Melanoma Incidence in Children and Adolescents: Decreasing Trends in the United States

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Objective To assess trends in the incidence of melanoma in children and adolescents in the US from 2000-2010.

Study design Using the Surveillance, Epidemiology, and End Results cancer registry data, we calculated age-adjusted incidence rates of melanoma in children and adolescents (age <20 years) from 2000-2010, as well as annual percent changes. We analyzed incidence trends using joinpoint regression models. We further stratified incidence rates and trends by age group, sex, race, and melanoma-specific characteristic (histology, anatomic site, Breslow depth, ulceration status, lymph node involvement, and presence of metastasis).

Results We included 1185 pediatric patients (age <20 years) diagnosed with melanoma from 2000-2010. In patients age <20 years overall, we found a significant decreasing incidence (11.58% per year) from 2004-2010. Overall, significant decreasing incidence trends were also noted in males, melanoma located on the trunk, melanoma located on the upper extremities, superficial spreading melanoma, and melanoma with good prognostic indicators. When further subdividing the pediatric population by age group, these significant decreasing incidence trends were most notable in adolescents (age 15-19 years), decreasing 11.08% per year from 2003-2010. Furthermore, in 15- to 19-year-olds, decreasing trends were found to be significant in melanoma located on the trunk, superficial spreading melanoma, and melanoma with good prognostic indicators.

Conclusions Decreasing trends in melanoma incidence in the pediatric population from 2000-2010 stand in contrast to previous reports of increasing long-term incidence trends. Possible contributors to these decreasing trends include effective public health initiatives, decreased time spent outdoors, and increased sunscreen use. *(J Pediatr 2015;166:1505-13)*.

Melanoma is an aggressive cancer that continues to threaten the US population. Over the past 40 years, melanoma incidence has increased in adults,[1-13] especially in females[5,7,10] and the geriatric population.[3,6,14]

Melanoma in the pediatric population (age <20 years) has not been studied as extensively as adult melanoma. The upper age cutoff for pediatric melanoma is controversial, but the majority of recent reports on pediatric melanoma, including those that use the Surveillance, Epidemiology, and End Results (SEER) database, as well as the National Cancer Institute, use <20 years as the cutoff.[15-19] Melanoma incidence is about 5-6 per million in children under age 20 years.[15-18] Although rare, pediatric melanoma remains a health concern because incidence rates (IRs) have been reported to be increasing.[15-18] Melanoma accounts for 7.1% of cancers in 15- to 19-year-olds.[5] Adolescents 15-19 years of age account for most cases of pediatric melanoma (73.2%), followed by 10- to 14-year-olds (17.3%), 5- to 9-year-olds (5.7%), and 1- to 4-year-olds (3.8%).[19] Pediatric melanoma does not behave uniformly. Incidence increases with age[15,18] and varies by sex,[17,18] anatomic location of the lesion,[17,18,20] and geographic residence[16-18] across multiple age groups. For example, in older children (age >10 years), incidence is greater in females than in males.[17,18]

Our current knowledge of incidence of pediatric melanoma trends is limited. Trends over the past decade have not been delineated; thus, we may be missing important short-term trends. Furthermore, there are insufficient reports of the incidence trends for age groups within the overall pediatric population and when analyzing patterns of melanoma-specific characteristics (histology, anatomic site, Breslow depth, ulceration status, lymph node involvement, presence of metastasis) by age. Our study sought to obtain an in-depth view of recent

APC	Annual percent change
ICD-O-3	*International Classification of Diseases for Oncology, Third Edition*
IR	Incidence rate
NOS	Not otherwise specified
SEER	Surveillance, Epidemiology, and End Results
UVR	Ultraviolet radiation

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melanoma IRs and trends in children and adolescents from 2000-2010, stratified by age, using SEER cancer registry data.

Methods

This study was exempt from institutional review board approval because it is based on publicly available SEER data. Publicly available cancer data from SEER-18 registries (representing about 28% of the US population) were used to identify cases of cutaneous melanoma in children and adolescents from 2000-2010. The SEER-18 registries encompass Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland standard metropolitan statistical area, Seattle-Puget Sound, Utah, Alaska Natives, greater California, greater Georgia, Kentucky, Los Angeles, Louisiana, New Jersey, rural Georgia, and San Jose-Monterey[21] (http://seer.cancer.gov/). Patients with a first cancer diagnosis of cutaneous melanoma between 2000 and 2010 were identified. Additional criteria included age at diagnosis 0-19 years, known race (white, black, American Indian/Alaska Native, Asian/Pacific Islander), microscopically confirmed cases, melanoma-specific histology classified by the *International Classification of Diseases for Oncology, Third Edition* (ICD-O-3) codes 8720-23, 8728, 8730, 8740-46, 8761, 8770-74, 8780,[22] and surgically treated cases. Exclusion criteria included diagnosis by autopsy or death certificate, melanoma in situ, coding errors, and unknown age, sex, or race.

SEER*Stat 8.1.2 was used to calculate descriptive statistics and melanoma IRs for these pediatric melanoma cases grouped by age, sex, race, primary tumor site, Breslow depth (melanoma thickness), ulceration status, lymph node status, and presence or absence of distant metastases[21] (http://seer.cancer.gov/). Age categorization (0-4, 5-9, 10-14, and 15-19 years) was based on standard age groups available in SEER. Race/ethnicity was designated as White (White Non-Hispanic and White Hispanic), Black, or other (American Indian/Alaska Native, Asian/Pacific Islander). Histology was classified using ICD-O-3 histologic codes as superficial spreading (8743), nodular (8721), malignant melanoma–not otherwise specified (NOS, 8720), and other (8722-23, 8728, 8730, 8740-42, 8744-46, 8761, 8770-74, 8780). The primary melanoma site was organized by location using ICD-O-3 primary site codes: head and neck (C44.0-C44.4), trunk (C44.5), upper limb and shoulder (C44.6), lower limb and hip (C44.7), and overlapping sites/NOS (C44.8-44.9). Breslow depth was categorized accordingly: 0.01-1.00 mm, 1.01-2.00 mm, 2.01-4.00 mm, greater than 4 mm, or unknown.

Ulceration status was defined as absent, present, or unknown. The level of lymph node involvement was defined as no node involvement, regional node involvement, distant node involvement, or NOS/unknown. Distant metastasis status was categorized as absent, present, or unknown. Coding discrepancies for the extent of disease variables were resolved to reflect SEER coding revisions made in 2004.[23] All IRs were age-adjusted and calculated per 1 000 000 person-years using the 2000 US standard population; a 95% CI was generated for each rate. Age-adjusted annual IRs over time (2000-2010) were plotted for the overall pediatric population (age <20 years), as well as for each subdivided age group (0-4, 5-9, 10-14, and 15-19 years) and sex. Trends in melanoma IRs from 2000-2010 were calculated for each age group, as well as by sex, race, and each melanoma-specific variable within each age group. Melanoma incidence trends were calculated for each year (1-year end points) using a weighted least squares method and the Tiwari et al 2006 modification for CIs, generating the annual percent change (APC) with 95% CIs from 2000-2010 for each interval group; significance $P < .05$. The APC signifies percent increase or decrease in incidence per year over the 2000-2010 time period. The APCs and 95% CIs were further evaluated using joinpoint regression models (Joinpoint Regression Program 4.0.4),[24] allowing for ≤1 inflection point. This method fits the simplest joinpoint model that the data will allow and is the standard method for assessing incidence trends in cancer registry data.

Results

From 2000-2010, there were 1185 cases of melanoma in children and adolescents (age <20 years) identified in SEER-18 registries (**Table I**). Melanoma cases increased with age. More patients were female except in 0- to 4- and 10- to 14-year-olds, in which proportions of male and female patients were fairly equal. Overall, patients were predominantly White (96.96%) with Non-Hispanic White patients comprising 90.13% of the pediatric melanoma cases. There were 81 Hispanic Whites. Superficial spreading melanoma was the most common specific histologic type overall (31.22%); however, superficial and nodular histology were in more equal proportions in the younger patients (0-9 years). Anatomic location varied across age groups.

Melanomas were located primarily on the trunk in 15- to 19-year-olds, trunk and head/neck in 10- to 14-year-olds, extremities in 5- to 9-year olds, and head/neck in 0- to 4-year-olds. Overall, most melanomas were thin (0.01-1.00 mm); however, there were more equal proportions of thin and thicker tumors in the younger patients (0-9 years). Thick tumors (>4.01 mm) were most common in 5- to 9-year-olds. Most melanoma cases lacked ulceration, lymph node involvement, or distant metastases; however, the greatest proportion of melanoma with ulceration, regional lymph node involvement, and distant metastases was found among younger patients (0-9 years).

Age-adjusted annual IRs of melanoma are illustrated as scatter plots in **Figure 1** both for the overall pediatric population and further subdivided by age group from 2000-2010 with superimposed line segments representing the APCs over time that were generated through joinpoint modeling. Melanoma IR and APCs are also depicted

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