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HIGHLIGHTS

Incidence

- Among children, particularly before the adolescent years, carcinomas are very rare.
- In the US, approximately 1,050 children and adolescents younger than 20 years of age are diagnosed with carcinomas each year, of which approximately 350 are thyroid carcinomas and 300-350 are melanomas.
- All of the carcinomas combined comprised 9.2% of cancer in children younger than 20. The majority of the carcinomas were either thyroid carcinomas (35.5%) or melanomas (30.9%). Adrenocortical carcinomas (1.3%), nasopharyngeal carcinomas (4.5%), and other skin carcinomas (0.5%) combined for only a small proportion of the total, while other and unspecified carcinomas comprised 27.3%.
- The incidence rates for thyroid carcinoma were highest among the 15-19 year olds and much higher among females (24.4 per million) than males (4.7 per million) (Table XI.2).
- The incidence rates for malignant melanoma were highest among the 15-19 year olds and higher among females (16.5 per million) than males (10.0 per million) (Table XI.2).

Survival

- The 5-year survival rate was 99% for thyroid carcinomas. Males had a slightly lower survival rate than females (Table XI.4).
- The 5-year survival rate was 91% for malignant melanoma. Females had a 93% survival rate compared to males with an 87% survival rate (Table XI.4).

Risk factors

- The most well established risk factor for thyroid carcinoma is ionizing radiation exposure, from both environmental and therapeutic sources.
- The primary risk factors for melanoma are sun exposure and number of melanocytic and dysplastic nevi.

INTRODUCTION

Carcinomas are malignancies that originate in epithelial tissues. Epithelial cells cover the external surface of the body, line the internal cavities, and form the lining of glandular tissues [1,2]. Cancers that originate from epithelial cells, including those of the breast, lung, prostate, and colon, are by far the most common types of cancer in adults. Among children, however, particularly before the adolescent years, carcinomas are very rare. Leukemias, central nervous system cancer, lymphomas, sarcomas, and the embryonal cancers such as neuroblastoma, retinoblastoma and Wilms' tumor, represent a far greater burden to young children than does any specific epithelial cancer. Nevertheless, a variety of carcinomas do occur in children, especially during late adolescence, and in this report we provide descriptive epidemiologic data to characterize their occurrence. In the US, approximately 1,050 children and adolescents younger than 20 years of age are diagnosed with carcinomas each year, of which approximately 350 are thyroid carcinomas and 300-350 are melanomas.

Classification system

Although other classification systems exist [2], the diverse types of epithelial malignancies that are called 'carcinomas and other malignant epithelial neoplasms' by the ICCC system are classified into six broad subgroups [3]:

a. adrenocortical carcinoma
b. thyroid carcinoma
c. nasopharyngeal carcinoma
d. malignant melanoma
e. skin carcinoma other than melanoma
f. other and unspecified carcinomas

All of the malignancies within the group 'other and unspecified carcinomas' are very rare in children. Neoplasms of the salivary gland, colon, appendix, lung and bronchus, uterine cervix, and urinary bladder account for most of this group. Likewise, the adrenocortical, nasopharyngeal, and skin carcinomas (other than melanoma) rarely occur in children. Because thyroid carcinomas and malignant melanoma (henceforth called melanoma) are the only epithelial malignancies that occur with any significant frequency in children, we will focus primarily on these two cancers in this report. It should be noted that the ICCC system includes germ cell carcinomas within 'germ cell, trophoblastic, and other gonadal neoplasms', rather than 'carcinomas and other malignant epithelial neoplasms'. The incidence rate of gonadal carcinomas for children younger than 20 years of age is only 1.0 per million, so this omission will not appreciably influence our results. Please note also that we have calculated frequencies and rates from SEER data for the years 1975 through 1995, and, unless otherwise specified, we report incidence rates as average annual rates per million children younger than 20 years of age, adjusted to the 1970 US standard population.

Thyroid carcinomas are endocrine tumors, although they do not necessarily exhibit hormonal activity. There are four types of thyroid carcinomas: papillary, follicular, medullary and anaplastic. In children, papillary tumors represent greater than 70% of thyroid carcinomas, and follicular tumors another 20%. Only a small proportion of thyroid carcinomas are medullary (5-10%), or anaplastic (extremely rare). The vast majority of childhood thyroid carcinomas are well differentiated tumors, and despite their malignant pathology, the clinical course of most thyroid carcinomas is relatively benign [4-6].

Malignant cutaneous melanomas arise from epidermal melanocytes and are often classified into one of three histopathological types according to the presence and pattern of intraepidermal growth: superficial spreading melanoma, nodular melanoma, and lentigo maligna melanoma. Melanomas occur most frequently on the trunk in white males, the lower limbs in white females, and the soles of the feet in blacks [7,8].

INCIDENCE

All of the carcinomas combined comprised 9.2% of cancer in children during the time period of this study. The majority of the 2,735 epithelial cancers were either thyroid carcinomas (35.5%) or melanomas (30.9%). Adrenocortical carcinomas (1.3%), nasopharyngeal carcinomas (4.5%), and other skin carcinomas (0.5%) combined for only a small proportion of the total, while other and unspecified carcinomas comprised 27.3%. Nearly 75% (2,047) of the childhood carcinomas occurred in adolescents 15-19 years of age, including 75% of the thyroid carcinomas, 80% of the melanomas, 63% of the nasopharyngeal carcinomas, and 74% of the other and unspecified carcinomas. Although there were only 36 adrenocortical carcinomas reported to

SEER areas, 18 of them occurred in children younger than 5 years of age.

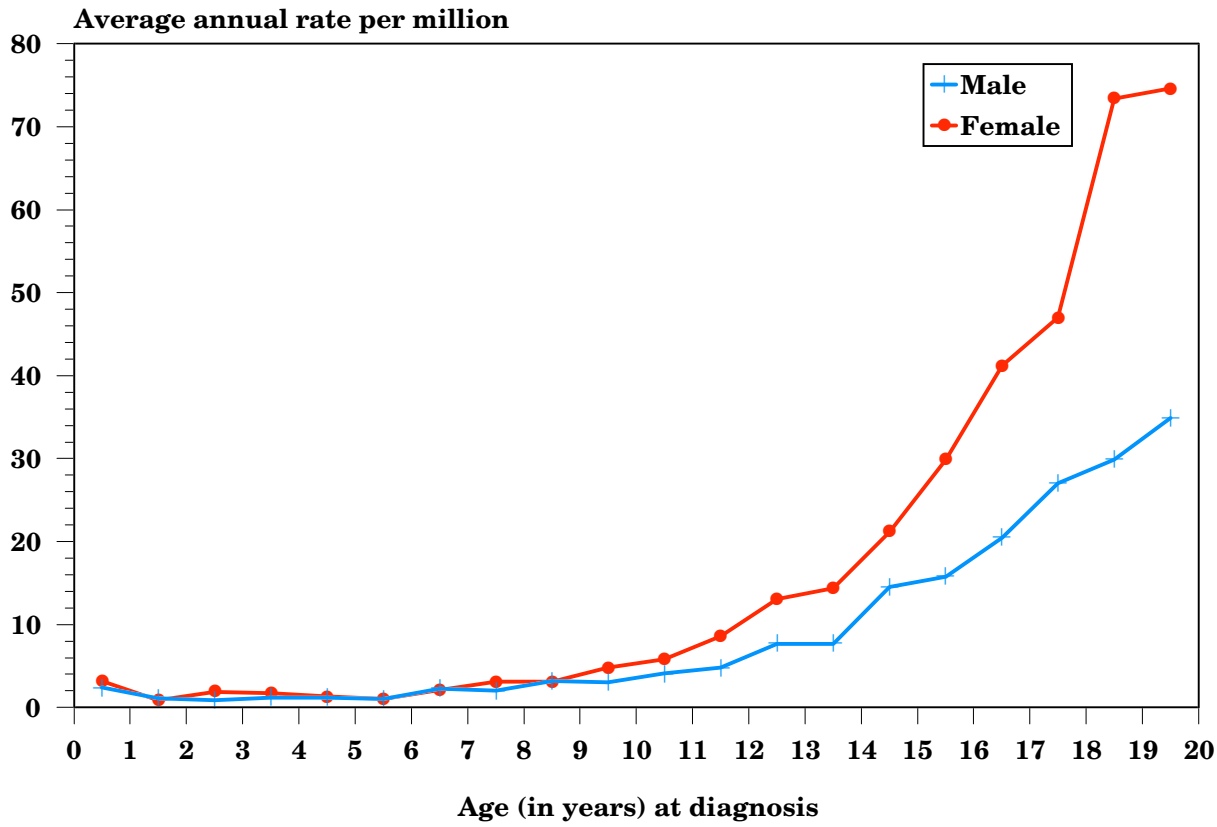
Age-specific incidence

The impressive age differences in incidence rates of carcinomas are shown in Table XI.1. Incidence rates of thyroid carcinoma and melanoma were practically negligible in very young children. Among 15-19 year olds, however, both melanoma and thyroid cancer substantially increased in occurrence over younger ages, particularly for females. The male-to-female ratios

Table XI.1: Average annual age-specific incidence rates per million by histology and sex, all races, SEER, 1975-95

Tumor type	Age	Total	Females	Males	F/M Ratio
All carcinomas	0-4	1.6	1.9	1.3	1.5
	5-9	2.7	3.1	2.3	1.3
	10-14	10.0	12.1	8.0	1.5
	15-19	40.3	55.5	25.9	2.1
Adrenocortical carcinoma	0-4	0.4	0.5	0.3	1.7
	5-9	0.1	0.1	0	
	10-14	0.1	0.1	0.1	1.0
	15-19	0.2	0.2	0.1	2.0
Thyroid carcinoma	0-4	0.1	0.2	0	
	5-9	1.0	1.3	0.8	1.6
	10-14	3.9	6.0	1.8	3.3
	15-19	14.4	24.4	4.7	5.2
Nasopharyngeal carcinoma	0-4	0.1	0	0.1	
	5-9	0.1	0	0.1	
	10-14	0.8	0.3	1.30	0.2
	15-19	1.5	1.2	1.8	0.7
Malignant melanoma	0-4	0.7	0.7	0.7	1.0
	5-9	0.7	0.8	0.7	1.1
	10-14	2.2	2.5	1.9	1.3
	15-19	13.2	16.5	10.0	1.7
Skin carcinoma other than melanoma	0-4	0	0	0	
	5-9	0	0	0	
	10-14	0.1	0.1	0.1	1.0
	15-19	0.2	0.2	0.1	2.0
Other and unspecified carcinomas	0-4	0.4	0.5	0.3	1.7
	5-9	0.8	0.9	0.6	1.5
	10-14	2.8	3.0	2.7	1.1
	15-19	11.0	12.8	9.2	1.4

Figure XI.1: Total carcinoma age-specific incidence rates by sex, all races, SEER, 1976-84 and 1986-94



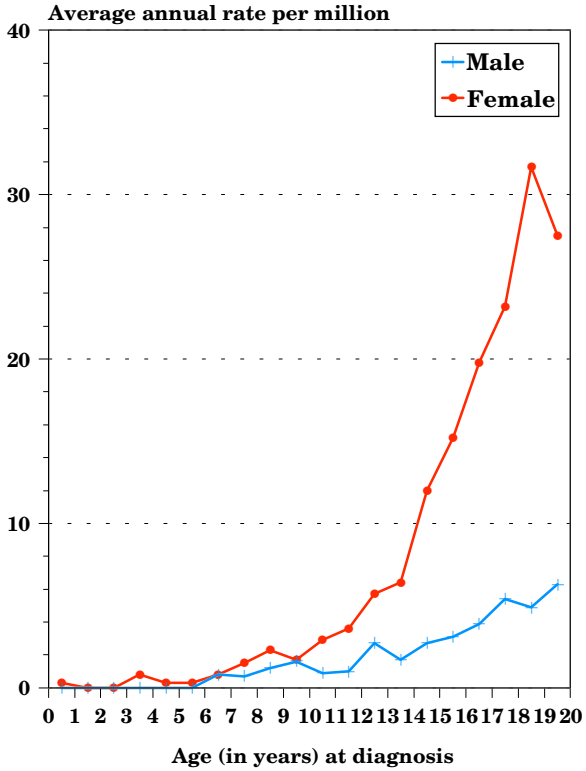
in rates were greatest among adolescents 15-19 years, and the sex difference was most pronounced for thyroid carcinoma. Figure XI.1 provides greater detail on the age-specific patterns of incidence for all carcinomas combined[1]. Carcinoma incidence was quite low through age 10 years, but the rates increased dramatically in older children. At age 19, incidence rates were 35 per million males and 75 per million females. For thyroid carcinoma (Figure XI.2), the age-specific incidence rates for males and females began to diverge at age 10 years. Beginning at age 13, the rates increased substantially for females, while the increase in male rates was more modest. Incidence rates of melanoma are shown in Figure XI.3. Rates differed minimally by sex until age 16, when the rates for females became greater than those for males.

Sex-specific and race-specific incidence

As shown in Table XI.2, the incidence rate of all childhood carcinomas combined was 13.8 per million. The ratio of white to black rates was 1.5 to 1. The magnitude of this racial difference is explained by the 2.5 to 1 ratio for thyroid cancer and the dra-

[1] Enumeration of the population at risk by single years of age was available only for the census years 1980 and 1990. The US Bureau of the Census provides intercensal population estimates by 5-year age groups, but not by single years of age. Therefore, the population estimates for 1980 were used in rate calculations for cases diagnosed from 1976-84 and the 1990 estimates were used for cases diagnosed from 1986-94.

Figure XI.2: Thyroid carcinoma age-specific incidence rates, by sex, all races SEER, 1976-84 and 1986-94



matic 16 to 1 ratio for melanoma. The variation in carcinoma rates between whites and blacks was greater among females than males.

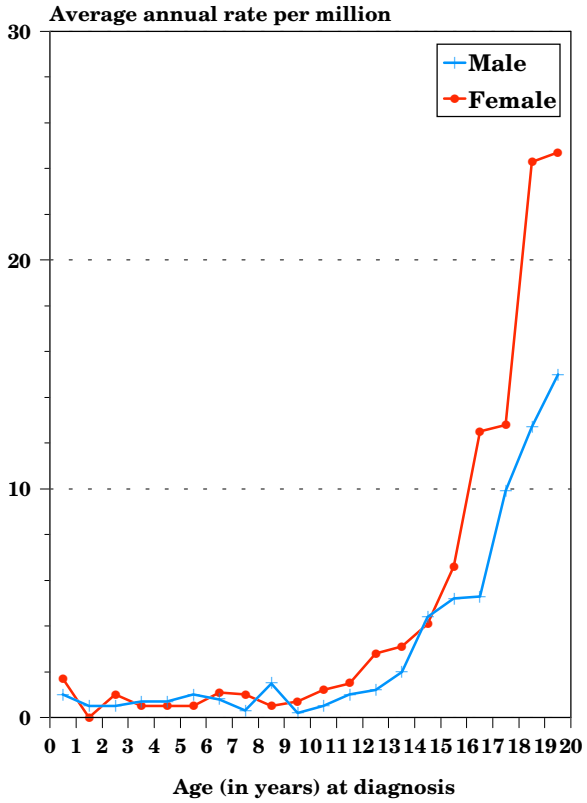
Table XI.2 further illustrates that incidence rates of thyroid carcinoma were over 4-fold higher in females than males for both white and black children. Among whites, melanoma was more common in females than males, but not nearly to the extent that was observed for thyroid cancer. In fact, among whites, male rates of melanoma were higher than male rates of thyroid cancer. As is well known, occurrence of melanoma in blacks is extremely unusual. Although not shown in the table, black children had a slightly higher rate of other and unspecified carcinomas than white children (4.7 versus 3.6 per million, respectively).

Table XI.2: Average annual age-adjusted* incidence rates per million by histology, race, and sex, age <20, SEER, 1975-95

Tumor type	Race	Total	Females	Males	F/M Ratio
All carcinomas	All races	13.8	18.2	9.5	1.9
	Whites	14.2	19.3	9.4	2.1
	Blacks	9.3	10.7	7.8	1.4
Thyroid carcinoma	All races	4.9	8.1	1.9	4.3
	Whites	5.2	8.6	2.0	4.3
	Blacks	2.1	3.4	0.7	4.9
Malignant melanoma	All races	4.2	5.1	3.3	1.5
	Whites	4.8	5.8	3.8	1.5
	Blacks	0.3	0.2	0.3	0.7

* Adjusted to the 1970 US standard population

Figure XI.3: Malignant melanoma age-specific incidence rates, by sex, all races SEER, 1976-84 and 1986-94



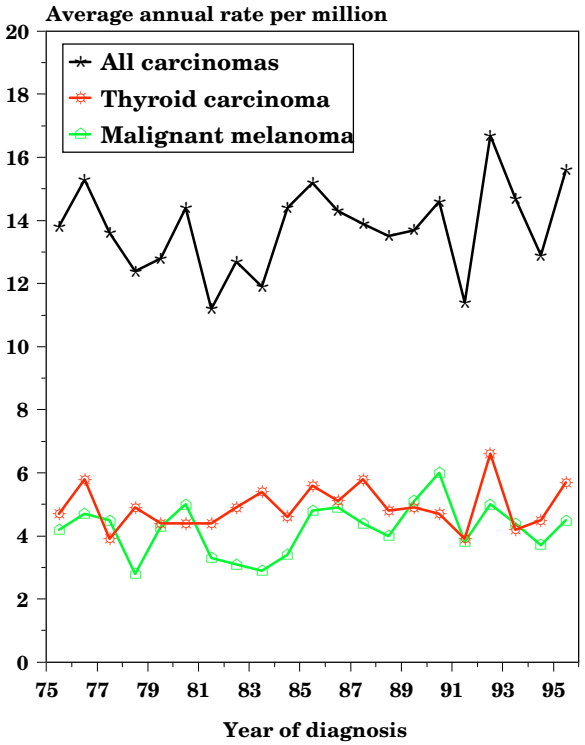
TRENDS

Figure XI.4 illustrates yearly rates of carcinomas from 1975-95. Age-adjusted incidence rates did not increase appreciably over this time frame for either melanoma or thyroid carcinoma. Incidence rates over time are further illustrated in Table XI.3, where rates by sex are shown within specific time periods.

SURVIVAL

Survival probability is excellent for children with either thyroid carcinoma or melanoma. Table XI.4 provides 5-year relative survival probabilities for both major types of childhood carcinoma, as well as for all carcinomas combined. Virtually no change in survival was observed for thyroid carcinoma over the time periods 1975-84 versus 1985-94 (Figure XI.5). Survival improved slightly for melanoma, from 85% for those diagnosed during 1975-84, to 91% during 1985-94 (Figure XI.6).

Figure XI.4: Trends in carcinoma age-adjusted* incidence rates, by histology, age <20 all races, both sexes, SEER 1975-95



*Adjusted to the 1970 US standard population

Table XI.3: Trends in average annual age-adjusted* incidence rates per million, by histology and sex, age <20, all races SEER, 1975-95

Tumor type	Year of diagnosis	Total	Females	Males
All carcinomas	1975-79	13.6	18.7	8.7
	1980-84	12.9	16.1	9.4
	1985-89	14.1	18.4	10.1
	1990-95	14.3	19.3	9.7
Thyroid carcinoma	1975-79	4.8	7.8	1.8
	1980-84	4.7	7.2	2.4
	1985-89	5.2	8.8	1.8
	1990-95	4.9	8.6	1.5
Malignant melanoma	1975-79	4.1	5.1	3.1
	1980-84	3.6	4.4	2.8
	1985-89	4.6	5.5	3.9
	1990-95	4.6	5.6	3.6

* Adjusted to the 1970 US standard population

For each type of carcinoma shown, females had slightly better survival probabilities than males. Black children appeared to fare worse than white children for all carcinomas combined, however there were only 29 black males and 34 black females during the time period, so the results should be viewed very cautiously. Similarly, there were too few black children with either thyroid carcinoma or melanoma on whom to base relative survival rates.

RISK FACTORS

Risk factors for thyroid carcinoma have been reviewed in several previous reports [9-15] and will only be briefly summarized here. The most well established risk factor for thyroid carcinoma is ionizing radiation exposure, from both environmental and therapeutic sources. Irradiation treatment for conditions such as tinea capitis, enlarged thymus, acne, and cancer have clearly been shown to increase risk for thyroid carcinoma development. Other than cancer treatment, however, these causes are primarily of historical concern. Environmental exposures to ionizing radiation from the atomic bombings in Japan and from the nuclear disaster at Chernobyl also have definitively been shown to cause substantial increases in thyroid carcinoma. The preponderance of thyroid cancer in females suggests that hormonal factors may mediate disease occurrence. Other potential etiologic factors include benign thyroid diseases and certain inherited cancer susceptibility syndromes, such as familial adenomatous polyposis, and multiple endocrine neoplasia (MEN) types I, IIA and IIB.

The primary risk factors for melanoma are sun exposure and number of melanocytic and dysplastic nevi. An extensive review of studies related to sun expo-

Table XI.4: Five-year relative survival rates by histology, race and sex age <20, SEER, 1985-94

Tumor type	Total	Females	Males
	Percent	Percent	Percent
All carcinomas			
All races	89	93	83
White	91	93	86
Black	77	85	65
Thyroid carcinoma			
All races	99	99	95
White	98	99	94
Black	*	*	*
Malignant melanoma			
All races	91	93	87
White	91	93	88
Black	*	*	*

*Less than 25 cases.

Figure XI.5: Thyroid carcinoma 5-year relative survival rates by sex, race, age and time period, SEER (9 areas), 1975-84 and 1985-94

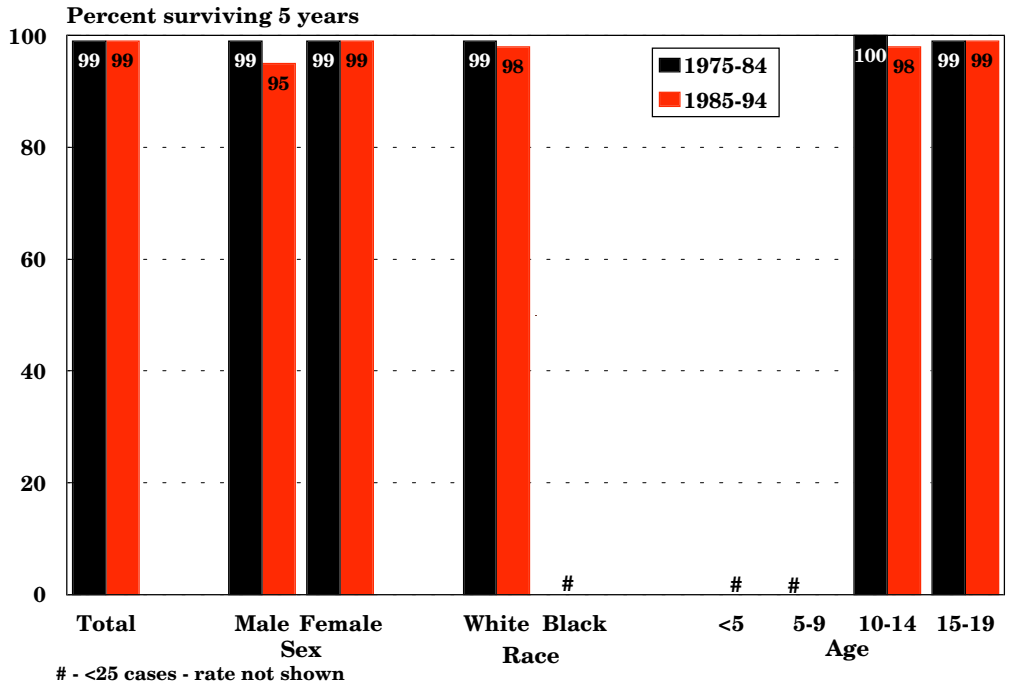
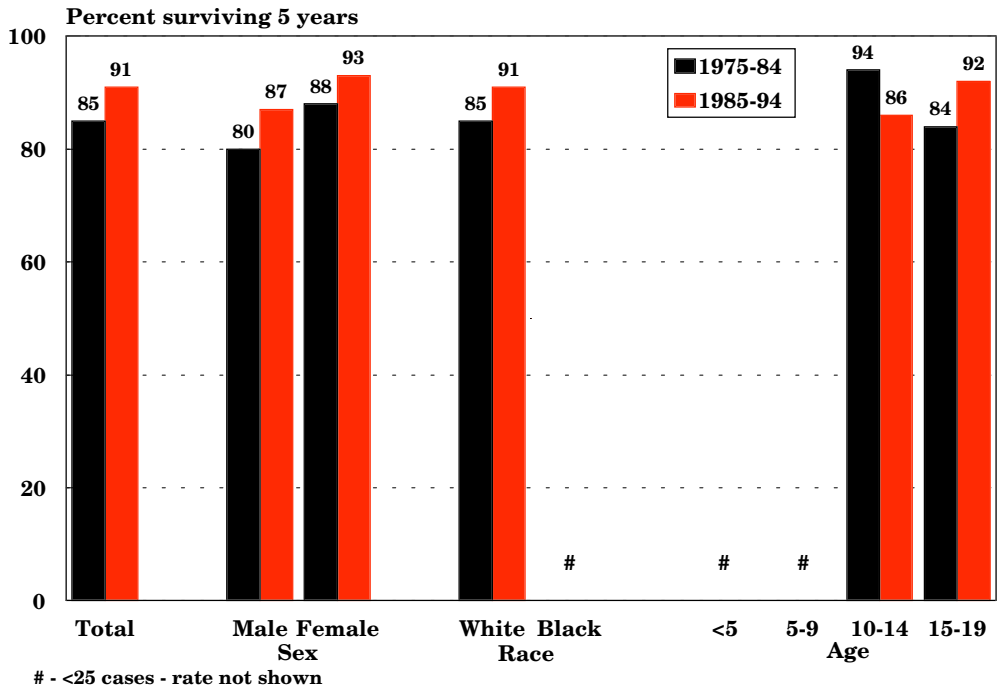


Figure XI.6: Malignant melanoma 5-year relative survival rates by sex, race, age and time period, SEER (9 areas), 1975-84 and 1985-94



sure, nevi, and other potential risk factors can be found in reference 6.

SUMMARY

In stark contrast to cancer incidence in adults, carcinomas were very rare in children, especially those younger than 15 years of age. Rates increased quite substantially with increasing age, however, particularly among females aged 10-19 years. The most common types of epithelial cancer in children were thyroid carcinomas (4.9 per million younger than 20 years of age) and melanomas (4.2 per million younger than 20 years of age). Females, however, had 4 times the thyroid cancer rate observed for males. Additionally, white children had 2.5 times the thyroid cancer rate and 16 times the melanoma rate observed for black children. From 1975-95 incidence rates of both thyroid cancer and melanoma remained fairly stable. The strongest known risk factor for thyroid carcinoma is ionizing radiation exposure. Sun exposure and number of nevi are the best described risk factors for melanoma occurrence. Fortunately, 5-year survival probability is excellent for both thyroid cancer (99%) and melanoma (91%).

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