in comparisons between rates in black and white children in the United States (Fraumeni & Glass, 1970; Glass & Fraumeni, 1970). The ratio between osteosarcoma and Ewing sarcoma in childhood in African registries is around 10:1, compared with approximately equal numbers in white populations (Parkin *et al.*, 1993). This suggests that genetic factors are important in predisposition to (or protection against) Ewing sarcoma. Incidence increases with age, though less steeply than for osteosarcoma. Compared with osteosarcoma, Ewing sarcoma arises more frequently in the ribs, pelvis (especially in older children) and skull (in younger children) and correspondingly less frequently in the long bones.

Soft-tissue sarcomas

Among white populations, soft-tissue sarcomas account for 4–8% of all childhood cancers and have a combined ASR of 6–11 per million. Between two thirds and three quarters are rhabdomyosarcomas, 10–20% are fibrosarcomas (including malignant fibrous histiocytoma and neurofibrosarcoma) and the remainder are other rare types. Among blacks in the United States, rhabdomyosarcoma has a similar incidence whereas fibrosarcoma is somewhat more common.

Table 8. Childhood cancer: age-standardized (world) incidence per million
Wilms tumour

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	25	**6.6**	38	**10.1**	63	0.7	**8.3**
*Egypt, Alexandria (1980-1989)	31	**4.9**	19	**3.2**	50	1.6	**4.1**
Tunisia, 3 registries	7	**6.8**	5	**5.2**	12	1.4	**6.0**
Africa, West							
The Gambia (1988-1998)	10	**4.1**	7	**3.0**	17	1.4	**3.6**
Guinea, Conakry (1993-1999)	14	**9.3**	5	**3.2**	19	2.8	**6.3**
Mali, Bamako (1988-1997)	10	**6.1**	4	**2.3**	14	2.5	**4.2**
Niger, Niamey (1993-1999)	-	-	2	**2.1**	2	0.0	**1.1**
Nigeria, Ibadan (1993-1999)	2	**3.8**	3	**3.3**	5	0.7	**3.5**
Africa, Central							
Congo, Brazzaville (1996-1999)	3	**5.8**	3	**6.2**	6	1.0	**6.0**
Africa, East							
France, La Reunion (1988-1994)	3	**4.9**	9	**18.3**	12	0.3	**11.5**
Kenya, Eldoret (1998-2000)	8	**19.8**	6	**14.9**	14	1.3	**17.4**
Malawi, Blantyre (1991-2001)	12	**7.0**	8	**4.4**	20	1.5	**5.7**
Uganda, Kyadondo County (1993-1997)	12	**9.9**	6	**4.5**	18	2.0	**7.2**
Zimbabwe, Harare: African (1990-1997)	22	**12.8**	27	**15.2**	49	0.8	**14.0**
Africa, South							
*Namibia (1983-1992)	17	**6.8**	13	**5.2**	30	1.3	**6.0**
South Africa: Black (1989-1992)	*110*	**5.2**	*112*	**5.3**	*222*	*1.0*	**5.3**
South Africa: Indian (1989-1992)	*3*	**5.8**	*1*	**1.6**	*4*	*3.0*	**3.7**
South Africa: Mixed race (1989-1992)	*10*	**4.9**	*8*	**4.1**	*18*	*1.3*	**4.5**
South Africa: White (1989-1992)	*20*	**9.7**	*17*	**8.6**	*37*	*1.2*	**9.2**
Swaziland (1996-1999)	3	**4.3**	6	**8.4**	9	0.5	**6.4**
Europe/USA							
USA, SEER: White (1993-1997)	94	**9.9**	88	**9.6**	182	1.1	**9.8**
USA, SEER: Black (1993-1997)	16	**9.3**	28	**16.6**	44	0.6	**12.9**
France, 8 registries (1993-1997)	27	**10.6**	27	**11.6**	54	1.0	**11.1**
The Netherlands (1993-1997)	72	**10.7**	62	**9.7**	134	1.2	**10.2**
UK, England (1993-1997)	164	**7.4**	156	**7.2**	320	1.1	**7.3**

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In Africa, incidence rates of childhood soft-tissue sarcomas other than Kaposi sarcoma are unremarkable (Table 10).

In the 1970s, Kaposi sarcoma had an ASR of 2–2.5 per million in Kampala, Uganda, and Bulawayo, Zimbabwe, and in Bulawayo it was the most common childhood soft-tissue sarcoma (Parkin *et al.*, 1988). These data from the period preceding the AIDS epidemic in sub-Saharan Africa give an indication of the incidence of childhood Kaposi sarcoma attributable to the endemic form of the disease. Since then, there have been very large increases in the incidence of Kaposi sarcoma among children in East and Central Africa. In Kampala during 1993–97, the ASR was 52.7 per million and among African residents of Harare, Zimbabwe, during 1990–97 it was 10.3 per million (Table 11). In these two series, Kaposi sarcoma accounted for 33% and 10% of all childhood cancers respectively. In Zambia over a similar period, the relative frequency was 19% (Chintu *et al.*, 1995). It is clear that the great majority of the increase in incidence is related to the AIDS epidemic, which has been particularly severe in East and Central Africa. As very high rates of HIV infection are a more recent phenomenon in western and southern Africa, the peak incidence of childhood Kaposi sarcoma may also occur later in these countries. In Harare, however, while the incidence of Kaposi sarcoma at all ages combined doubled between 1990–92 and 1993–95, in children it rose by only around 15% (Bassett *et al.*, 1995; Chokunonga *et al.*, 2000).

Even before the onset of the AIDS epidemic, however, Kaposi sarcoma in childhood had very different clinical features from endemic Kaposi sarcoma of adults, and more resembled epidemic AIDS-related Kaposi sarcoma. Thus, it was often poly-lymphadenopathic, with either absent or sparse and anomalously sited skin lesions. Progression was rapid (Slavin *et al.*, 1970; Olweny *et al.*, 1976).

Germ-cell and gonadal tumours

Germ-cell tumours generally account for less than 4% of all childhood cancers. Testicular tumours are rare in black children in the United States (Miller, 1977); incidence rates for germ-cell tumours are about one third to one quarter those in white children (Parkin *et al.*, 1998). These cancers are rare in all series of childhood cancers from Africa (Davies, 1973; Williams, 1975). Table 12 shows the rates from the series in this volume.

Epithelial tumours

By far the highest relative frequency of childhood nasopharyngeal carcinoma is in North Africa, a region of intermediate risk for adults, where it accounts for 7–15% of all childhood cancers; the ASR in Algeria was 2.6 per million. Among Israeli-born Jews, the highest incidence is among those whose parents were born in North Africa (Parkin & Iscovich, 1997). In the United States, black children had

Table 9. Childhood cancer: age-standardized (world) incidence per million
Bone tumours

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	34	**7.2**	32	**7.4**	66	1.1	**7.3**
*Egypt, Alexandria (1980-1989)	54	**8.4**	47	**6.9**	101	1.1	**7.6**
Tunisia, 3 registries	5	**3.6**	5	**3.6**	10	1.0	**3.6**
Africa, West							
The Gambia (1988-1998)	3	**1.4**	5	**2.3**	8	0.6	**1.9**
Guinea, Conakry (1993-1999)	11	**7.6**	3	**2.3**	14	3.7	**5.0**
Mali, Bamako (1988-1997)	3	**1.8**	3	**1.7**	6	1.0	**1.8**
Niger, Niamey (1993-1999)	9	**11.4**	5	**5.8**	14	1.8	**8.5**
Nigeria, Ibadan (1993-1999)	3	**5.5**	1	**0.8**	4	3.0	**2.4**
Africa, Central							
Congo, Brazzaville (1996-1999)	1	**1.9**	-	-	1	-	**1.0**
Africa, East							
France, La Reunion (1988-1994)	4	**6.0**	2	**2.8**	6	2.0	**4.5**
Kenya, Eldoret (1998-2000)	2	**4.9**	1	**2.3**	3	2.0	**3.6**
Malawi, Blantyre (1991-2001)	3	**1.8**	3	**1.7**	6	1.0	**1.7**
Uganda, Kyadondo County (1993-1997)	5	**4.6**	5	**3.8**	10	1.0	**4.3**
Zimbabwe, Harare: African (1990-1997)	9	**5.5**	5	**2.8**	14	1.8	**4.1**
Africa, South							
*Namibia (1983-1992)	11	**4.0**	9	**3.3**	20	1.2	**3.7**
South Africa: Black (1989-1992)	*52*	**2.3**	*55*	**2.5**	*107*	*0.9*	**2.4**
South Africa: Indian (1989-1992)	*5*	**7.9**	*3*	**4.6**	*8*	*1.7*	**6.3**
South Africa: Mixed race (1989-1992)	*2*	**0.9**	*4*	**1.7**	*6*	*0.5*	**1.3**
South Africa: White (1989-1992)	*15*	**6.1**	*31*	**12.9**	*46*	*0.5*	**9.4**
Swaziland (1996-1999)	3	**3.7**	9	**9.7**	12	0.3	**6.7**
Europe/USA							
USA, SEER: White (1993-1997)	88	**7.7**	58	**5.3**	146	1.5	**6.6**
USA, SEER: Black (1993-1997)	11	**5.5**	7	**3.6**	18	1.6	**4.5**
France, 8 registries (1993-1997)	18	**5.7**	19	**6.2**	37	0.9	**6.0**
The Netherlands (1993-1997)	54	**7.1**	46	**6.3**	100	1.2	**6.7**
UK, England (1993-1997)	139	**5.3**	141	**5.6**	280	1.0	**5.4**

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In italics: histopathology-based registries

an ASR of 0.8 per million, five times that in whites, and nasopharyngeal carcinoma was the most frequent epithelial neoplasm in the case series from Ibadan, Nigeria (Williams, 1975), Uganda (Davies, 1973) and Zambia (Chintu *et al.*, 1995)

Ascertainment of skin carcinoma is probably incomplete in most registries but incidence is exceptionally high in Tunisia, where it accounts for 9% of all registrations in a series from the National Cancer Institute (Parkin *et al.*, 1988). Among the 81 cases, 70% were squamous cell carcinoma and 30% were basal cell; 89% of cases were in children with xeroderma pigmentosum.

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Table 10. Childhood cancer: age-standardized (world) incidence per million

Soft tissue sarcomas

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	21	**5.0**	8	**1.9**	29	2.6	**3.5**
*Egypt, Alexandria (1980-1989)	24	**3.7**	9	**1.5**	33	2.7	**2.6**
Tunisia, 3 registries	3	**2.4**	4	**3.9**	7	0.8	**3.1**
Africa, West							
The Gambia (1988-1998)	1	**0.4**	4	**1.7**	5	0.3	**1.0**
Guinea, Conakry (1993-1999)	6	**4.3**	2	**1.4**	8	3.0	**2.9**
Mali, Bamako (1988-1997)	1	**0.6**	2	**1.2**	3	0.5	**0.9**
Niger, Niamey (1993-1999)	3	**4.1**	1	**1.0**	4	3.0	**2.5**
Nigeria, Ibadan (1993-1999)	4	**6.4**	5	**4.8**	9	0.8	**5.3**
Africa, Central							
Congo, Brazzaville (1996-1999)	4	**7.6**	1	**2.0**	5	4.0	**4.9**
Africa, East							
France, La Reunion (1988-1994)	1	**1.3**	2	**3.5**	3	0.5	**2.4**
Kenya, Eldoret (1998-2000)	5	**12.2**	2	**4.8**	7	2.5	**8.5**
Malawi, Blantyre (1991-2001)	28	**16.1**	18	**10.0**	46	1.6	**13.0**
Uganda, Kyadondo County (1993-1997)	88	**76.8**	53	**42.0**	141	1.7	**58.6**
Zimbabwe, Harare: African (1990-1997)	31	**18.1**	18	**10.1**	49	1.7	**14.0**
Africa, South							
*Namibia (1983-1992)	5	**1.9**	10	**3.7**	15	0.5	**2.8**
South Africa: Black (1989-1992)	*76*	**3.5**	*69*	**3.3**	*145*	*1.1*	**3.4**
South Africa: Indian (1989-1992)	*7*	**12.3**	*2*	**3.5**	*9*	*3.5*	**8.0**
South Africa: Mixed race (1989-1992)	*7*	**3.3**	*7*	**3.3**	*14*	*1.0*	**3.3**
South Africa: White (1989-1992)	*16*	**7.0**	*8*	**3.9**	*24*	*2.0*	**5.5**
Swaziland (1996-1999)	9	**10.9**	4	**5.4**	13	2.3	**8.1**
Europe/USA							
USA, SEER: White (1993-1997)	60	**5.8**	67	**6.6**	127	0.9	**6.2**
USA, SEER: Black (1993-1997)	12	**6.1**	6	**3.2**	18	2.0	**4.7**
France, 8 registries (1993-1997)	14	**4.8**	10	**3.9**	24	1.4	**4.3**
The Netherlands (1993-1997)	51	**7.2**	37	**5.4**	88	1.4	**6.3**
UK, England (1993-1997)	94	**3.9**	94	**4.1**	188	1.0	**4.0**

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Table 11. Childhood cancer: age-standardized (world) incidence per million

Kaposi sarcoma

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	-	-	-	-	-	-	-
*Egypt, Alexandria (1980-1989)	-	-	-	-	-	-	-
Tunisia, 3 registries	-	-	-	-	-	-	-
Africa, West							
The Gambia (1988-1998)	1	**0.4**	1	**0.4**	2	1.0	**0.4**
Guinea, Conakry (1993-1999)	-	-	-	-	-	-	-
Mali, Bamako (1988-1997)	-	-	-	-	-	-	-
Niger, Niamey (1993-1999)	-	-	-	-	-	-	-
Nigeria, Ibadan (1993-1999)	-	-	-	-	-	-	-
Africa, Central							
Congo, Brazzaville (1996-1999)	1	**1.9**	-	-	1	-	**1.0**
Africa, East							
France, La Reunion (1988-1994)	-	-	-	-	-	-	-
Kenya, Eldoret (1998-2000)	3	**7.2**	-	-	3	-	**3.6**
Malawi, Blantyre (1991-2001)	26	**15.0**	16	**8.9**	42	1.6	**11.8**
Uganda, Kyadondo County (1993-1997)	81	**70.2**	46	**36.6**	127	1.8	**52.7**
Zimbabwe, Harare: African (1990-1997)	26	**15.2**	10	**5.6**	36	2.6	**10.3**
Africa, South							
*Namibia (1983-1992)	2	**0.8**	2	**0.7**	4	1.0	**0.7**
South Africa: Black (1989-1992)	*3*	**0.1**	*6*	**0.3**	*9*	*0.5*	**0.2**
South Africa: Indian (1989-1992)	-	-	-	-	-	-	-
South Africa: Mixed race (1989-1992)	*2*	**0.9**	-	-	*2*	-	**0.5**
South Africa: White (1989-1992)	*1*	**0.4**	-	-	*1*	-	**0.2**
Swaziland (1996-1999)	5	**6.1**	2	**2.8**	7	2.5	**4.4**
Europe/USA							
USA, SEER: White (1993-1997)	-	-	-	-	-	-	-
USA, SEER: Black (1993-1997)	-	-	-	-	-	-	-
France, 8 registries (1993-1997)	-	-	-	-	-	-	-
The Netherlands (1993-1997)	-	-	1	**0.1**	1	0.0	**0.1**
UK, England (1993-1997)	1	**0.0**	-	-	1	-	**0.0**

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Table 12. Childhood cancer: age-standardized (world) incidence per million

Germ cell tumours

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	6	**1.7**	7	**1.9**	13	0.9	**1.8**
*Egypt, Alexandria (1980-1989)	8	**1.2**	12	**2.0**	20	0.7	**1.6**
Tunisia, 3 registries	2	**1.7**	2	**1.5**	4	1.0	**1.6**
Africa, West							
The Gambia (1988-1998)	1	**0.4**	-	-	1	-	**0.2**
Guinea, Conakry (1993-1999)	1	**0.5**	1	**0.6**	2	1.0	**0.5**
Mali, Bamako (1988-1997)	-	-	-	-	-	-	-
Niger, Niamey (1993-1999)	1	**1.1**	-	-	1	-	**0.5**
Nigeria, Ibadan (1993-1999)	3	**5.5**	2	**2.0**	5	1.5	**3.2**
Africa, Central							
Congo, Brazzaville (1996-1999)	-	-	-	-	-	-	-
Africa, East							
France, La Reunion (1988-1994)	3	**5.6**	2	**4.2**	5	1.5	**4.9**
Kenya, Eldoret (1998-2000)	-	-	-	-	-	-	-
Malawi, Blantyre (1991-2001)	-	-	3	**1.7**	3	0.0	**0.9**
Uganda, Kyadondo County (1993-1997)	1	**0.8**	2	**1.8**	3	0.5	**1.3**
Zimbabwe, Harare: African (1990-1997)	1	**0.6**	6	**3.3**	7	0.2	**2.0**
Africa, South							
*Namibia (1983-1992)	-	-	6	**2.3**	6	0.0	**1.1**
South Africa: Black (1989-1992)	*14*	**0.7**	*42*	**2.0**	*56*	*0.3*	**1.3**
South Africa: Indian (1989-1992)	*8*	**14.7**	-	-	*8*	-	**7.4**
South Africa: Mixed race (1989-1992)	*3*	**1.6**	*8*	**3.6**	*11*	*0.4*	**2.6**
South Africa: White (1989-1992)	*5*	**2.2**	*8*	**3.7**	*13*	*0.6*	**3.0**
Swaziland (1996-1999)	-	-	2	**2.5**	2	0.0	**1.2**
Europe/USA							
USA, SEER: White (1993-1997)	54	**5.3**	48	**4.7**	102	1.1	**5.0**
USA, SEER: Black (1993-1997)	5	**2.5**	14	**8.4**	19	0.4	**5.4**
France, 8 registries (1993-1997)	12	**4.4**	6	**2.6**	18	2.0	**3.5**
The Netherlands (1993-1997)	30	**4.2**	48	**7.0**	78	0.6	**5.6**
UK, England (1993-1997)	67	**2.9**	100	**4.2**	167	0.7	**3.5**

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Table 13. Childhood cancer: age-standardized (world) incidence per million

All cancers

	MALE		FEMALE		TOTAL		
	Cases	ASR(W)	Cases	ASR(W)	Cases	M/F	ASR(W)
Africa, North							
Algeria, 4 registries	495	**119.1**	320	**79.7**	815	1.5	**99.7**
*Egypt, Alexandria (1980-1989)	799	**121.8**	516	**81.1**	1315	1.5	**101.4**
Tunisia, 3 registries	110	**92.9**	98	**88.0**	208	1.1	**90.5**
Africa, West							
The Gambia (1988-1998)	89	**37.7**	73	**31.6**	162	1.2	**34.7**
Guinea, Conakry (1993-1999)	119	**76.9**	74	**50.9**	193	1.6	**64.0**
Mali, Bamako (1988-1997)	74	**45.5**	59	**33.6**	133	1.3	**39.4**
Niger, Niamey (1993-1999)	61	**76.5**	58	**67.1**	119	1.1	**71.7**
Nigeria, Ibadan (1993-1999)	110	**205.7**	66	**64.9**	176	1.7	**113.1**
Africa, Central							
Congo, Brazzaville (1996-1999)	32	**60.9**	24	**48.6**	56	1.3	**54.9**
Africa, East							
France, La Reunion (1988-1994)	59	**102.5**	63	**112.7**	122	0.9	**107.5**
Kenya, Eldoret (1998-2000)	58	**141.7**	42	**103.2**	100	1.4	**122.6**
Malawi, Blantyre (1991-2001)	155	**87.8**	108	**59.2**	263	1.4	**73.2**
Uganda, Kyadondo County (1993-1997)	246	**217.3**	169	**134.4**	415	1.5	**173.9**
Zimbabwe, Harare: African (1990-1997)	215	**127.4**	171	**96.0**	386	1.3	**111.3**
Africa, South							
*Namibia (1983-1992)	128	**48.8**	107	**40.7**	235	1.2	**44.8**
South Africa: Black (1989-1992)	*1285*	**59.4**	*1010*	**47.5**	*2295*	*1.3*	**53.5**
South Africa: Indian (1989-1992)	*106*	**178.0**	*51*	**84.3**	*157*	*2.1*	**131.8**
South Africa: Mixed race (1989-1992)	*164*	**78.2**	*133*	**62.8**	*297*	*1.2*	**70.5**
South Africa: White (1989-1992)	*445*	**204.3**	*374*	**179.5**	*819*	*1.2*	**192.2**
Swaziland (1996-1999)	44	**55.1**	49	**61.1**	93	0.9	**58.1**
Europe/USA							
USA, SEER: White (1993-1997)	1660	**163.2**	1365	**140.0**	3025	1.2	**151.9**
USA, SEER: Black (1993-1997)	254	**140.1**	204	**116.6**	458	1.2	**128.5**
France, 8 registries (1993-1997)	456	**163.9**	309	**116.8**	765	1.5	**140.9**
The Netherlands (1993-1997)	1086	**153.0**	887	**131.1**	1973	1.2	**142.3**
UK, England (1993-1997)	3352	**142.4**	2724	**118.9**	6076	1.2	**130.8**

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In italics: histopathology-based registries

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