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Behaviors Associated with Ultraviolet Radiation Exposure in a Cohort of Adult Survivors of Childhood and Adolescent Cancer. A Report from the Childhood Cancer Survivor Study¹

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Abstract

Background—Previous research from the Childhood Cancer Survivor Study (CCSS) has shown that risk of skin cancer is strongly associated with exposure to radiation therapy. The potential role of ultraviolet radiation exposure in survivors has not been described.

Participants Methods—The CCSS is a retrospective cohort study designed to investigate late effects among 5-year survivors of children and adolescents diagnosed with cancer between 1970–1986. Data regarding current sun protection behavior were collected on 9,298 survivors and 2,950 sibling controls. Median age at follow-up was 31 years (range: 17–54).

Results—In this cohort, childhood cancer survivors and siblings showed similar patterns of sunscreen use (67% vs. 66%). Survivors were significantly less likely to report having sunbathed in the previous year (none vs. any in previous year: RR=0.92, 95%CI=0.89–0.95) or use artificial tanning (none vs. any in previous year: RR=0.76, 95%CI=0.70–0.83). Compared to survivors without radiation therapy, survivors with radiation exposure showed increased use of sunscreen (RR=1.06, 95%CI=1.03–1.10), and less sunbathing (none vs. any in previous year; RR=0.89, 95%CI=0.86–0.92) or artificial tanning (none vs. any in previous year; RR=0.62, 95%CI=0.56–0.69). In adjusted multivariable analysis, statistically significant factors for regular sunscreen use in the past summer (vs. never/rarely) in the survivor population were being female, having lighter skin complexions, having previously been examined for skin cancer, and having skin that burned when in the sun unprotected.

Conclusions—Survivors of childhood cancer self-reported lower tanning practices than siblings. However, because of the potential increased risk of skin cancer from therapy-related exposures, future research should be directed at intervention studies to further reduce UV exposures.

Keywords

Skin cancer; sun protection behaviors; survivor; radiation; siblings

¹Other investigators and institutions participating in the Childhood Cancer Survivors Study are listed in Appendix

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Introduction

While skin cancer is the most preventable type of cancer, it is ironically the most common and rapidly increasing form of cancer diagnosed in the United States (US) today¹. Annually, there are over one million cases of non-melanoma skin cancer (basal cell cancers (BCC) and squamous cell cancers (SCC)) that occur in the US. If not detected early, non-melanoma skin cancer is capable of extensive tissue destruction, and is responsible for considerable morbidity and health care expenditures in the United States each year.

The Surveillance, Epidemiology, and End Results Program (SEER) does not collect incidence data on non-melanoma skin cancer (NMSC), limiting the ability to track overall rates and trends in the United States. In a population-based study in New Hampshire, Karagas et al., found that between 1979–1980 and 1993–1994, the incidence rates of BCC increased by 82% in both men and women, and incidence rates of SCC increased by 235% in men, and 350% in women². Incidence rates of newly diagnosed SCC and BCC over a one-year period in residences of New Hampshire, demonstrated that these rates increase with age. In 1993–1994, the incidence rates per 100,000 person years for BCC were 8.7, 113.4, and 283.8 in age groups of < 35 years, 35–44, and 45–54 respectively. These incidence rates continued to increase with age, with a rate of 1081.8 per 100,000 for individuals between the ages of 65–74.

In the general population, the likelihood of developing skin cancer is related to genetic predisposition and subsequent exposure to environmental risk factors. Skin color is the major constitutional risk factor for skin cancer of all types, with individuals who have less melanin in their skin at highest risk for skin cancer³. Dark-skinned populations show much lower incidence than white populations living in the same climates. In the white population, red hair and light skin color emerge strongly as independent risk factors.

Sun exposure, the main source of ultraviolet (UV) radiation, is the strongest environmental risk factors for skin cancer. Intermittent sun exposure has been shown to be associated with both melanoma and BCC whereas cumulative exposure is associated with SCC^{4–7}. Likewise, associations between developing melanoma and artificial tanning have been found in several studies^{8–9}. Specifically, the frequency and duration of artificial tanning and starting artificial tanning before age 30 have been shown to produce the highest risk.

While sun exposure and UVA exposure from tanning pose vital risks, the impact of exposure can be dramatically reduced by practicing sun protection behaviors. Common sun protection behaviors include wearing sunscreen and protective clothing, in addition to avoiding tanning and sunbathing¹⁰. While the general population spends time in direct contact with ultraviolet rays emitted from the sun on a daily basis, occasional use of sun protection behaviors are reported at best. Specifically, children reportedly only use sunscreen one-third to one-half of the time that they are being exposed to the sun, while only wearing protective clothing 8% of the time¹¹.

Skin cancer has also been associated with exposure to non-solar forms of ionizing radiation³. Researchers found an increased risk of BCC in atomic bomb survivors in Japan, with risk highest in individuals exposed at younger ages¹². In later studies of radiation therapy for treatment of tinea capitis, similar results were seen, with increased risk associated with younger age at exposure, and with fair skin¹³. Available evidence also suggests that the excess risk of skin cancer increases from time of exposure and continues for 45 years or more following radiation¹⁴. Some evidence exists for an interaction between radiation treatment and amount of subsequent ultraviolet radiation exposure from sunlight^{15–16}. Other studies have not confirmed these findings, possibly because these

studies involved ethnic groups less sensitive to UV radiation, or had insufficient power to detect a possible interaction between UV and ionizing radiation.

While skin cancer and its associated risk factors have been examined in the general population, less literature is available on incidence rates, risk factors and sun protection behaviors in survivors of childhood cancer. In a previous study, the Childhood Cancer Survivor Study (CCSS) reported that skin cancer is the most frequently occurring subsequent cancer in the CCSS cohort, with non-melanoma skin cancer accounting for 41% of all confirmed subsequent cancers, and melanoma for 3%. The incidence rate of BCC was 168.4, 1449.3, and 3785.9 per 100,000 person years for survivors who were <35 years, 35–44 years, and 45–54 years of age respectively¹⁷. Review of the radiation records found that 91% of the NMSC occurred within the previous radiation fields. These alarming rates indicate that childhood cancer survivors with a history of radiation treatment are especially susceptible to skin cancer and may subsequently increase their risk through sun exposure.

There is very limited information in the literature comparing sun protection behaviors of childhood cancer survivors to individuals without a history of cancer. It is also unclear if childhood cancer survivors with a history of radiation treatment utilize sun protection behaviors at equivalent or different rates than survivors without a radiation history. This manuscript examines data from the CCSS regarding sun sensitivity, past sun exposure, and present sun protection behavior. The primary objective of this analysis is to determine the current sun protection behaviors in a cohort of childhood cancer survivors, and to compare these behaviors to a sibling population. The secondary objective is to determine whether survivors who are at higher risk of skin cancer because of previous radiation therapy have improved sun protection behavior.

Methods

Participants

The Childhood Cancer Survivor Study (CCSS) is a retrospective, multi-center initiative tracking health outcomes in a cohort of 14,370 pediatric and adolescent cancer survivors. Eligibility criteria for entry into the CCSS cohort includes: a) diagnosis of cancer between January 1, 1970 and December 31, 1986, b) diagnosis of leukemia, CNS malignancies (all histologies), Hodgkin's disease, non-Hodgkin's lymphoma, malignant kidney tumor, neuroblastoma, soft tissue sarcoma, or malignant bone tumor, c) initial treatment at one of the 26 collaborating institutions; d) less than 21 years of age at the time of initial diagnosis, e) survived at least 5 years after the date of diagnosis.

The CCSS protocol and contact documents were approved by the Human Subjects Committee at each participating institution. Details of study design and cohort characteristics have been described elsewhere¹⁸. Briefly, baseline data were collected from participants (or parents of those under age 18) using 289 item self-administered questionnaires. This questionnaire assessed demographic information, physician-diagnosed medical conditions, psychosocial health-related behaviors, and information regarding recurrence of the primary cancer, a new diagnosis of cancer, and/or benign neoplasms.

Of the 20,698 patients determined to be eligible for the CCSS, 3,058 (14.8%) were lost to follow-up due to unsuccessful tracing efforts, 3,205 (15.5%) refused to participate in the study, and 65 (0.3 %) were unable to participate due to a language problem (and were subsequently considered ineligible). A total of 14,370 individuals participated in the initial baseline questionnaire administered by CCSS between 1994–1996. Comparison of participants, non-participants, and those who were lost to follow-up showed similar demographic, disease, and treatment characteristics¹⁹. A randomly selected subset of

survivors were asked to identify all living siblings, from which the nearest-age sibling was selected and asked to participate. Among the 4,790 siblings contacted to participate, 3901 (81.4%) completed the baseline questionnaire, 851 declined to participate and 38 could not be located.

Two subsequent follow-up questionnaires were administered in 2000 and 2002. From the time of entry into the cohort to administration of the 2002 survey, 1215 participants subsequently died, 1158 declined further participation in the cohort, and 416 were lost to follow-up. Of the remaining 11,581 eligible survivors, 9,308 subjects responded to the 2002 Follow-up survey, 1741 declined participation in this survey, 254 participants died, and 278 were lost to follow-up at the time of the survey. The data relevant to the current analysis was obtained from the 2002 Follow-up questionnaire to which 9,308 subjects responded. Among those, 9,298 survivors and 2,950 sibling controls answered at least one of the sun behavior related questions, and these participants are included in analyses presented here.

Instruments

The current analysis examined selected questions regarding genetic characteristics, sun sensitivity, sun exposure and sun protection behaviors that might predict higher risk for skin cancer (study questions from the LTFU Survey are available online at www.stjude.org/ccss). Specifically, skin color was assessed using one question based on a 4-point likert scale ranging from “pale or milky white” to “brown, dark brown or black.” Sun exposure of participants in the previous year was assessed using one question based on a 4-point likert scale ranging from “none” to “6+ times”. Sun protection behaviors practiced in the previous summer were assessed using five questions based on a 5-point likert scale.

Cancer treatment information

Characteristics of the original cancer diagnosis were obtained from the treating institution for all eligible cases. Cancer-related variables included cancer type, age at diagnosis, and interval from cancer diagnosis to follow-up survey. Details regarding cancer therapy were collected, including both initial treatment and treatment for relapse. Qualitative information was abstracted from the medical record for 42 specific chemotherapeutic agents. Data were also obtained on the field(s) of radiation therapy. Cancer treatment variables included in the analysis were: radiation therapy (yes/no), and chemotherapy (yes/no).

Data Analysis

This analysis of the CCSS data had two primary objectives: 1) to examine potential differences in utilization of sun protection behaviors between cancer survivors and their siblings; and 2) evaluate the impact of known risk factors for skin cancer on a cancer survivor's sun protection behaviors. Demographic and cancer related characteristics (for survivors) are summarized using standard measures. Each sun protection outcome variable was dichotomized: sunscreen use (Never/Rarely vs. Some/often/always), days sunbathed (None vs. ≥ 1 day) and days artificially tanned (None vs. ≥ 1 day). Given that these outcomes have high prevalence of occurring ($>10\%$), rather than using logistic regression to estimate odds ratios (which can only be interpreted as relative risks when the outcome is relatively rare), we fit Poisson regression models with robust variance estimates to directly evaluate relative risk (RR) estimates for the impact of risk factors on these outcomes²⁰. The generalized estimating equations approach to evaluating robust variance estimates appropriately accounts for intra-family correlation between survivors and siblings. Initial models were fit among both survivors and siblings to evaluate the impact of survivor vs. sibling in univariable and adjusted analyses. A second set of univariable and multivariable models was fit only among survivors to evaluate the impact of having received previous radiation treatment on sun behaviors. Potential confounding factors evaluated for inclusion

in all multivariable models included gender, age at questionnaire completion (0–34 vs. 35–44 vs. ≥ 45), years since diagnosis (15–19 vs. 20–24 vs. 25–29 vs. ≥ 30), skin color (pale or milky white vs. very light brown sometimes freckles vs. light tan, brown or olive vs. brown, dark brown or black), subject's evaluation of skin type (never tan, always burn vs. sometimes tan, usually burn vs. usually tan, sometimes burn vs. always tan, rarely burn) and whether the subject was ever examined for skin cancer (yes vs. no). Factors were included in final models if they were significant themselves or if their inclusion in the model impacted the relative risk for other factors markedly. RR, 95% confidence intervals (CI) and p-values are presented for each factor. All p-values were considered significant at the .05 level.

Results

Descriptive information on survivors and their siblings, as well as diagnosis and treatment related variables for survivors are listed in Table 1. Survivors ranged from 17 to 54 years of age (median age of 31 years) at the time of evaluation and were inclusive of both male (51%) and female (49%) respondents. Survivors were 85.9% Caucasian, 3.4% African American and 10.6% other race/ethnicity. Siblings were older in age at the 2002 Follow-up survey, and were more likely to be Caucasian, female, and have a higher household income than survivors. Siblings were less likely to have been examined for skin cancer, or to have been diagnosed with skin cancer than survivors.

Analyses were performed to compare UV protection behaviors (sunscreen use, avoidance of sunbathing and artificial tanning) among survivor versus sibling status (Table 2). Within the study population, 66% of siblings and 67% of cancer survivors practiced at least some sunscreen use in the past summer. Additionally, 33% of siblings and 39% of cancer survivors reported no sunbathing in the previous year; 80% of siblings and 85% of survivors reported no artificial tanning in the past year. When compared to siblings, childhood cancer survivors were less likely to have sunbathed in the past year (none vs. any: RR=0.92, 95%CI=0.89–0.95) or use artificial tanning methods in the past year (none vs. any: RR=0.76, 95%CI=0.70–0.83).

Analyses were again performed to examine sun protection behaviors for survivors with and without a history of radiation therapy (Table 3). Compared to survivors without RT, survivors with RT exposure showed slightly increased use of sunscreen in the past summer (RR=1.06, 95%CI=1.03–1.10), and slightly less sunbathing (none vs. any in previous year; RR=0.89, 95%CI=0.86–0.92) or artificial tanning (none vs. any in previous year; RR=0.62, 95%CI=0.56–0.69).

Multivariable analysis showed factors associated with survivor's sunscreen use (vs. rarely/never) in the previous year were exposure to therapeutic radiation, being female, having lighter skin complexions, having previously been examined for skin cancer, and higher predisposition to sunburn, (sometimes, usually or always burn) (Table 4). Variables associated with increased sunbathing in the previous year among survivors were: no previous radiation, gender (female), younger age (≤ 45 years), the number of years post diagnosis (≤ 30 years), darker skin color, and lower predisposition to sun burn (usually, sometimes, rarely burn). Among survivors, no history of radiation exposure, gender (female), younger age (≤ 35 years), darker skin color, and lower predisposition to sun burn (usually, sometimes, rarely burn) were all significantly associated with increased artificial tanning in the past year. Due to the correlations between having had a previous skin exam and prior skin cancer, we fit a separate set of multivariable models (adjusted for the same factors in Table 4, except "Examined for skin cancer") to examine the influence of a previous skin cancer on current sun behaviors and found that subjects with a prior skin

cancer were more likely to use sunscreen (RR 1.12; 95% CI 1.06, 1.18, $p<0.001$) and less likely to sunbathe (RR 0.87; 95% CI 0.79, 0.96; $p=0.006$).

Discussion

The CCSS is an invaluable resource for the examination of risk factors which may impact cancer survivors. It is unique in that the cohort under study has been extensively characterized according to previous cancer therapy, and cohort members have been followed into adulthood. This current study contributes to the literature by examining demographic and behavioral variables (age, gender, sun exposure history, and skin color) that can impact sun protection behaviors associated with preventing skin cancer.

The purpose of the present study was to examine sun sensitivity, past and current sun exposure, and current sun protection behavior, and how these variables might deviate based on survivor versus sibling status, or one's history of therapeutic radiation. It was hypothesized that survivors of childhood cancers would have similar sun protection behaviors as siblings. Study findings supported this hypothesis when comparing siblings and survivors on current sunscreen use, but did not support this assumption for sunbathing and artificial tanning behaviors in the previous year. Specifically, siblings were found to sunbathe and tan more than survivors. The prevalence of sunscreen use and tanning practices in the United States are varied and dependent on the age. In a recent US survey, the prevalence of skin cancer risk behaviors was assessed, and stratified by individuals 18–29, 30–39, and 40–49 years of age²¹. The prevalence of infrequent use of sunscreen was 57%, 50%, and 48% respective to age group; and artificial tanning use in the previous year was 20%, 17%, and 14% respectively. In an earlier US survey, the overall prevalence of sunburn in the previous year was 32%, with the highest rate among adults 18–29 years of age (58%) and white non-Hispanic males (44%)²². These prevalence rates suggest that CCSS cohort members report better sunscreen use than the general population, but similar sunbathing and artificial tanning practices.

Our secondary hypothesis proposed that survivors of childhood cancer who received radiation therapy would have similar sun protection behaviors as survivors who did not receive radiation therapy. Previous reported findings from CCSS demonstrated that individuals who received radiation were more likely to receive risk-based survivor focused care than those who did not receive radiation therapy (21% vs. 12% respectively)²³. Our findings show that survivors at highest risk (those who were previously exposed to radiation therapy) have somewhat better sun protection behavior, suggesting these survivors have been told of their risk and had complied with risk recommendations. This suggestion supports behavioral research theory which shows one's perceived risk to be a good motivator of one's actions or behavioral response²⁴. The magnitude of the difference between out two groups, however, was relatively small. This is consistent with previous sun protection intervention research which shows that one's cognitive perception of risk of skin cancer is not the best predictor of one's actual sun protection behaviors²⁵.

While survivors who had a history of radiation were found to use sun protection behaviors more than those without history of radiation, survivors as a whole are not using most sun protection behaviors at higher rates than in the general (non-illness) population¹¹. In the US, the use of sun protection behaviors in the general population are associated with lighter skin color, being female, history of sunburn, and older age¹¹. Likewise, these characteristics are also associated with increase use of sun protection behaviors among survivors, in addition to their previous history of radiation exposure, their age at diagnosis, and whether they have been examined for skin cancer.

The present study has several strengths and limitations. A strength of this study is its utilization of self-report measures to examine previous history of sun exposure, protection behaviors, and other health related information. Previous studies have shown that individuals can accurately report skin characteristics, lifetime sun exposure, and history of skin screening 26–28. In addition, we were able to use the sibling population in this cohort as a comparison group, thereby minimizing possible reporting bias. Siblings make an appropriate comparison group because results are likely less affected by possible confounding variables such as socio-economic status, ethnicity. On the flip side, however, familial influences during childhood specific to sun behavior may mean that a selected sibling of a survivor has sun protection behaviors that are more similar to his or her survivor sibling than a randomly selected subject from the general population would have. As such, the differences shown here between groups may be conservative estimates of differences in behavior. We note, however, that in this study all respondents are over the age of 18, so that direct day to day parental influence of sunscreen use is not likely to be a factor in the decision of these survivors and siblings to practice safe sun behaviors.

A shortcoming to this analysis is the limited information on a racial/ethnically diverse population, with 86% of survivors and 92% of siblings who responded to this survey reporting their race as White non-Hispanic. Findings from this cohort, therefore, are not representative of all cancer survivors in the United States 29. Additionally, information on the sun protection behaviors of study participants who did not respond to the 2002 Follow-up survey (i.e. subsequently died, withdrew from the study, or were lost to follow-up) is not known. However, our comparison of these non-participants to participants, showed no difference by cancer diagnosis, original cancer treatment, or age at diagnosis which are all factors that influenced behaviors in our analysis, thereby suggesting no bias due to drop outs in the cohort.

Sixty-one percent of CCSS survivors, and 60% of survivors with previous radiation therapy exposure, engaged in sunbathing at least once in the previous year, which increased their exposure to UV radiation. Hence, findings from the present study should be used to change ways in which health promotion campaigns and educational information dissemination are conducted with childhood cancer survivors. While limited interventions to promote sun protection behaviors are available to childhood cancer survivors, primary care providers are uniquely positioned to provide educational information and verbally promote increase utilization of protection behaviors. Communication regarding a survivor's increased risk due to previous radiation therapy, particularly those with a fair skin complexion that easily burns when in the sun, should be discussed with patients during routine appointments and through the dissemination of educational material to survivors.

The manner in which this information is discussed with patients has been found to be an important indicator of change in patient's sunscreen protection behavior. Specifically, the use of pictures paired with written educational information in sun protection information dissemination has been shown to increase judgment, cognitive processing, and persuasiveness, which can directly affect an individual's perception of the benefits to engaging in sun protection behaviors³⁰. An emerging body of literature examining ways of increasing sun protection behaviors in the general population has also shown that providing school-based sun protection interventions (e.g. teaching kits for teachers and students) can be effective at increasing awareness and utilization of better sun protection behaviors among children³¹. Future research should utilize the successful techniques identified through these interventions for targeting pediatric cancer survivors while at clinic visits.

While this study contributes to the understanding of skin cancer and sun protection behaviors, further research is needed to determine other factors, which might impact one's

decision to engage in sun protection behaviors. Specifically, psychosocial variables, such as one's perception of benefits and barriers to utilization have the potential to impact one's decision to engage in sun protection behaviors, but have not adequately been explored in survivorship populations. Examining how perceptions of skin complexion and general psychopathology related to skin cancer and previous medical illness may impact sun protection behaviors, is imperative and will assist future interventions in this area.

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Table 1

Demographic, Diagnosis, Treatment and Sun Sensitivity of Siblings and Survivors.

	Sibling		Survivor		p-value
	N	%	N	%	
Age at 2002 Survey					<0.001
0–34	1682	57.0%	6192	66.6%	
35–44	961	32.6%	2643	28.4%	
≥45	307	10.4%	463	5.0%	
Race					<0.001
White	2549	91.9%	7957	85.9%	
Black	63	2.3%	319	3.4%	
Other	163	5.9%	986	10.6%	
Sex of patient					<0.001
Male	1367	46.3%	4716	50.7%	
Female	1583	53.7%	4582	49.3%	
Total household income (US\$)					<0.001
less than 20,000	195	6.8%	1054	11.7%	
20,000–39,999	467	16.2%	1875	20.8%	
40,000–59,999	516	17.9%	1631	18.1%	
60,000–79,999	479	16.6%	1301	14.4%	
80,000–99,999	398	13.8%	832	9.2%	
over 100,000	588	20.4%	1260	13.9%	
don't know	239	8.3%	1082	12.0%	
Natural skin color(unexposed)					0.003
Pale or milky white	1343	45.8%	4391	47.6%	
Very light brown sometimes freckles	811	27.6%	2528	27.4%	
Light tan, brown, or olive	721	24.6%	2045	22.2%	
Brown, dark brown, or black	59	2.0%	263	2.9%	
Out in the sun without protection					0.39
never tan, always burn	548	18.8%	1785	19.5%	
sometimes tan, usually burn	908	31.1%	2789	30.4%	

	Sibling		Survivor		p-value
	N	%	N	%	
usually tan, sometimes burn always tan, rarely burn	1020	35.0%	3119	34.0%	<0.001
	440	15.1%	1474	16.1%	
Examined for skin cancer					
Yes	720	24.5%	2707	29.3%	<0.001
No	2092	71.2%	5861	63.4%	
Not sure	126	4.3%	682	7.4%	<0.001
Total	2938	100.0%	9250	100.0%	
Prior Skin Cancer					
No	2923	99.1%	8860	95.3%	<0.001
Yes	27	0.9%	438	4.7%	
Total	2950	100.0%	9298	100.0%	
Age at Diagnosis					
0–4	NA	NA	3784	40.7%	<0.001
5–9	NA	NA	2073	22.3%	
10–14	NA	NA	1866	20.1%	<0.001
15–21	NA	NA	1575	16.9%	
Diagnosis					
Leukemia	NA	NA	3161	34.0%	<0.001
CNS	NA	NA	1174	12.6%	
HD	NA	NA	1185	12.7%	<0.001
NHL	NA	NA	701	7.5%	
Kidney (Wilms)	NA	NA	869	9.3%	<0.001
Neuroblastoma	NA	NA	629	6.8%	
Soft tissue sarcoma	NA	NA	818	8.8%	<0.001
Bone cancer	NA	NA	761	8.2%	
Radiation					
No	NA	NA	2871	33.8%	<0.001
Yes	NA	NA	5626	66.2%	
Chemotherapy					
No	NA	NA	1754	20.6%	<0.001

Sibling		Survivor		p-value
N	%	N	%	
NA	NA	6753	79.4%	Yes

Table 2

Univariable Relative Risk estimates (95% CI) for survivor vs. sibling comparisons for previous UV exposure behaviors

	Sibling N	Sibling %	Survivor N	Survivor %	Relative Risk*	95% CI
Ever Sunbathed by the Water						
No	340	11.6%	1613	17.5%		
Yes	2590	88.4%	7600	82.5%	0.93	(0.92, 0.95)
Days Sunbathed in Previous Year						
None	971	33.3%	3560	38.7%		
>= 1 day	1949	66.7%	5629	61.3%	0.92	(0.89, 0.95)
Ever Use Artificial Tanning						
No	1621	55.5%	6145	66.7%		
Yes	1301	44.5%	3063	33.3%	0.75	(0.71, 0.78)
Days Artificial Tanning in Previous Year						
None	2353	80.3%	7845	85.0%		
>= 1 day	578	19.7%	1387	15.0%	0.76	(0.70, 0.83)
Sunscreen Use in Previous Summer						
Never/Rarely	991	33.8%	3036	33.1%		
Some/often/always	1938	66.2%	6139	66.9%	1.01	(0.98, 1.04)
Wearing Protective Clothing in Previous Summer						
Never/Rarely	1872	64.2%	5388	59.0%		
Some/often/always	1045	35.8%	3743	41.0%	1.14	(1.09, 1.21)
Wearing a Hat in Previous Summer						
Never/Rarely	1240	42.7%	3686	40.5%		
Some/often/always	1667	57.3%	5418	59.5%	1.04	(1.00, 10.8)

RR = Relative risk; CI= confidence interval

* RR for risk of behavior outcome in row for survivors vs. siblings; RRs and CIs obtained from separate univariable Poisson regression models with robust variance estimates.

Table 3

Univariable Relative Risk estimates (95% CI) for radiation yes vs. no comparisons among survivors for previous UV exposure behaviors

	Radiation				Relative Risk	95%CI
	No	Yes	N	%		
Ever Sunbathed by the Water						
No	410	14.4%	1000	17.9%		
Yes	2439	85.6%	4572	82.1%	0.96	(0.94, 0.98)
Days Sunbathed in Previous Year						
None	931	32.8%	2238	40.3%		
>= 1 day	1910	67.2%	3320	59.7%	0.89	(0.86, 0.92)
Ever Use Artificial Tanning						
No	1730	60.9%	3872	69.5%		
Yes	1113	39.1%	1703	30.5%	0.78	(0.73, 0.83)
Days Artificial Tanning in Previous Year						
None	2279	79.9%	4890	87.5%		
>= 1 day	574	20.1%	696	12.5%	0.62	(0.56, 0.69)
Sunscreen Use in Previous Summer						
Never/Rarely	991	35.0%	1714	30.9%		
Some/often/always	1843	65.0%	3841	69.1%	1.06	(1.03, 1.10)
Wearing Protective Clothing in Previous Summer						
Never/Rarely	1834	64.9%	3088	56.0%		
Some/often/always	991	35.1%	2431	44.0%	1.26	(1.19, 1.33)
Wearing a Hat in Previous Summer						
Never/Rarely	1299	46.2%	2049	37.2%		
Some/often/always	1512	53.8%	3458	62.8%	1.17	(1.12, 1.22)

RR = Relative risk; CI= confidence interval

* RR for risk of behavior outcome in row for radiation therapy yes vs. no; RRs and CIs obtained from separate univariable Poisson regression models with robust variance estimates.

Table 4

Multivariable model of predictors of behaviors for UV exposure in previous year for survivors

Covariate	Sunscreen use		Sunbathed		Artificial tanning	
	RR	95% CI	RR	95% CI	RR	95% CI
Radiation						
No	1		1		1	
Yes	1.04	(1.01, 1.08)*	0.90	(0.87, 0.93)*	0.67	(0.61, 0.74)*
Sex						
Male	1		1		1	
Female	1.18	(1.15, 1.22)*	1.15	(1.11, 1.19)*	2.82	(2.51, 3.17)*
Age at 2002 survey						
0–34	--		1		1	
35–44			0.99	(0.95, 1.03)	0.67	(0.60, 0.76)*
≥ 45			0.82	(0.74, 0.90)*	0.41	(0.29, 0.58)*
Years since Diagnosis						
15 – 19	--		1		--	
20 – 24			1.00	(0.97, 1.05)		
25 – 29			0.957	(0.91, 1.01)		
≥ 30			0.925	(0.86, 0.99)*		
Natural skin color						
Pale or milky white	1		1		1	
Very light brown, freckles	1.03	(0.99, 1.06)	1.14	(1.10, 1.19)*	1.37	(1.22, 1.55)*
Light tan, brown, or olive	0.99	(0.94, 1.04)	1.17	(1.12, 1.23)*	1.39	(1.214, 1.59)*
Brown, dark brown, black	0.67	(0.54, 0.83)*	0.71	(0.58, 0.86)*	0.30	(0.13, 0.66)*
Examined for skin cancer						
Yes	1		--		1	
No	0.85	(0.82, 0.87)*			0.98	(0.87, 1.09)
Not sure	0.88	(0.83, 0.94)*			0.73	(0.57, 0.92)*
In sun without protection						
never tan, always burn	1		1		1	

Covariate	Sunscreen use		Sunbathed		Artificial tanning	
	RR	95% CI	RR	95% CI	RR	95% CI
sometimes tan, usually burn	0.94	(0.91, 0.97)*	1.24	(1.18, 1.32)*	1.61	(1.35, 1.92)*
usually tan, sometimes burn	0.83	(0.80, 0.86)*	1.28	(1.21, 1.35)*	2.02	(1.70, 2.42)*
always tan, rarely burn	0.58	(0.54, 0.63)*	1.12	(1.04, 1.20)*	1.60	(1.29, 1.99)*

RR = Relative risk; CI= confidence interval

* p-value < 0.01

-- Variable not included in final multivariable model

Appendix

The **Childhood Cancer Survivor Study (CCSS)** is a collaborative, multi-institutional project, funded as a resource by the National Cancer Institute, of individuals who survived five or more years after diagnosis of childhood cancer. **CCSS** is a retrospectively ascertained cohort of 20,346 childhood cancer survivors diagnosed before age 21 between 1970 and 1986 and approximately 4,000 siblings of survivors, who serve as a control group. The cohort was assembled through the efforts of 26 participating clinical research centers in the United States and Canada. The study is currently funded by a U24 resource grant (NCI grant # U24 CA55727) awarded to St. Jude Children's Research Hospital. Currently, we are in the process of expanding the cohort to include an additional 14,000 childhood cancer survivors diagnosed before age 21 between 1987 and 1999. For information on how to access and utilize the CCSS resource, visit www.stjude.org/ccss

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