Incidence of Childhood Cancer: Experience of a Decade in a Population-Based Registry[1,2]

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ABSTRACT—Incidence rates of cancer among children aged 0–14 for the period 1970–79 have been generated with the use of data from the Greater Delaware Valley (GDV) Pediatric Tumor Registry. This population-based registry covers a 31-county area and has a pediatric base population of 2 million. During the period, approximately 2,300 cases of childhood cancer were diagnosed in the region. Incidence rates for all histologic types combined are similar to rates from other large surveys conducted in the United States and Western Europe. However, certain histology-specific rates in the GDV vary by race. In the GDV nonwhites relative to whites have higher rates of Wilms' tumor, soft tissue sarcomas other than rhabdomyosarcoma, and retinoblastoma. These contrasts are supported by surveys in African populations showing relatively higher rates of these tumors among African black children. GDV whites exceed nonwhites in incidence of acute leukemia, neuroblastoma, and Ewing's sarcoma. African black children also experience low rates of these tumors. The frequency of central nervous system tumors is similar for GDV whites and nonwhites, despite reports of a rarity of these neoplasms in African blacks. Variations in incidence rates reveal population subgroups with particular tumor susceptibilities and may provide clues as to the relative influence of heredity and environment on patterns observed.—JNCI 1983; 70:49–55.

After accidents and congenital malformations, cancer, although rare, is the third leading cause of death in the pediatric age range. Great interest is therefore focused on the characterization of the distribution of childhood cancer in the population and subgroups at high risk. This information is crucial in the identification of risk factors, the formulation of testable hypotheses regarding etiology, and ultimately in the designation of preventive strategies.

Reliable incidence data on childhood cancer are scarce because they must be generated through registries or special surveys conducted in well-defined populations that allow complete and unbiased ascertainment of cases. The GDVPTR is an exclusively pediatric registry and one of the largest in the world. This paper summarizes incidence rates during the first 10 years (1970–79) of operation of the GDVPTR and highlights population subgroups who appear to experience unusual patterns of risk.

METHODS

Established by The Children's Hospital of Philadelphia, the GDVPTR is a population-based registry of pediatric cancer that covers a 31-county region designated the GDV (text-fig. 1). This region has a base population of approximately 2 million people aged 0–14 years with a racial distribution similar to that of the overall U.S. population (16% nonwhite). The GDV includes urban, highly industrialized communities as well as rural, agricultural areas.

Eligibility criteria for inclusion in the GDVPTR are: 1) diagnosis of a malignant tumor on or after January 1, 1970; 2) age 0–14 years at the time of diagnosis; and 3) residence in the 31-county region at the time of diagnosis. All of the 150 hospitals within the 31 counties as well as 10 major referral centers outside the region cooperate in ascertainment of eligible cases. Hospital-based audits of tumor registry data are periodically conducted, or in the absence of a hospital tumor registry, surveys are made of inpatient medical records as well as hospital departments such as pathology, radiation therapy, surgery, and hematology. Of the hospitals contributing to the GDVPTR, 72% have active tumor registries. A GDVPTR staff member reviews medical records to abstract details pertaining to clinical and disease characteristics, therapy, other significant conditions, and demographic information. In addition to hospital surveillance, reviews are done of death certificates from all counties covered by the registry and contiguous areas for individuals less than 20 years of age who have cancer or a cancer-related condition listed as a cause of death. Cases initially identified through the death certificate review for whom no supporting clinical information is located are not considered eligible for the registry.

Pathologic review by a pediatric pathologist was conducted for approximately 85% of cases with a tissue diagnosis

Abbreviations used: CNS=central nervous system; GDV=Greater Delaware Valley; GDVPTR=GDV Pediatric Tumor Registry; SEER=Surveillance, Epidemiology, and End Results (Program); SIR=standardized incidence ratios; TNCS=Third National Cancer Survey.

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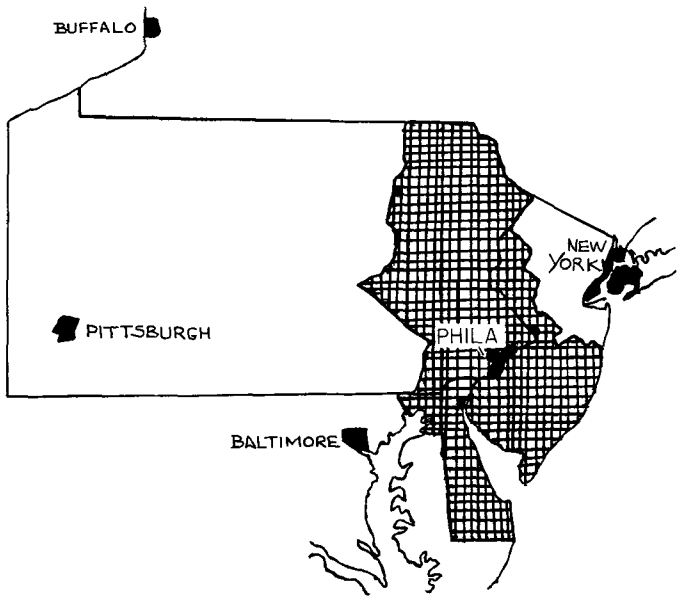

TEXT-FIGURE 1.—*Cross-hatched* area is included in the GDVPTR. The total population is 10 million and the pediatric population is 2.2 million.

for the period covered by this report. For the remaining 15%, the pathology report from the hospital of diagnosis was reviewed and, combined with information on clinical characteristics, treatment received, and response to therapy, a decision was made either to accept or to further investigate the reported diagnosis. Histologic type for eligible cases is classified according to the International Classification of Diseases for Oncology (*1*). The incidence data presented in this paper include all malignant neoplasms as well as intracranial tumors of uncertain behavior, i.e., craniopharyngioma, pinealoma, and subependymoma. Benign tumors are not included.

Average annual incidence rates per million were calculated in the following manner:

$$\frac{\text{Number of cases for the 10-year period}}{\text{Midperiod (1975) population}} \times \frac{1}{10} \times 10^6$$

Intercensal estimates of the population by county, age, race, and sex (for each year from 1971 to 1977), which were developed for the National Cancer Institute by the U.S. Bureau of the Census, were provided by Dr. Thomas Mason of the National Cancer Institute. Incidence rates were calculated for two race categories, white and nonwhite. The nonwhite group is comprised primarily of blacks (96%), although it also includes 8 Chinese, 2 Vietnamese, 2 Japanese, 1 Indian, 1 Arab, and 4 children of unknown racial background. Rates for each race category were age adjusted according to the indirect method (*2*) with the use of age-specific rates for all races combined from the GDVPTR as a standard. The age categories used in the adjustment were 0–4, 5–9, and 10–14 years. The indirect method of age standardization generates the number of cases that would be "expected" to occur if individuals in each age stratum were experiencing the same risk as that of the standard population. The number of cases expected is then summed over all age categories, and a ratio of observed cases to expected cases is formed. This ratio is known as the SIR. Within each histologic type, race-specific comparisons were made by the examination of the ratio of their SIR. Exact 95% confidence limits on the ratios of SIR were calculated according to the method described for the determination of confidence limits on the ratio of two Poisson variables (*3*). When confidence limits around SIR or their ratios do not include unity, statistical significance has been achieved at the 0.05 level. Given the large number of comparisons in this survey, some spuriously significant results could occur by chance alone.

Only race-specific incidence rates were age adjusted be-

TABLE 1.—*Average annual incidence of cancer per million children aged 0–14: GDVPTR, 1970–79, whites*[a]

Histologic Type	Males[b]		Females[b]		Both sexes[b]	
	No.	Rate	No.	Rate	No.	Rate
I. Leukemias	*371*	*44.40*	*275*	*34.48*	*646*	*39.55*
Acute lymphocytic leukemia	295	35.30	210	26.33	505	30.91
Acute nonlymphocytic leukemia	52	6.22	50	6.27	102	6.24
Chronic myelocytic leukemia	9	1.08	5	0.63	14	0.86
Other leukemias	15	1.80	10	1.25	25	1.53
II. Lymphomas	*136*	*16.28*	*69*	*8.65*	*205*	*12.55*
Hodgkin's lymphoma	67	8.02	40	5.01	107	6.55
Non-Hodgkin's lymphoma	69	8.26	29	3.64	98	6.00
III. CNS tumors	*226*	*27.05*	*220*	*27.58*	*446*	*27.30*
A. Gliomas	*192*	*22.98*	*172*	*21.56*	*364*	*22.28*
Glioma	25	2.99	31	3.89	56	3.43
Mixed glioma	1	0.12	0	0	1	0.06
Subependymal glioma	1	0.12	1	0.13	2	0.12
Subependymal giant cell astrocytoma	1	0.12	0	0	1	0.12
Choroid plexus carcinoma	1	0.12	0	0	1	0.12
Ependymoma	26	3.11	16	2.01	42	2.57
Astrocytoma	83	9.93	91	11.41	174	10.65
Astroblastoma	0	0.0	1	0.13	1	0.06
Glioblastoma	3	0.36	1	0.13	4	0.24

[a] The midperiod (1975) populations at risk were 835,611 white males and 797,668 white females.
[b] *Numbers in italics* are totals.

TABLE 1 (continued).—*Average annual incidence of cancer per million children aged 0–14: GDVPTR, 1970–79, whites*[a]

Histologic Type	Males[b]		Females[b]		Both sexes[b]	
	No.	Rate	No.	Rate	No.	Rate
Oligodendroglioma	1	0.12	1	0.13	2	0.12
Medulloblastoma	46	5.50	28	3.51	74	4.53
Cerebellar sarcoma	4	0.48	2	0.25	6	0.37
B. Neuroepitheliomatous tumors	*1*	*0.12*	*8*	*1.00*	*9*	*0.55*
Neuroblastoma	0	0	0	0	0	0
Ganglioglioma	1	0.12	8	1.00	9	0.55
C. Meningioma	*3*	*0.36*	*1*	*0.13*	*4*	*0.24*
Meningioma	2	0.24	0	0	2	0.12
Leptomeningeal sarcoma	1	0.12	1	0.13	2	0.12
D. Germ cell neoplasms	*6*	*0.72*	*9*	*1.13*	*15*	*0.92*
Dysgerminoma	1	0.12	0	0	1	0.06
Germinoma	1	0.12	3	0.38	4	0.24
Embryonal cell carcinoma	2	0.24	2	0.25	4	0.24
Teratoma	1	0.12	4	0.50	5	0.31
Teratocarcinoma	1	0.12	0	0	1	0.06
E. Other CNS tumors	*24*	*2.87*	*30*	*3.76*	*54*	*3.31*
Craniopharyngioma	12	1.44	11	1.38	23	1.41
Pinealoma	4	0.48	4	0.50	8	0.49
Pineoblastoma	0	0	2	0.25	2	0.12
Pineocytoma	0	0	1	0.13	1	0.06
Primitive neural ectodermal tumor	3	0.36	3	0.38	6	0.37
Chordoma	0	0	1	0.13	1	0.06
Melanoma	0	0	0	0	0	0
Cancer, not otherwise specified	5	0.60	6	0.75	11	0.67
Fibrosarcoma	0	0	1	0.13	1	0.06
Reticulum cell sarcoma	0	0	1	0.13	1	0.06
IV. Soft tissue sarcomas	*64*	*7.66*	*58*	*7.27*	*122*	*7.47*
Rhabdomyosarcoma	40	4.79	31	3.89	71	4.35
Neurogenous sarcoma	4	0.48	5	0.63	9	0.55
Fibrosarcoma	6	0.72	7	0.88	13	0.80
Synovial sarcoma	4	0.48	2	0.25	6	0.37
Liposarcoma	0	0	0	0	0	0
Malignant mesenchymoma	0	0	2	0.25	2	0.12
Leiomyosarcoma	0	0	3	0.38	3	0.18
Hemangiosarcoma	3	0.36	3	0.38	6	0.37
Other sarcomas	7	0.84	5	0.63	12	0.73
V. Liver tumors	*11*	*1.32*	*5*	*0.63*	*16*	*0.98*
Hepatoblastoma	7	0.84	2	0.25	9	0.55
Hepatocellular carcinoma	3	0.36	2	0.25	5	0.31
Other liver tumors	1	0.12	1	0.13	2	0.12
VI. Bone tumors	*51*	*6.10*	*48*	*6.02*	*99*	*6.06*
Osteosarcoma	25	2.99	21	2.63	46	2.82
Ewing's sarcoma	24	2.87	21	2.63	45	2.76
Chondrosarcoma	1	0.12	4	0.50	5	0.31
Other bone tumors	1	0.12	2	0.25	3	0.18
VII. Gonadal tumors	*14*	*1.68*	*18*	*2.26*	*32*	*1.96*
Germ cell tumor	14	1.68	11	1.38	25	1.53
Tumor of surface epithelium	0	0	5	0.63	5	0.31
Sex cord and stromal tumors	0	0	2	0.25	2	0.12
VIII. Neoplasms of sympathetic nervous system	*86*	*10.29*	*57*	*7.15*	*143*	*8.76*
Neuroblastoma	76	9.10	47	5.89	123	7.53
Ganglioneuroblastoma	10	1.20	10	1.25	20	1.22
IX. Retinoblastoma	*39*	*4.67*	*24*	*3.01*	*63*	*3.86*
X. Kidney tumors	*56*	*6.70*	*47*	*5.87*	*103*	*6.31*
Wilms' tumor	54	6.46	47	5.87	101	6.18
Renal cell carcinoma	2	0.24	0	0	2	0.12
XI. Cutaneous melanoma	*6*	*0.72*	*3*	*0.38*	*9*	*0.55*
XII. Histiocytosis X, malignant	*4*	*0.48*	*3*	*0.38*	*7*	*0.43*
XIII. Miscellaneous tumors	*26*	*3.11*	*36*	*4.51*	*62*	*3.80*
Nasopharyngeal tumor	2	0.24	1	0.13	3	0.18
Parotid gland tumor	2	0.24	4	0.50	6	0.37
Thyroid gland tumor	7	0.84	12	1.50	19	1.16
Adrenal gland tumor	1	0.12	0	0	1	0.06
Other miscellaneous	14	1.68	19	2.38	33	2.02
All types of tumors	*1,090*	*130.44*	*863*	*108.19*	*1,953*	*119.57*

[a] The midperiod (1975) populations at risk were 835,611 white males and 797,668 white females.
[b] *Numbers in italics* are totals.

TABLE 2.—*Average annual incidence of cancer per million children aged 0-14: GDVPTR, 1970-79, nonwhites*[a]

Histologic type	Males[b]		Females[b]		Both sexes[b]	
	No.	Rate	No.	Rate	No.	Rate
I. Leukemias	*57*	*31.40*	*23*	*12.87*	*80*	*22.20*
Acute lymphocytic leukemia	41	22.58	14	7.83	55	15.27
Acute nonlymphocytic leukemia	10	5.51	6	3.36	16	4.45
Chronic myelocytic leukemia	2	1.10	0	0	2	0.56
Other leukemias	4	2.20	3	1.68	7	1.94
II. Lymphomas	*24*	*13.22*	*14*	*7.83*	*38*	*10.55*
Hodgkin's lymphoma	15	8.26	8	4.48	23	6.38
Non-Hodgkin's lymphoma	9	4.96	6	3.36	15	4.16
III. CNS tumors	*48*	*26.44*	*46*	*25.74*	*94*	*26.09*
A. Gliomas	*40*	*22.03*	*34*	*19.02*	*74*	*20.54*
Glioma	7	3.86	6	3.36	13	3.61
Mixed glioma	0	0	1	0.56	1	0.28
Subependymal glioma	0	0	0	0	0	0
Subependymal giant cell astrocytoma	0	0	0	0	0	0
Choroid plexus carcinoma	0	0	0	0	0	0
Ependymoma	4	2.20	4	2.24	8	2.22
Astrocytoma	17	9.36	12	6.71	29	8.05
Astroblastoma	0	0	0	0	0	0
Glioblastoma	0	0	0	0	0	0
Oligodendroglioma	1	0.55	2	1.12	3	0.83
Medulloblastoma	10	5.51	7	3.92	17	4.72
Cerebellar sarcoma	1	0.55	2	1.12	3	0.83
B. Neuroepitheliomatous tumors	*2*	*1.10*	*0*	*0*	*2*	*0.56*
Neuroblastoma	2	1.10	0	0	2	0.56
Ganglioglioma	0	0	0	0	0	0
C. Meningioma	*0*	*0*	*1*	*0.56*	*1*	*0.28*
Meningioma	0	0	1	0.56	1	0.28
Leptomeningeal sarcoma	0	0	0	0	0	0
D. Germ cell neoplasms	*1*	*0.55*	*3*	*1.68*	*4*	*1.11*
Dysgerminoma	0	0	1	0.56	1	0.28
Germinoma	0	0	1	0.56	1	0.28
Embryonal cell carcinoma	0	0	0	0	0	0
Teratoma	1	0.55	0	0	1	0.28
Teratocarcinoma	0	0	1	0.56	1	0.28
E. Other CNS tumors	*5*	*2.75*	*8*	*4.48*	*13*	*3.61*
Craniopharyngioma	4	2.20	6	3.36	10	2.78
Pinealoma	0	0	0	0	0	0
Pineoblastoma	0	0	0	0	0	0
Pineocytoma	0	0	0	0	0	0
Primitive neural ectodermal tumor	0	0	0	0	0	0
Chordoma	0	0	0	0	0	0
Melanoma	0	0	1	0.56	1	0.28
Cancer, not otherwise specified	1	0.55	1	0.56	2	0.56
Fibrosarcoma	0	0	0	0	0	0
Reticulum cell sarcoma	0	0	0	0	0	0
IV. Soft tissue sarcomas	*23*	*12.67*	*14*	*7.83*	*37*	*10.27*
Rhabdomyosarcoma	10	5.51	6	2.80	16	4.44
Neurogenous sarcoma	0	0	2	1.12	2	0.56
Fibrosarcoma	4	2.20	1	0.56	5	1.39
Synovial sarcoma	1	0.55	0	0	1	0.28
Liposarcoma	1	0.55	2	1.12	3	0.83
Malignant mesenchymoma	3	1.65	1	0.56	4	1.11
Leiomyosarcoma	0	0	1	0.56	1	0.28
Hemangiosarcoma	2	1.10	1	0.56	3	0.83
Other sarcomas	2	1.10	0	0	2	0.56
V. Liver tumors	*1*	*0.55*	*1*	*0.56*	*2*	*0.56*
Hepatoblastoma	0	0	1	0.56	1	0.28
Hepatocellular carcinoma	1	0.55	0	0	1	0.28
Other liver tumors	0	0	0	0	0	0
VI. Bone tumors	*11*	*6.06*	*11*	*6.15*	*22*	*6.11*
Osteosarcoma	10	5.51	8	4.48	18	5.00
Ewing's sarcoma	0	0	1	0.56	1	0.28
Chondrosarcoma	1	0.55	1	0.56	2	0.56
Other bone tumors	0	0	1	0.56	1	0.28

[a] The midperiod (1975) populations at risk were 181,552 nonwhite males and 178,728 nonwhite females.
[b] *Numbers in italics* are totals.

TABLE 2 (continued).—*Average annual incidence of cancer per million children aged 0-14: GDVPTR, 1970-79, nonwhites*[a]

Histologic Type	Males[b]		Females[b]		Both sexes[b]	
	No.	Rate	No.	Rate	No.	Rate
VII. Gonadal tumors	*1*	*0.55*	*9*	*5.04*	*10*	*2.78*
Germ cell tumor	1	0.55	5	2.80	6	1.67
Tumors of surface epithelium	0	0	1	0.56	1	0.28
Sex cord and stromal tumors	0	0	3	1.68	3	0.83
VIII. Neoplasms of sympathetic nervous system	*8*	*4.41*	*9*	*5.04*	*17*	*4.72*
Neuroblastoma	8	4.41	7	3.92	15	4.16
Ganglioneuroblastoma	0	0	2	1.12	2	0.56
IX. Retinoblastoma	*8*	*4.41*	*11*	*6.15*	*19*	*5.27*
X. Kidney tumors	*17*	*9.36*	*26*	*14.55*	*43*	*11.94*
Wilms' tumor	17	9.36	26	14.55	43	11.94
Renal cell carcinoma	0	0	0	0	0	0
XI. Cutaneous melanoma	*0*	*0*	*0*	*0*	*0*	*0*
XII. Histiocytosis X, malignant	*2*	*1.10*	*0*	*0*	*2*	*0.56*
XIII. Miscellaneous tumors	*5*	*2.75*	*7*	*3.92*	*12*	*3.33*
Nasopharyngeal tumor	2	1.10	3	1.68	5	1.39
Parotid gland tumor	0	0	1	0.56	1	0.28
Thyroid gland tumor	0	0	0	0	0	0
Adrenal gland tumor	1	0.55	0	0	1	0.28
Other miscellaneous tumors	2	1.10	3	1.68	5	1.39
All types of tumors	*205*	*112.92*	*171*	*95.68*	*376*	*104.36*

[a] The midperiod (1975) populations at risk were 181,552 nonwhite males and 178,728 nonwhite females.
[b] *Numbers in italics* are totals.

cause the percent distribution of the population in each age category differed slightly between whites and nonwhites. The age distribution was the same for each sex group within the two race categories; therefore, sex-specific comparisons of rates did not require age adjustment.

RESULTS

Tables 1 and 2 present numbers of cases and average annual incidence rates of childhood cancer by histologic type and sex for whites and nonwhites over the period 1970–79. Incidence rates for all types combined were higher among whites than nonwhites and among males than females, regardless of race. Table 3 shows that the percentage distribution by type of tumor differed between race categories. Leukemia was the most common form of cancer among white children and accounted for 33.1% of all tumors. Other major histologic types occurring in white children in order of frequency were tumors of the CNS, lymphomas, neoplasms of the sympathetic nervous system, soft tissue sarcomas, Wilms' tumor, malignant bone neoplasms, and retinoblastoma. The relative frequency of major tumor types among nonwhites differed from that among whites, with CNS tumor predominating among nonwhites (24.8%) followed by leukemias, Wilms' tumor, lymphomas, soft tissue sarcomas, bone tumors, retinoblastoma, and tumors of the sympathetic nervous system.

Table 4 presents SIR for the major histologic types by race. When data from table 4 are combined with sex-specific

TABLE 3.—*Percent distribution of major histologic types of childhood cancer by race: GDVPTR, 1970-79*

Histologic type	Percent of all tumors	
	Whites	Nonwhites
Leukemias	33.1	21.1
CNS tumors	22.9	24.8
Lymphomas	10.5	10.0
Neoplasms of sympathetic nervous system	7.3	4.5
Soft tissue sarcomas	6.3	9.8
Wilms' tumor	5.2	11.3
Bone tumors	5.1	5.8
Retinoblastoma	3.2	5.0

TABLE 4.—*SIR for childhood cancer by race and histologic type*

Histologic type	Race	
	White	Nonwhite
Leukemias		
Acute lymphocytic leukemia[a]	1.13	0.54
Acute nonlymphocytic leukemia	1.04	0.91
Chronic myelocytic leukemia	1.07	0.70
Other leukemias	0.98	1.23
Lymphomas		
Hodgkin's lymphoma	1.00	1.01
Non-Hodgkin's lymphoma	1.06	0.75
CNS		
Glioma	0.99	1.04
Ependymoma	1.03	0.87
Astrocytoma	1.05	0.79
Medulloblastoma	0.99	1.03
Neuroblastoma[a]	1.10	0.58
Wilms' tumor[a]	0.86	1.60
Soft tissue sarcomas	0.95	1.29
Rhabdomyosarcoma	1.00	1.00
Other soft tissue sarcomas[a]	0.87	1.64
Retinoblastoma	0.94	1.23
Bone tumors		
Osteosarcoma[a]	0.87	1.60
Ewing's sarcoma[a]	1.20	0.05
Gonadal tumors	0.93	1.36
Liver tumors	1.10	0.61

[a] Ratio of race-specific SIR statistically significant at or <0.05 level.

data presented in tables 1 and 2, the following race–sex patterns emerge. Acute lymphocytic leukemia, neuroblastoma, and Ewing's sarcoma occur more often in whites and in males than in females. White males have the highest rate of non-Hodgkin's lymphoma, inasmuch as the male excess for non-Hodgkin's lymphoma is not seen in nonwhites. The incidence of CNS tumors does not appear to differ substantially by race. Nonwhites significantly exceed whites in incidence of Wilms' tumor, where there is a marked female preponderance. The frequency of bilateral Wilms' tumors (13 cases) was slightly higher among nonwhites (11.6%) than whites (7.7%). These proportions are higher than those found in the National Wilms' Tumor Study (*4*), which reported bilaterality in 3.7% of nonwhite cases and 5.8% of white cases.

Other rates statistically significantly elevated among nonwhites versus whites are for soft tissue sarcomas (other than rhabdomyosarcoma) and osteosarcoma, their excess being of the same magnitude as their deficiency of Ewing's sarcoma. Compared to other race–sex groups, nonwhite females had slightly higher rates of gonadal tumors and retinoblastoma. For retinoblastoma, the frequency of bilaterality was higher among whites (36.5%) than nonwhites (21.1%).

Data from the GDVPTR do not show a temporal increase in incidence of acute nonlymphocytic leukemia among nonwhite children (8 per million in 1970–74 and 6 per million in 1975–79) as was reported in Baltimore (*5*) nor an increase in incidence of acute lymphocytic leukemia (27 per million in 1970–74 and 29 per million in 1975–79) as has been observed in northwest England (*6*).

DISCUSSION

The ability to identify in children patterns of cancer incidence, specific for time, place, and personal characteristics, is helpful in providing clues regarding risk factors and may therefore be valuable in generating etiologic hypotheses. Reliable incidence data for pediatric neoplasms may only be obtained, however, through population-based surveys or registries that cover a large and well-characterized population base, have histopathologic expertise available, and maintain a high level of case ascertainment. The GDVPTR fulfills these criteria. Pediatric cancers generally produce serious enough morbidity that they are consistently brought to medical attention in developed countries. Thus hospital records and death certificates, if adequately reviewed, should identify all but an exceptional case. The GDVPTR is maintained by a well-known regional referral center for childhood cancer with a large network of community physicians who regularly interact with the physicians in the center. Formal cooperative arrangements for case reporting have been established with 150 hospitals and the three state health departments in the region covered by the registry. The 10-year review of death certificates was the initial source of ascertainment for only 3% of all cases. All death certificate cases included in the GDVPTR had supporting clinical data available; i.e., the patients had all sought medical care in the region. Only 6 cases were identified through a death certificate, with no hospital records ever found. These cases were excluded from the incidence series. The population at risk in the 31-county region has been stable over the decade studied and large enough to generate a sufficient number of cases of childhood cancer for meaningful analysis.

Summary incidence rates in the GDV for all histologic types combined are similar to U.S. rates from the TNCS (*7*) and the more recent SEER Program (*8*), as well as population-based registries in western Europe [(*9–11*) Pastore G: Personal communication]. More intriguing, however, are the variations that emerge when race-, sex-, and histology-specific rates are examined.

An excess risk among nonwhites is seen for Wilms' tumor, soft tissue sarcomas, and retinoblastoma. The finding of a significantly higher incidence rate of Wilms' tumor among nonwhites (especially among females) compared to whites was a surprise in light of the absence of an incidence difference by race in the TNCS (*7*). However, a link between African ancestry and high risk, particularly among females, is strengthened by reports from Johannesburg, South Africa (*12*), Israel (*13*), and the United States by the most recent SEER results (*8*), by a report from the New York State Cancer Registry (*14*), and by a survey conducted among black children in Washington, D.C. (*15*). The African and Israeli surveys indicate that black African children and African-born Israelis experience a rate of Wilms' tumor in excess of that observed in European and Caucasian American children. The New York State Registry and SEER data, while not finding significant differences in risk by race, did show that of all race–sex groups, black females had the highest rate of Wilms' tumor. Our observation of a high rate of soft tissue sarcomas (other than rhabdomyosarcoma) among GDVPTR nonwhite males is supported by a high incidence of soft tissue sarcomas among Ugandans (*15, 16*), an elevated rate of fibrosarcomas among Nigerian children (*17*), and a predominance of males over females among Nigerian cases (*17*) and among TNCS blacks (*7*). This high rate of fibrosarcoma may be due to the same phenomenon that causes excessive keloid formation among blacks, i.e., excessive growth of an intermediate population of cells, as has been proposed by Moolgavkar and Knudson (*18*) and Goldson et al. (*19*). Complementing the GDVPTR observation of a high rate of retinoblastoma among nonwhite females are reports from Africa noting a high rate of retinoblastoma among certain African populations (*16, 17*). The most recent SEER report (*8*) shows a slightly higher rate of retinoblastoma among blacks compared to whites, and the TNCS (*7*), although not reporting a racial difference in risk, did find twice as many cases of retinoblastoma among black females as black males.

White children in the GDV had significantly elevated rates compared to those of nonwhites of acute lymphocytic leukemia, neuroblastoma, and Ewing's sarcoma. The elevated rates of Ewing's sarcoma were expected, inasmuch as the extreme rarity of Ewing's sarcoma among blacks is a consistent finding regardless of geographical region and time period (*16*), which suggests resistance to this tumor among blacks. Surveys in Africa have reported that neuroblastoma is very uncommon (*16, 17, 20*), accounting for only 2% of all tumors in Ugandan and Nigerian blacks. Upon further examination of the racial heterogeneity for neuroblastoma,

it is observed that incidence rates for blacks in the GDVPTR are intermediate between those of African black children and U.S. whites, which suggests a geographic effect.

The large difference in risk by race noted for acute lymphocytic leukemia in our series is concordant with the long-recognized experience of black African children who have a low rate of acute leukemia (*16, 17, 21, 22*) and observed age peaks and types of leukemia that differ from children born in the United States and Europe. Surveys in Uganda (*23*) and Nigeria (*21*) have revealed that leukemia accounts for less than 10% of all childhood cancers (in Ibadan, Nigeria, the average annual incidence rate of acute leukemia was reported to be 1.9 per million children, a probable underestimate), with the peak incidence in the age group 10–15 years and 38% classified as myeloblastic. The GDVPTR and the TNCS show that in the United States leukemia in the pediatric age range accounts for approximately 21% of all tumors among blacks compared to 33% among whites, the latter percentage being similar to European Caucasians (*9–11*). Although most acute leukemias among blacks in the GDVPTR are lymphatic, a higher proportion are nonlymphatic (20%) than among whites (15%). Thus the incidence pattern of leukemias among U.S. black children is intermediate between that of U.S. whites and African blacks.

Similar to other surveys conducted in the United States (*7, 8*), the GDVPTR showed an equal risk of CNS tumors for whites and nonwhites. These findings contrast with reports from Africa (*24–26*) and Israel (*13*) that indicate a rarity of CNS neoplasms among Africans.

Although for some childhood tumors specific genetic and environmental factors have been identified as being associated with high risk (*27–29*), for most neoplasms the etiologies are unknown. We recognize that, in most cases, both heredity and environment contribute to tumor frequency. However, one or the other category of risk factors may clearly be more influential, such as occurs with Ewing's sarcoma (genetic factors predominating) and Burkitt's lymphoma (environmental influences). Comparisons made between frequencies observed in the GDV and other parts of the world reveal population subgroups with particular tumor susceptibilities and geographical areas that seem to be associated with high tumor-specific risk. Any differences observed may prove valuable in designing case–control studies of childhood cancer etiology, such as the one in which we are currently engaged.

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