

# Prospective Study of Sunburn and Sun Behavior Patterns During Adolescence

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## KEY WORDS

sunburn, suntan, adolescent, melanoma

## ABBREVIATIONS

CI—confidence interval

OR—odds ratio

UVR—UV light radiation

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**WHAT'S KNOWN ON THIS SUBJECT:** Childhood UV light exposures, specifically sunburns, have been shown to be associated with melanoma development later in life.



**WHAT THIS STUDY ADDS:** To date, most studies in this age group have been cross sectional in nature. This is the first prospective study of sunburn and sun behaviors in this age group.

## abstract



**OBJECTIVES:** Early childhood UV light radiation (UVR) exposures have been shown to be associated with melanoma development later in life. The objective of this study was to assess sunburn and changes in sunburn and sun behaviors during periadolescence.

**METHODS:** A prospective, population-based study was conducted in fifth-grade children (~10 years of age) from Framingham, Massachusetts. Surveys were administered at baseline (September–October 2004) and again 3 years later (September–October 2007). Surveys were analyzed to assess prevalence of reported sunburn and sun behaviors and to examine changes in response over the follow-up period.

**RESULTS:** Data were analyzed from 360 participants who had complete information regarding sunburn at both time points. In 2004, ~53% of the students reported having at least 1 sunburn during the previous summer, and this proportion did not significantly change by 2007 (55%,  $P = .79$ ), whereas liking a tan and spending time outside to get a tan significantly increased ( $P < .001$ ). In 2004, 50% of students reported “often or always” use of sunscreen when outside for at least 6 hours in the summer; this proportion dropped to 25% at the follow-up evaluation ( $P < .001$ ).

**CONCLUSIONS:** With at least 50% of children experiencing sunburns before age 11 and again 3 years later, targeting children in pediatric offices and community settings regarding unprotected UV exposure may be a practical approach. Because periadolescence is a time of volatility with regard to sun behaviors, learning more about children who receive sunburns versus those who avoid them is a critical research task. *Pediatrics* 2012;129:309–317

Melanoma is a significant and growing public health concern with an estimated 70 230 incident cases and 8790 associated deaths in the United States in 2011.<sup>1</sup> Between 2004 and 2008 in the United States, the age-adjusted incidence rate was 20.8 per 100 000 men and women per year based on Surveillance Epidemiology and End Results (SEER) estimates.<sup>2,3</sup> UV light radiation (UVR) exposure is the most important modifiable melanoma risk factor. Studies have shown that intense, intermittent exposures to UVR, as measured by sunburn frequency, have a higher melanoma-attributable risk than chronic UVR exposure.

UVR exposures at an early age are particularly important for the development of cutaneous melanoma in adulthood.<sup>4,5</sup> A recent meta-analysis of 51 studies found that ever reporting a sunburn during childhood almost doubled the risk for the development of cutaneous melanoma in adulthood.<sup>6</sup> During the past decade, there have been numerous public health efforts to increase the use of sun protection at a multitude of sites, including beaches,<sup>7</sup> schools,<sup>8</sup> pediatrician offices,<sup>9</sup> pools,<sup>7</sup> and ski slopes,<sup>10</sup> to name a few.<sup>11–14</sup> Despite these efforts, reported prevalence of recent sunburn in children and adolescents remains high.<sup>15</sup> Studies in this age group have shown that skin cancer knowledge increases with age; however, practices often trail behind.<sup>16</sup> Because of the imperative for protecting youth during these years, understanding more about their sun exposure and protection habits is critical to effective delivery of this important public health message.

Many of the studies evaluating sunburning rates in adolescents have been cross-sectional designs, and are subject to limitations. Understanding patterns of UVR exposure during adolescence can inform primary prevention strategies. The Study of Nevi in Children is a prospective population-based study

exploring the natural history of nevi in periadolescence. Before receiving photographs and dermoscopic examination of the skin, questionnaires regarding sun exposure and sun behaviors were administered to the study cohort at baseline (fifth grade); photographs and dermoscopic examination of the skin occurred again 3 years later (eighth grade), along with repeat questionnaires. We report the results of these questionnaires and explore changes in reported sun exposure, sun behaviors, and attitudes related to sun exposure during this important time of development.

## METHODS

The Study of Nevi in Children (SONIC) is a population-based longitudinal study exploring the natural history of nevi during adolescence. Detailed descriptions of the recruitment procedures are described elsewhere.<sup>17,18</sup> In brief, all fifth-grade students ( $n = 691$ ) and their parents residing in Framingham, Massachusetts, in 2004 were approached for participation in the study. Institutional review board approval was provided at Boston University, Harvard School of Public Health, and the Memorial Sloan-Kettering Cancer Center.

Data on student demographics, including race/ethnicity, were provided by the school district. Seventy percent of the fifth graders were white, 20.5% were nonwhite Hispanic, 4.3% were black/African American, and 5.2% were Asian American and other. The 2000 US census estimates for children ages 10 to 14 are as follows: white, 63%; nonwhite Hispanic, 17%; black/African American, 16%; and Asian American and other, 4%.<sup>19</sup> A total of 443 parents provided consent for their children and 443 students (64%) provided assent to enroll in the study. First, a study nurse broadly classified each student for phenotypic characteristics, such as skin color (7-point scale, ranging from

very fair to very dark/black) and hair color (7-point scale, ranging from blonde to black) and recorded these observations on a study data entry form. Students were asked to complete a self-administered survey regarding sun exposure and sun-protection practices. Survey questions were selected from numerous prior studies exploring sun exposure and sun behaviors in children.<sup>7,11,12,20</sup>

Surveys were distributed to the participants during the early autumn semester in 2004, <1 month after the end of the summer. The surveys included questions regarding sunburning episodes, outdoor exposure, sun behaviors, and attitudes about tanning during the previous summer. In the autumn semester of 2007, the same instrument was distributed to the cohort (now in eighth grade) for completion. A total of 366 students from the original cohort completed the survey. In both 2004 and 2007, all consented students underwent high-resolution imaging of the back after completion of the survey.

For this study, data obtained from the surveys and the nurse assessments were used. To quantify sunburning, the students were asked, "How many times in the past summer did your skin stay pink or red after going out in the sun?" Responses were recorded on a 5-point scale, ranging from "none" to "5 or more." Based on the distribution of survey responses, sunburning was grouped into 3 levels: "none," "1," and "2 or more." General outdoor exposure was assessed with the question, "On a typical day during the week in the past summer, how many hours did you spend outside?" The same question was asked regarding weekend exposures. Because weekday and weekend exposures were correlated (Spearman  $\rho = +0.61$ ), a composite variable to quantify total outdoor exposure for a typical week was created by combining weekday and weekend responses for

each student by their relative contributions. This composite variable was further categorized into low, medium, and high levels of exposure by creating cut points at tertiles of the distribution. Sunscreen use when outside for at least 6 hours in the summer was assessed on a 5-point Likert scale, ranging from “never” to “always.” Responses were further categorized to 2 categories, combining never, rarely, and sometimes, versus often and always. Students were also asked if they got a tan, spent time in the sun to get a tan in the previous summer, and whether they liked a tan. The potential responses to these questions were yes and no.

Descriptive statistics were used to characterize the study population and survey responses. Pearson  $\chi^2$  tests were used to evaluate differences in participant characteristics for those who were retained between baseline (2004) and follow-up (2007) and those who were lost to follow-up. To assess change in reported sunburn, sun behaviors, and tanning attitudes between baseline and follow-up, univariate analyses of the paired responses were completed using the McNemar test or the Stuart-Maxwell statistic for variables coded on 3 or more levels. In addition, a dichotomous variable was created and coded as 0 for participants who did not report an increase in sunburn between baseline and follow-up evaluations and 1 for those who did. Logistic regression models were used to assess the association between increased sunburn and participant characteristics, behaviors, and attitudes. To assess the change in sunburning and sun behaviors in this cohort, random-effect logistic regression models were used. Assessment time point was used at the outcome variable, where baseline (2004) was coded as 0 and follow-up (2007) was coded as 1. In these models, factors such as skin color, race, and gender do not vary between time points,

and hence are not included as potential covariates. To assess potential effect modification, interaction terms were created and models stratified by student gender and skin color were explored. In these analyses, the student identification variable was included in the model as a random effect. All statistical analyses were performed in Stata v.10.1 (Stata Corp, College Station, TX).

## RESULTS

A total of 366 students were evaluated both at baseline, September to October 2004, and follow-up assessments, September to October 2007. Of these, 360 had complete information regarding sun protection, sun exposure, and sunburn at both time points. The final analysis is based on the 360 paired observations. Table 1 presents the demographic characteristics of the study population. Most of these students were male (62%), white (74%), and had “very fair” to “fair” skin color (68%). A total of 83 students completed the 2004 assessment but were lost to follow-up because of relocation from

the Framingham area. At baseline, the students who were lost to follow-up in 2007 were more likely to report being “nonwhite” as reported by the school district, and accordingly had a darker phenotype. Retention rates were similar for male and female study participants. The average age of the cohort at baseline was 10 years 8 months (SD = 4 months) and 13 years 8 months (SD = 4 months) at the follow-up assessment.

### Sunburn, Sun Behaviors, and Sun Attitudes at Baseline and Follow-up

In 2004, ~53% of the students reported having at least 1 sunburn during the summer, and there was little change at follow-up evaluation (Table 2). Many other sun-related behaviors and attitudes changed substantially. For example, 53% of students reported “liking a tan” at baseline; this proportion increased to 66% 3 years later ( $P < .001$ ). Similarly, a higher proportion of students reported spending time in the sun to get a tan at the follow-up evaluation compared with baseline (39.8% vs 21.8%,  $P < .001$ ). Although participants

**TABLE 1** Characteristics of Participants Who Completed Both the Baseline and Follow-up Assessments, and Those Lost to Follow-up Since Baseline Evaluation

Characteristic	Completed Both Assessments (n = 360)		Students Lost to Follow-up (n = 83)		P <sup>a</sup>
	n	%	n	%	
Gender					
Male	224	62.2	48	57.8	.46
Female	136	37.8	35	42.2	
Race/Ethnicity					
Native American	1	0.2	0	0.0	<.001
Asian	17	4.7	5	6.0	
Black/African American	14	1.1	5	6.0	
White	267	74.1	42	50.6	
Hispanic	61	16.9	31	37.3	
Hair color					
Blonde/Light brown/Red	155	43.1	12	14.4	<.001
Medium brown	101	28.0	28	33.7	
Dark brown/Black	104	28.9	43	51.8	
Skin color					
Very fair/Fair	244	67.8	33	39.8	<.001
Light olive/Light brown	81	22.5	36	43.4	
Medium brown/Black	35	9.7	14	16.9	

<sup>a</sup> Based on  $\chi^2$ .

**TABLE 2** Reported Sunburn and Sun Behaviors at Baseline (2004) and Follow-up (2007) Assessments

Question	Baseline 2004, n (%)	Follow-up 2007, n (%)	P <sup>a</sup>
How many times in the past summer, did your skin stay pink or red after going out in the sun?			.79
None	170 (47.5)	161 (45.0)	
1	79 (22.1)	92 (25.7)	
2+	109 (30.4)	105 (29.3)	
Do you like to get a suntan?			<.001
No	159 (46.5)	120 (33.5)	
Yes	183 (53.5)	238 (66.5)	
During the past summer, did you spend time in the sun to get a tan?			<.001
No	272 (78.2)	216 (60.2)	
Yes	76 (21.8)	143 (39.8)	
Did you get a tan on any part of your skin this past summer?			.39
No	48 (13.5)	57 (15.9)	
Yes	307 (86.5)	302 (84.1)	
Outdoor exposure during past summer.			.55
Low	111 (30.9)	125 (34.7)	
Medium	131 (36.5)	115 (31.9)	
High	117 (32.6)	120 (33.3)	
During the past summer, when you were outside for at least 6 h, how often did you have sunscreen on?			<.001
Never	55 (15.5)	81 (22.6)	
Rarely	47 (13.2)	89 (24.9)	
Sometimes	76 (21.4)	103 (28.8)	
Often	108 (30.3)	54 (15.1)	
Always	70 (19.7)	31 (8.7)	

<sup>a</sup> P value based on the paired comparison from baseline to follow-up evaluation. For dichotomous variables, the McNemar's test was used. For variables with 3 or more categories, the Stuart-Maxwell statistic was calculated.

reported increases in liking a tan and spending time in the sun to get a tan, no overall differences were observed for getting a tan or for the amount of total outdoor exposure between baseline and follow-up. Student responses indicate a sharp decrease in the use of sunscreen between baseline and follow-up. At baseline, 50% of students reported “often or always” use of sunscreen when outside for at least 6 hours in the summer; this proportion dropped to 25% at the follow-up evaluation 3 years later ( $P < .001$ ).

### Sunburns Stratified by Student Characteristics, Behaviors, and Attitudes

Table 3 presents self-reported sunburn stratified by student characteristics, sun behaviors, and attitudes. Overall, during this period, 28% of children increased their number of sunburns, 25% experienced a decrease, and 47%

had no change. Subgroups at highest risk of skin cancer experienced the sharpest increase in sunburns. For example, 34% of respondents with “very fair to fair” skin reported increased sunburning by follow-up; in contrast, only 15% of respondents with “light brown to light olive” skin reported more sunburns ( $P < .001$ ). A similar trend was observed for race/ethnicity, where “white” participants were more likely to report an increase in sunburning by the follow-up evaluation, whereas “Hispanics” reported a significant decrease in sunburn ( $P < .001$ ). Similarly, children who got a tan versus those who did not were more likely to increase their number of sunburns ( $P = .02$ ).

### Sunburn, Sun Behaviors, and Sun Attitudes Stratified by Student Gender and Skin Color

Homogeneity of effect for sunburns, sun behaviors, and sun attitudes was

evaluated by student gender and skin color. Since interaction terms for (1) student gender and spending time in the sun, and (2) skin color and reported sunburn indicated the presence of statistical interaction, with P-values of 0.005 and 0.007, respectively, stratified results are presented in Tables 4 and 5. Girls were more than 2 times more likely (odds ratio [OR] = 2.4; 95% confidence interval [CI]: 1.4–4.0) to report liking a tan in 2007 compared with 2004 (Table 4). They were also significantly more likely in 2007 to report spending time in the sun in the previous summer to get a tan (OR = 4.2; 95% CI: 2.5–7.0, Table 4). Similarly, boys were also more likely to report liking a tan (OR = 1.5; 95% CI: 1.0–2.2) and spending time in the sun to get a tan (OR = 1.6; 95% CI 1.0–2.5) in 2007 compared with 2004; however, there was not a significant increase in actually getting a tan between baseline and follow-up evaluations. A dramatic reduction in reported sunscreen use between 2004 and 2007 was observed for both girls and boys, with girls being 60% less likely to report “often or always” sunscreen use when at the beach or pool during the past summer (OR = 0.4; 95% CI: 0.2–0.6), and boys 70% less likely (OR = 0.3; 95% CI: 0.2–0.4) compared with their baseline responses. For boys and girls, reports of getting a tan did not increase.

Students with very fair to fair skin were 40% more likely to report 2 or more sunburns in 2007 than 2004 (OR = 1.4; 95% CI: 0.9–2.1, Table 5), whereas those students with light olive to black skin were 70% less likely to report 2 or more burns at follow-up compared with baseline (OR = 0.3; 95% CI: 0.1–0.8). The other sun behaviors and sun attitudes did not differ in magnitude between skin colors.

## DISCUSSION

The purpose of this study was to assess self-reported sunburn, sun behaviors,

**TABLE 3** Reported Sunburns by Student Characteristics and Sun Behaviors

Variable	Sunburns	Baseline, n (%)	Follow-up, n (%)	P for Difference in % Increased Sunburn from Baseline to Follow-up	Percentage Change in Self-reported Sunburn between Baseline and Follow-up Assessments				P <sup>a</sup>		
					Overall Change	Increased	Decreased	Remained the Same			
Gender	Male	None	170 (47.5)	161 (45.0)	Referent	53	28	25	47	.79	
		1	79 (22.1)	92 (25.7)							
		2+	109 (30.4)	105 (29.3)							
	Female	None	112 (50.5)	104 (46.4)							.73
		1	39 (17.6)	60 (26.8)							
		2+	71 (32.0)	60 (26.8)							
Skin color	Very fair/Fair	None	58 (42.7)	58 (42.7)	Referent	59	34	25	41	.09	
		1	40 (29.4)	33 (24.3)							
		2+	38 (27.9)	45 (33.1)							
	Light olive/ Light brown	None	90 (37.0)	70 (28.7)							.001
		1	62 (25.5)	75 (30.7)							
		2+	91 (37.5)	99 (40.6)							
Race/Ethnicity	Medium brown /Black	None	51 (63.8)	61 (75.3)	.005	23	9	14	77	.28	
		1	13 (16.3)	14 (17.3)							
		2+	16 (20.0)	6 (7.4)							
	Asian/Black	None	29 (82.9)	31 (88.6)							.05
		1	4 (11.4)	4 (11.4)							
		2+	2 (5.7)	0 (0.0)							
Liking a tan	Hispanic	None	26 (81.3)	25 (78.1)	<.001	28	16	12	72	.74	
		1	5 (15.6)	6 (18.8)							
		2+	1 (3.1)	1 (3.1)							
	White	None	37 (60.7)	47 (77.1)							Referent
		1	11 (18.0)	7 (11.5)							
		2+	13 (21.3)	7 (11.5)							
Getting a tan	Yes	None	107 (40.4)	90 (33.7)	.30	54	30	24	46	.52	
		1	63 (23.8)	80 (30.0)							
		2+	95 (35.9)	97 (36.3)							
	No	None	90 (49.5)	74 (40.4)							Referent
		1	37 (20.3)	50 (27.3)							
		2+	55 (30.2)	59 (32.2)							
Spending time to get a tan	Yes	None	69 (43.4)	81 (50.9)	.02	53	30	23	47	.16	
		1	38 (23.9)	37 (23.3)							
		2+	52 (32.7)	41 (25.8)							
	No	None	141 (46.2)	131 (42.7)							Referent
		1	71 (23.3)	81 (26.4)							
		2+	93 (30.5)	95 (30.9)							
Sunscreen use	Often/ Always	None	27 (56.3)	28 (58.3)	.15	56	32	24	44	.29	
		1	8 (16.7)	11 (22.9)							
		2+	13 (27.1)	9 (18.8)							
	Never / Sometimes	None	59 (41.5)	53 (37.0)							Referent
		1	40 (28.2)	40 (28.0)							
		2+	43 (30.3)	50 (35.0)							
Outdoor Exposure	Low	None	111 (51.6)	109 (50.5)	.25	49	22	27	51	.42	
		1	38 (17.7)	53 (24.5)							
		2+	66 (30.7)	54 (25.0)							
	Medium	None	135 (49.8)	132 (48.4)							.63
		1	56 (20.7)	70 (25.6)							
		2+	80 (29.5)	71 (26.0)							
Sunburn use	High	None	34 (40.0)	29 (34.1)	.20	59	30	29	41	.72	
		1	23 (27.1)	23 (27.1)							
		2+	28 (32.9)	33 (38.8)							
	None	None	57 (46.0)	61 (48.8)							Referent
		1	27 (21.8)	30 (24.0)							
		2+	40 (32.3)	34 (27.2)							

**TABLE 3** Continued

Variable	Sunburns	Baseline, n (%)	Follow-up, n (%)	P for Difference in % Increased Sunburn from Baseline to Follow-up	Percentage Change in Self-reported Sunburn between Baseline and Follow-up Assessments				P <sup>a</sup>
					Overall Change	Increased	Decreased	Remained the Same	
	1	23 (19.3)	30 (25.0)						
	2+	33 (27.7)	39 (32.5)						

Percentage change in reported sunburns for each category is based on the paired observations from baseline and follow-up evaluations.

<sup>a</sup> P value based on the paired comparison from baseline to follow-up evaluation. For dichotomous variables, the McNemar test was used. For variables with 3 or more categories, the Stuart-Maxwell statistic was calculated.

**TABLE 4** The Association between Study Time Point and Sunburn, Sun Exposure, and Sun Attitudes Stratified by Student Gender

Variable		Female				Male			
		OR	95% CI		P	OR	95% CI		P
			Lower	Upper			Lower	Upper	
Sunburn	None	1.0	—	—	—	1.0	—	—	—
	1	0.8	0.5	1.5	.5	1.7	1.0	2.7	.04
	2+	1.2	0.7	2.1	.6	0.9	0.6	1.4	.7
Like a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	2.4	1.4	4.0	.002	1.5	1.0	2.2	.04
Spend time to get a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	4.2	2.5	7.0	<.001	1.6	1.0	2.5	.03
Got a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	1.2	0.6	2.3	.7	0.7	0.4	1.2	.2
Outdoor exposure	Low	1.0	—	—	—	1.0	—	—	—
	Moderate	0.6	0.2	1.6	.3	0.8	0.3	1.8	.5
	High	0.6	0.3	1.5	.3	0.6	0.3	1.4	.3
Sunscreen use	Never / Sometimes	1.0	—	—	—	1.0	—	—	—
	Often / Always	0.4	0.2	0.6	<.001	0.3	0.2	0.4	<.001

and sun exposure among the same children during periadolescence. We found that students, regardless of skin color or gender, reported more time spent in the sun to get a tan and increased positive tanning attitudes by our follow-up evaluation; however, we did not observe a commensurate increase in reported burning or tanning. Overall, we found that rates of sunburn, which exceeded 50% at around age 11, remained high at our follow-up evaluation 3 years later.

This study describes a period of notable changes in tan-promoting attitudes and practices, whereby half of children using sunscreen routinely in 2004 no longer did so in 2007. In fact, only 25% of children in this population-based sample were still using sunscreen routinely in 2007. We did not observe an increase in sunburning rates during

these 3 years and this may be explained by the fact that students' reported number of hours of sun exposure did not increase. The observation that more than 50% of the children received sunburns in both the summers of 2004 and 2007 is troublesome. However, efforts should be made to intensify current sun-protection programs while devising new and creative messages for children of this age, especially because the use of tanning beds, particularly for girls, begins at age 14.<sup>21</sup> A recent review of sun behavior counseling in children highlights the difficulties of changing these behaviors, but demonstrates that it is possible to decrease midday sun exposure and increase sunscreen use via counseling in the primary care setting.<sup>22</sup> With more than 80% of children in 2004 and 2007 reporting that they got a tan the previous summer

and tan-promoting attitudes and practices increasing substantially from ages 11 to 14, new approaches must be taken to discourage tan-promoting attitudes that drive the desire for tan seeking from natural and artificial sources of UVR.

Melanoma incidence continues to rise and sunburns have been consistently shown to be an important risk factor for melanoma development. Attitudes regarding intentional tanning have important implications for the effective delivery of primary prevention campaigns. There is mounting evidence that excessive UVR exposure, particularly during youth, is shifting some of the melanoma burden to younger populations.<sup>23</sup> One of the hypothesized reasons for this has been increased intentional UVR exposure (ie, tanning and tanning bed use). The current public health primary prevention message for skin cancer is focused on sun protection, and a large proportion of that is sunscreen use. Sunscreen is the most common form of sun protection for children and parents<sup>18,24,25</sup> and to date is the only sun-protection measure to demonstrate a reduction in melanoma incidence in a randomized trial.<sup>26</sup> Determining current gaps and deficits in the use of sunscreen will be useful in targeting future interventions to children and their families, to promote proper sunscreen use and, by extension, likely provide important insights into the overall use of sun protection.

Sunburn is an observable response to a high dose of UVR and is implicated in

**TABLE 5** The Association Between Study Time Point and Sunburn, Sun Exposure, and Sun Attitudes Stratified by Student Skin Color

Variable		Very Fair/Fair			Light Olive/Black				
		OR	95% CI		P	OR	95% CI		P
			Lower	Upper			Lower	Upper	
Sunburn	None	1.0	—	—	—	1.0	—	—	—
	1	1.6	1.0	2.5	.06	0.9	0.4	1.9	.8
	2+	1.4	0.9	2.1	.1	0.3	0.1	0.8	.01
Like a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	1.9	1.3	2.7	.002	1.6	0.9	2.7	.08
Spend time to get a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	2.8	1.9	4.1	<.001	1.7	0.9	3.0	.08
Got a tan	No	1.0	—	—	—	1.0	—	—	—
	Yes	0.8	0.5	1.5	.5	0.8	0.4	1.5	.5
Outdoor exposure	Low	1.0	—	—	—	1.0	—	—	—
	Moderate	0.7	0.3	2.0	.5	0.6	0.3	1.4	.2
	High	0.5	0.2	1.4	.2	0.8	0.3	1.7	.5
Sunscreen use	Never/ Sometimes	1.0	—	—	—	1.0	—	—	—
	Often/Always	0.3	0.2	0.4	<.001	0.3	0.1	0.5	<.001

the chain of causation leading to skin cancer. Therefore, a key priority for skin cancer prevention programs should be to understand the factors needed to reduce the occurrence of sunburn; in particular, frequent sunburns that are strongly implicated in the development of skin cancer, especially melanoma. One possible yardstick for the success of a specific sun-protection program is its ability to influence behaviors of at-risk children. Rates of sunburning found in this current study fall within those reported in the literature, accounting for differences in the ages and specific wording from other surveys. In a national survey of children ages 11 to 18, Cokkinides et al<sup>15</sup> found the prevalence of sunburn to be 72% in 1998 and 69% in 2004. Higher rates of sunburning (83%) were found among children of nurses. Hall et al<sup>27</sup> reported the prevalence of sunburn in the previous summer was 46.2%, but the cohort was younger and this study showed an increasing prevalence with age.

In prior studies, the relationship between the occurrence of sunburns and the use of sun protection has been mixed. A national study of the parents of younger children (ages 6 months to 11 years)

found that among children who burned, 64% had 1 sunburn, 21% had 2 sunburns, and 16% had 3+ sunburns. Sunburning was less common in children who always used sunscreen and who never used sunscreen, compared with those who often, sometimes, or rarely used sunscreen.<sup>27</sup> In a national study of older children (ages 11–18), Davis et al<sup>28</sup> found that children who never, rarely, or sometimes used sunscreen were more likely than often or always users to have had 5+ sunburns compared with no sunburns. In a study of the correlates of sunburn, Hall et al<sup>27</sup> found the reduced likelihood of sunburning among people who wore hats always, or most of the time; however, there were no differences by sunscreen use.

There were several limitations of this study. First, obtaining accurate and objective assessments of UVR exposure is difficult. In this study, all sun behaviors are self-reported. Self-reported sun behaviors have been shown to have fair to moderate agreement with direct observation, and in these studies there was no substantial over-reporting or under-reporting of sun behaviors.<sup>29</sup> Second, by 2007, 19% of the students were no longer in the

study, and a disproportionate percentage of these participants were “non-white.” Although darker phenotype is generally protective against skin cancer, this understudied population could have provided unique and invaluable information regarding sun behaviors. Third, it was beyond the scope of this study to ascribe reasons for the drop in sunscreen use during these 3 years. We did not include questions on peer or parent influences<sup>30–32</sup> or the potential effect news stories highlighting the benefits of vitamin D and the downsides of sunscreen may have played a role. Future studies should explore reasons for decline in the use of sunscreen. Fourth, the children who participated in this study were aware that the goal was to examine their moles and to undergo photographic evaluation of their entire back. The nurse evaluation and photography occurred immediately after completing the baseline survey as fifth graders. Although no education on sun protection was provided, there is the possibility that some children may have changed their sun practices as a result of greater attention to their moles; however, this is unlikely, as we observed a precipitous drop in sunscreen use over the study follow-up period. We also did not collect any information on the school’s sun-protection policies and practices, and are unaware if these policies changed over the course of the study follow-up period. Study participation was strongest among white boys and weakest among girls and Hispanic children. Anecdotally, some of the parents of girls who did not participate commented that their daughters were reluctant to show their backs, particularly in the presence of a male photographer. Major strengths include the population-based sampling, the prospective study design, the retention of 86% of the white children for 3 years, survey completion soon after the end of the summer,

and the opportunity to simultaneously assess sun-protection practices, sun exposure, and rates of sunburn.

## CONCLUSIONS

Melanoma is 1 of the 2 most common cancers of young Americans,<sup>33</sup> therefore establishing comprehensive sun-protection practices at early ages are strongly needed. We have identified a crucial period of periadolescence in which students increase time spent in the sun to get a tan and strengthen tan-promoting attitudes. Rates of sunburn, which exceeded 50% at age 11, remained high at our follow-up evaluation 3 years later. Furthermore, we

have shown that the time between ages 11 and 14 is one of volatility, as more than 50% of at-risk children increase or decrease their use of sun protection, obtain sunburns, or change their tan-promoting attitudes. Of most concern, it appears that groups at highest risk of skin cancer, very fair/fair children and those who obtained tans, were more likely to increase their number of sunburns during this crucial period.

Along with educational efforts in physicians' offices and schools, further studies are required to learn how to interweave enhanced sun-protection policies in settings such as beaches, after-school sites, and sporting events

frequented by preadolescents and adolescents. Adolescence and teenage years are tremendously difficult because it is a period of flexing independence, coupled with feelings of invincibility. With at least 50% of children experiencing sunburns before age 11, complementing outreach to adolescents by targeting children at an earlier age is a potential approach.

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**FLYING CUDDLE CLASS:** *I fly frequently, and while most of my flights are fairly short, occasionally I have much longer ones. During these long flights, I always try to find a comfortable position so I can sleep. If the plane is full, there really is no way to spread out (like most in the 99%, I fly coach). If the plane has many empty seats, passengers claim, as quickly as possible, two or three seats in a row so they can stretch out and snooze. I tend to be slower than most (or less savvy) and usually wind up pinned in my own seat for hours on end. However, according to an article in The Wall Street Journal (Life & Culture: December 15, 2011), at least one major airline has recognized the need or desire for passengers flying coach to stretch out and sleep during long flights. Dubbed “cuddle class”, two passengers can spread out over three seats. While this seems to be a fairly straightforward idea, it took months of research and many hours of time in a simulation laboratory to figure out what worked best. The challenge for the airline was to create something a little bit more comfortable, but not too comfortable. The airline did not want to deter passengers from paying additional money to fly business or first class. The solution was to allow passengers, usually a couple, to purchase the middle seat of a three-row section, at a reduced price. Additionally, the seats in this section have a padded foot rest that can be locked into position flush with the seat. Because the armrests are fully retractable, the couple can now spread out over the three seats or sky couch. For the airline, passengers are happy and middle seats, previously often unsold, are now generating revenue – usually \$500 - \$800 for an overnight flight. For passengers, an opportunity to sleep is welcomed. Of course, “cuddle class” is not like sleeping at home. Couples still only have approximately 4.5 feet in which to extend their bodies so both parties will need to scrunch up a bit. Additionally, even with the foot rest in place, the width of the sky couch is approximately 32 or 33 inches long. On most flights offering sky couches, a trip down the aisle includes dodging feet extending into the aisle. Still, the option has proven so popular that many other airlines are looking into their own versions. I have a long flight with my wife planned for next May. Maybe we will try “cuddle class.”*

Noted by WVR, MD

## Prospective Study of Sunburn and Sun Behavior Patterns During Adolescence

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