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Sunburn and sun-protective behaviors among adults with and without previous nonmelanoma skin cancer: a population-based study

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Abstract

Background—Individuals with previous nonmelanoma skin cancer (NMSC) are at increased risk for subsequent skin cancer, and should therefore limit UV exposure.

Objective—To determine whether individuals with previous NMSC engage in better sun protection than those with no skin cancer history.

Methods—We pooled self-reported data (2005 and 2010 National Health Interview Surveys) from US non-Hispanic white adults (758 with and 34,161 without previous NMSC). We calculated adjusted prevalence odds ratios (aPOR) and 95% confidence intervals (95% CI), taking into account the complex survey design.

Results—Individuals with previous NMSC versus no history of NMSC had higher rates of frequent use of shade (44.3% versus 27.0%; aPOR=1.41; 1.16–1.71), long sleeves (20.5% versus 7.7%; aPOR=1.55; 1.21–1.98), a wide-brimmed hat (26.1% versus 10.5%; aPOR=1.52; 1.24–1.87), and sunscreen (53.7% versus 33.1%; aPOR=2.11; 95% CI=1.73–2.59), but did not have significantly lower odds of recent sunburn (29.7% versus 40.7%; aPOR=0.95; 0.77–1.17). Among subjects with previous NMSC, recent sunburn was inversely associated with age, sun avoidance, and shade but not sunscreen.

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Limitations—Self-reported cross-sectional data and unavailable information quantifying regular sun exposure.

Conclusion—Physicians should emphasize sunburn prevention when counseling patients with previous NMSC, especially younger adults, focusing on shade and sun avoidance over sunscreen.

Keywords

Nonmelanoma skin cancer; photo-protection; sunscreen; sunburn; UV exposure; multimodal sun protection; skin cancer prevention

INTRODUCTION

Nonmelanoma skin cancers (NMSC) are the most common of all human malignancies.¹ Individuals with previous NMSC are at increased risk for subsequent NMSC^{2–5} and melanoma.^{6–12} UV radiation and sunburn are the main avoidable contributing factors to NMSC and melanoma.^{1,13–15} Thus, it is advisable for individuals with previous NMSC to engage in sun-protective practices to help avoid harmful sun exposure and potentially prevent subsequent skin cancers. Two previous US studies suggest that subjects report engaging in better sun-protective practices after NMSC treatment;^{16,17} however, evidence suggests that certain photo-protective practices may not necessarily translate into sunburn prevention.¹⁸

Our study uses nationally representative US data to examine (1) whether subjects with previous NMSC engage in better photo-protection than subjects without history of skin cancer and (2) correlates of recent sunburn among subjects reporting previous NMSC.

METHODOLOGY

Study population

We obtained data from the National Health Interview Survey (NHIS), a nationally representative cross-sectional survey of the US civilian non-institutionalized population that involves a complex survey design and population-based weights.¹⁹ As detailed in Supplemental Figure 1, we pooled self-reported data from 2005 ($N=31,428$) and 2010 ($N=27,157$), the most recent survey years with our questions of interest. Final adult response rates for the 2005 and 2010 NHIS were 69.0%²⁰ and 60.8%,¹⁹ respectively. Analyses were restricted to non-Hispanic whites ($N=35,648$), as NMSC primarily affects this population.²¹ We excluded individuals reporting previous melanoma ($N=323$) regardless of history of NMSC, reporting skin cancer of unknown kind ($N=352$), or with missing responses to questions about previous cancer or NMSC ($N=54$). Our study population thus included 758 subjects reporting previous NMSC and 34,161 subjects without history of skin cancer. This study was exempt from Johns Hopkins University IRB review.

Definitions of covariates

Intuitive categories for age at interview were chosen with consideration for the low incidence of NMSC at younger ages. Survey responses for gender, region of the US, survey year, family history of skin cancer in any first-degree relative, highest level of education, and

previous full-body skin examination were reported. Sun sensitivity was characterized as the effect of going out into the sun for an hour without photo-protection on the skin after several months of not being in the sun very much. Included responses were (a) “get a severe sunburn with blisters,” (b) “have a moderate sunburn with peeling,” (c) “burn mildly with some or no darkening/tanning,” (d) “turn darker without sunburn,” (e) “nothing would happen to my skin,” or (f) “do not go out in the sun.” Survey questions quantifying sun exposure were not available, thus we included surrogate variables (BMI and physical activity level). For physical activity level, we summed the reported minutes of mild-to-moderate and vigorous activity per week and created categories (0, <180, 180–360, 360+ minutes/week) using cut-points corresponding approximately to the 50th and 75th percentiles among subjects reporting physical activity.

Definitions of outcome variables

Survey respondents were asked four separate questions regarding how often they (1) stay in the shade, (2) wear a hat that shades their face, ears, and neck, such as a hat with a wide brim all around, (3) wear a long sleeved shirt, and (4) use sunscreen, when they go outside on a warm sunny day for more than one hour. For each of the four questions, we included responses of always, most of the time, sometimes, rarely, never, or “do not go out in the sun”. We defined sun avoidance as a response of “do not go out in the sun” to any of five questions regarding sunscreen, long sleeves, hat, shade, or sun sensitivity. Among the remaining sun-exposed individuals (did not avoid the sun), we examined responses for questions 1–4 categorized as frequent (always or most of the time), sometimes, or rare (rarely or never). We defined individuals with frequent multimodal sun protection as sun-exposed individuals who reported frequent use of at least two of the four examined sun-protective methods (questions 1–4). Recent sunburn was characterized as sunburn within the last 12 months.

Statistical analysis

We performed multivariate logistic regression to estimate prevalence odds ratios (PORs) for the outcome variables using previous NMSC (compared to no history of skin cancer) as the main exposure variable. We selected covariates for adjustment a priori based on their known association with the primary outcomes and/or UV-exposure behaviors, including age, sex, region, family history of skin cancer, sun sensitivity, education, BMI, and physical activity.^{22–26} Refused, not ascertained, and unknown responses were coded collectively as missing for the above analysis. Frequencies of missing subjects were reported for descriptive (Supplemental Table 1) and sun-protective variables (Table 1). Additional logistic regression was performed for stratified analyses by descriptive variables and for subpopulation analyses restricted to subjects reporting previous NMSC with complete data (additionally adjusting for previous full-body skin examination). As a portion of survey respondents reported previous skin cancer of unknown type, we conducted sensitivity analyses looking at subjects reporting previous NMSC and skin cancer of unknown type together compared to subjects without history of skin cancer to examine whether point estimates for photo-protection would change if all skin cancers of unknown type had also been NMSC. We computed the P_{trend} using the Wald statistic treating categorized exposure variables as continuous. Sample weights were adjusted by dividing each sample weight by 2 (the number of pooled years).¹⁹

All analyses were performed (SAS 9.4, Cary, NC) taking into account the adjusted sample weights, complex survey design, and differing 2005 and 2010 sample designs.¹⁹

RESULTS

Descriptive characteristics among subjects with and without previous NMSC are reported in Supplemental Table 1. Table 1 shows the percentage of all subjects with versus without previous NMSC reporting recent sunburn (29.7% versus 40.7%) and sun avoidance (12.8% versus 7.3%). Among sun-exposed individuals, we report the percentage of subjects with versus without previous NMSC reporting frequent use of shade (44.3% versus 27.0%), long sleeves (20.5% versus 7.7%), a wide-brimmed hat (26.1% versus 10.5%), sunscreen (53.7% versus 33.1%), and multi-modal sun protection (44.7% versus 19.4%; Table 1). The crude percentage difference in sunburn between subjects with and without previous NMSC disappeared after stratification by age (Figure 1a). Approximately two-thirds (66.9%) of individuals aged 18–39 with previous NMSC reported recent sunburn (Figure 1a). The proportion of individuals reporting recent sunburn decreased with age among subjects with and without previous NMSC ($P_{\text{trend}} < 0.001$ for both groups; Figure 1a), while use of multimodal sun protection increased significantly with age among subjects reporting no history of skin cancer ($P_{\text{trend}} < 0.001$; Figure 1b). Among individuals employing multimodal sun protection, frequent sunscreen use decreased with age ($P_{\text{trend}} < 0.001$; Supplemental Table 2).

Among sun-exposed individuals, previous NMSC (compared to no history of skin cancer) was associated with higher odds of frequent use (versus rare or sometimes use) of shade (adjusted prevalence odds ratio (aPOR)=1.41; 95% CI=1.16–1.71), long sleeves (aPOR=1.55; 1.21–1.98), a wide-brimmed hat (aPOR=1.52; 1.24–1.87), and sunscreen (aPOR=2.11; 1.73–2.59) on a warm sunny day (Table 2). Previous NMSC was also associated with multimodal sun protection (aPOR=2.49; 1.93–3.22). Previous NMSC was not significantly associated with higher odds of sun avoidance (aPOR=1.30; 0.77–2.19) or lower odds of recent sunburn (aPOR=0.95; 0.77–1.17) among all subjects after multivariate adjustment (Table 2). The association between previous NMSC and sunburn remained non-significant even after stratification by age, sex, region, family history of skin cancer, sun sensitivity, education, BMI, physical activity, and survey year (results not shown). Sensitivity analysis looking at subjects reporting previous NMSC and skin cancer of unknown type together compared to subjects with no history of skin cancer did not substantially impact point estimates (results not shown).

Among all subjects with previous NMSC, recent sunburn was associated with younger age, residence outside of the South, previous full-body skin examination, and increasing sun sensitivity (Table 3). Recent sunburn was inversely associated with sun avoidance (aPOR=0.3; 0.1–0.9) among all subjects with previous NMSC (Table 4). Among sun-exposed individuals with previous NMSC, recent sunburn was associated with less frequent use of shade ($P_{\text{trend}} < 0.001$) and long sleeves ($P_{\text{trend}} = 0.02$), but not a wide-brimmed hat ($P_{\text{trend}} = 0.06$) or sunscreen ($P_{\text{trend}} = 0.75$; Table 4). Using more modes of frequent photoprotection was associated with decreasing odds of recent sunburn ($P_{\text{trend}} = 0.001$; Table 4).

DISCUSSION

Individuals reporting previous NMSC reported similar relative odds of recent sunburn compared to individuals without history of skin cancer, despite having better sun-protective practices. Our findings are supported by a recent study showing no significant difference in reported rates of sunburn between subjects with and without any previous skin cancer.²⁷ Smaller studies looking at patients before and four months after NMSC treatment have similarly shown significant improvements in the use of shade,¹⁶ protective clothing,¹⁶ hats,^{16,17} and sunscreen.¹⁷

Approximately 30% of non-Hispanic whites reporting previous NMSC identified having recently sunburned. In recent literature, similar rates of sunburn were found in a Canadian study post-melanoma,²⁸ while higher rates were reported among northern Australian men post-NMSC.²⁹ We observed even higher rates of sunburn in the younger population. Previous studies have observed associations of previous NMSC with subsequent skin cancer,^{2–12} cumulative sun exposure with risk of NMSC,^{30–34} and sunburn at any age with melanoma.^{13–15} Thus, these high rates of sunburn are concerning in the young post-NMSC population, as younger subjects have more years to accumulate harmful sun exposure. We generally observed increasing use of multimodal photo-protection with age, despite the oldest populations possibly experiencing less relative benefit with regard to increased longevity. Our findings suggest that the observed decrease in sunburn with age may result from increased photo-protection in addition to less engagement in activities with sun exposure.³⁵ Among users of multimodal photo-protection, frequent sunscreen use decreased with age, which may reflect that sunscreen application is often a more active decision in the older population than dressing in protective clothing.

Overall, subjects reporting previous NMSC more frequently engage in photo-protective practices reducing chronic UV exposure, which may help reduce the risk of subsequent NMSC.^{30–34} However, their sun-protective practices may still not be consistent enough to prevent acute episodes of UV exposure leading to sunburns, which are associated with risk of melanoma and BCC.^{13–15} Physicians should thus continue to emphasize the importance of sunburn prevention, especially among younger individuals with previous NMSC. It is important to consider that individuals with previous NMSC likely had higher UV exposure compared to the general population before NMSC diagnosis, and thus improved sun-protective practices post-NMSC may have contributed to returning their rates of sunburn back to rates comparable to the general population.

Among individuals reporting previous NMSC, risk factors associated with recent sunburn included younger age, residence outside of the South, increasing sun sensitivity, and lack of previous full-body skin examination. This association with age is consistent with previous studies.^{29,25} The observed association with previous full-body skin examination may be due in part to counseling from health care providers about photo-protection, or conversely if subjects who engage in photo-protection are more proactive about skin cancer screening. The association between region and recent sunburn may be explained in part by better photo-protection counseling at lower latitudes in the U.S.³⁶

Sun avoidance and frequent use of shade were associated with the largest reduction in odds of recent sunburn among subjects with previous NMSC; however, we observed the smallest magnitudes of association between previous NMSC and these behaviors. Interestingly, while frequent use of sunscreen was the most commonly employed sun-protective method, it was not associated with lower odds of recent sunburn among subjects with previous NMSC, suggesting that individuals may not necessarily be effectively applying sunscreen. Other studies similarly suggest that sunscreen alone may not provide adequate protection from harmful sun exposure,^{18,37,38} as sunscreen use correlates with more overall sun exposure,^{39,40} sunscreen application may be too thin,^{39,41} areas of skin may be left unprotected after application.^{40,42} Additionally, intermittent sunscreen use may result in skin that is not as hardened from chronic UV exposure and more susceptible to acute episodes of sun exposure resulting in sunburn. As the most effective methods of photo-protection may not be the most common methods used among subjects with previous NMSC, this discrepancy may help explain the similar relative odds of recent sunburn in subjects with versus without previous NMSC. Thus, use of effective protective methods such as sun avoidance and shade should be advised. Additionally, we believe that emphasizing patient counseling about proper sunscreen application could increase effectiveness of sunscreen application in preventing sunburn. As sunscreen is the most common form of photo-protection employed, improving the effectiveness of sunscreen could have a large impact on decreasing unnecessary sunburn. Multimodality of sun protection was associated with lower odds of sunburn and thus may offer a highly beneficial approach to prevent sunburns in individuals with previous NMSC.

Strengths of this study include the large sample size using a nationally representative sample. Pooling multiple years of data allowed for increased precision of estimates, especially among smaller subpopulations.

Limitations include the cross-sectional study design with reliance on current sun-protective practices and lack of data quantifying sun exposure (e.g., at midday) in the survey questionnaire, although we attempted to address residual confounding by examining physical activity level and BMI. Additionally, pooling multiple years of data may make findings less generalizable to a specific year, and as much of the data is old (up to 10 years), the accuracy of the data representing the current US population may be limited. The data is self-reported and recall bias is possible, as those with previous NMSC may better remember sunburn or photo-protection if their physician advised being mindful of photo-protection; however, our estimates are consistent and agree with smaller studies with short-term follow-up.^{16,17} An additional limitation is the use of non-confirmed NMSC cases, as the NHIS is thought to underreport cases.^{43,44} While melanoma is generally recognized as serious, certain individuals may perceive their NMSC diagnosis as less important and may therefore be less likely to report NMSC. This would further underscore the need to better emphasize sun-protection in this at-risk population. Survey information on subtype of NMSC and sunburn severity was not available. It is possible that despite similar odds of recent sunburn in subjects with and without previous NMSC, sunburn among subjects with previous NMSC was less severe. Prospective studies are still needed to examine relative photo-protective behaviors and risk of sunburn post-NMSC in the context of both prior photo-protective behaviors and current UV exposures and to examine whether proper photo-protection and

sunburn prevention will help reduce the risk of subsequent skin cancers in the population with previous NMSC.

CONCLUSIONS

Among non-Hispanic whites, we observe that individuals with previous NMSC engage in better sun-protective practices but not sunburn prevention compared to subjects with no history of skin cancer, suggesting that photo-protection may still not be consistent enough to prevent acute sun exposure leading to sunburn. Physicians should thus continue to emphasize the importance of sunburn prevention, especially among younger individuals with previous NMSC. Sun avoidance (including shade) may be a more effective means of photo-protection than use of sunscreen in subjects with previous NMSC, and should thus be emphasized when counseling patients. However, due to the commonness of sunscreen use, counseling efforts on ways to improve sunscreen effectiveness could also have a large public health impact in preventing sunburn.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ABBREVIATIONS

NMSC	non-melanoma skin cancer
UV	ultraviolet
POR	prevalence odds ratio
aPOR	adjusted prevalence odds ratio
95% CI	95% confidence interval
US	United States
NHIS	National Health Interview Survey
IRB	Institutional Review Board

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Figure 1.

A. Percentage of subjects reporting sunburn in the last year according to age. **B.** Percentage of subjects reporting frequent multimodal sun protection according to age. Data are pooled from the 2005 and 2010 NHIS. Percentages are weighted according to US census data and reported with standard error (SE) measurements. P -values for linear trend (P_{trend}) were calculated using logistic regression treating age categories as a continuous variable. Point estimates are reported in Supplemental Table 3 (sunburn) and Supplemental Table 4 (frequent multimodal sun protection).

Table 1

Weighted percentages (Wt %) of various sun-protective practices and recent sunburn according to reported history of previous nonmelanoma skin cancer (NMSC) among non-Hispanic white subjects

<u>No history of skin cancer</u>		<u>Previous NMSC</u>	
N	Wt % (SE) ^a	N	Wt % (SE) ^a
Among all subjects (N=34919)			
Recent sunburns ^d			
0	18868 52.6 (0.3)	525 66.3 (2.0)	
1	6393 20.0 (0.3)	96 14.0 (1.6)	
2+	6618 20.7 (0.3)	103 15.7 (1.5)	
Missing	2282 6.7 (0.2)	34 4.0 (0.7)	
Sun avoidance			
No	28603 85.2 (0.3)	613 82.0 (1.7)	
Yes	2985 7.3 (0.2)	100 12.8 (1.4)	
Missing	2573 7.5 (0.2)	45 5.2 (0.9)	
Among sun-exposed subjects (N=31834)			
Shade ^b			
Rare	8777 28.8 (0.3)	116 18.0 (1.6)	
Sometimes	11374 36.9 (0.4)	208 33.1 (2.1)	
Frequent	8732 27.0 (0.3)	299 44.3 (2.2)	
Missing	2293 7.3 (0.2)	35 4.6 (0.8)	
Long sleeves ^b			
Rare	21956 71.9 (0.3)	359 56.1 (2.1)	
Sometimes	4359 13.4 (0.3)	122 19.1 (1.7)	
Frequent	2625 7.7 (0.2)	144 20.5 (1.7)	
Missing	2236 7.1 (0.2)	33 4.3 (0.8)	
Wide-brimmed hat ^b			
Rare	21833 71.2 (0.3)	340 52.0 (2.2)	
Sometimes	3603 11.3 (0.2)	112 17.6 (1.8)	
Frequent	3516 10.5 (0.2)	173 26.1 (1.9)	
Missing	2224 7.1 (0.2)	33 4.3 (0.8)	
Sunscreen ^b			
Rare	12208 38.9 (0.4)	171 25.3 (1.8)	
Sometimes	6401 21.0 (0.3)	104 16.7 (1.7)	
Frequent	10361 33.1 (0.4)	351 53.7 (2.2)	
Missing	2206 7.0 (0.2)	32 4.3 (0.8)	
Frequent protection practices ^c			
0	12519 41.2 (0.4)	124 20.3 (1.8)	
1	10013 32.1 (0.3)	200 30.7 (2.1)	
2	4367 13.5 (0.2)	170 26.0 (2.0)	
3+	2010 5.9 (0.2)	131 18.7 (1.6)	

	<u>No history of skin cancer</u>		<u>Previous NMSC</u>	
	N	Wt % (SE) ^a	N	Wt % (SE) ^a
Missing	2267	7.2 (0.2)	33	4.3 (0.8)

Pooled data from the 2005 and 2010 National Health Interview Surveys (NHIS)

^aPercentages are weighted according to US census data and reported with standard error (SE) measurements; weighted percentages (Wt %) may not add up to 100% due to rounding.

^bSelf-reported frequency of the sun-protective practice on a warm sunny day.

^cNumber of the four examined sun protection techniques that sun-exposed subjects reported frequently using on a warm sunny day.

^dNumber of sunburns reported in the last year.

Table 2Reported history of NMSC^a as a predictor of recent sunburn and various sun-protective practices

	POR ^b	(95% CI)
Among all subjects (N=34919)		
Recent sunburn ^c	0.95	(0.77–1.17)
Sun avoidance ^d	1.30	(0.77–2.19)
Among sun-exposed subjects (N=31834)		
Shade ^e	1.41	(1.16–1.71)
Long sleeves ^e	1.55	(1.21–1.98)
Wide-brimmed hat ^e	1.52	(1.24–1.87)
Sunscreen ^e	2.11	(1.73–2.59)
Multimodal sun protection ^f	1.98	(1.62–2.41)

The analysis was conducted using pooled data from the 2005 and 2010 NHIS among non-Hispanic white subjects

^aSubjects who reported no history of skin cancer were used as the reference group

^bPrevalence odds ratio (POR) estimates were adjusted for age (18–39, 40–49, 50–59, 60–69, 70–79, 80+ years), sex, region (Northeast, Midwest, South, West), family history of skin cancer, sun sensitivity (severe sunburn, moderate sunburn, mild sunburn, no sunburn, no change), highest level of education (less than high school, high school diploma, some college, college degree or higher), BMI (<18.5, 18.5–<25.0, 25.0–<30.0, 30.0+ kg/m²), physical activity level (0, <180, 180–<360, 360+ min/wk), and survey year (2005, 2010).

^cOutcome variable: at least one sunburn in the last year versus none; this model included all study subjects and thus the covariate of sun sensitivity included the additional response of “do not go into sun.”

^dOutcome variable; model not adjusted for sun sensitivity because the covariate was used to create the outcome variable

^eOutcome variable: frequent use versus rare or sometimes use on a warm sunny day

^fOutcome variable: frequent use of at least two of the four sun protection methods examined among sun-exposed subjects versus fewer than two methods

Table 3

Weighted percentage and odds of recent sunburn^a according to descriptive characteristics among non-Hispanic white subjects reporting a history of previous NMSC

	Recent sunburn ^a		POR ^c (95% CI)	P-value
	No, N=492	Yes, N=188		
	Wt % (SE) ^b	Wt % (SE) ^b		
Age (years)				
18–39	2.0 (0.7)	8.1 (2.3)	3.8 (1.3–10.8)	
40–49	8.4 (1.7)	25.7 (4.0)	2.3 (1.2–4.6)	
50–59	18.7 (2.1)	25.4 (3.7)	1.0 (Ref)	
60–69	28.2 (2.3)	27.4 (3.7)	0.7 (0.4–1.3)	
70–79	23.5 (2.1)	10.1 (2.4)	0.3 (0.2–0.6)	
80+	19.2 (2.0)	3.2 (1.2)	0.2 (0.1–0.4)	<0.001 ^e
Gender				
Male	50.4 (2.7)	55.9 (4.1)	1.4 (0.9–2.2)	
Female	49.6 (2.7)	44.1 (4.1)	1.0 (Ref)	0.11
Region				
South	47.3 (2.6)	28.1 (3.7)	1.0 (Ref)	
Northeast	11.3 (1.8)	17.9 (3.5)	3.0 (1.5–5.9)	0.002
Midwest	21.9 (2.0)	29.4 (4.1)	2.3 (1.3–4.1)	0.004
West	19.5 (2.0)	24.6 (3.3)	2.2 (1.2–3.8)	0.007
Family history of skin cancer				
No	73.0 (2.4)	66.3 (4.0)	1.0 (Ref)	
Yes	27.0 (2.4)	33.7 (4.0)	1.4 (0.9–2.4)	0.17
Sun sensitivity				
Severe sunburn	13.7 (1.8)	18.5 (3.3)	5.6 (2.6–12.4)	<0.001
Moderate sunburn	29.3 (2.4)	36.9 (4.0)	3.7 (1.8–7.5)	<0.001
Mild sunburn	22.1 (2.0)	35.8 (4.0)	4.9 (2.3–10.4)	<0.001
No sunburn ^d	22.2 (2.1)	6.5 (1.7)	1.0 (Ref)	
Do not go into the sun	12.7 (1.8)	2.3 (1.1)	1.3 (0.3–4.9)	0.75
Highest level of education				
Less than high school	10.0 (1.5)	5.5 (1.9)	1.0 (0.4–4.9)	
High school diploma	25.3 (2.2)	20.2 (3.2)	0.8 (0.5–1.5)	
Some college	26.3 (2.3)	23.3 (3.2)	0.9 (0.5–1.6)	
College degree or higher	38.4 (2.7)	51.0 (4.3)	1.0 (Ref)	0.62 ^e
Body mass index (kg/m ²)				
<25.0 ^d	37.3 (2.4)	36.0 (3.9)	1.0 (Ref)	
25–<30	38.3 (2.4)	41.6 (4.1)	1.4 (0.8–2.3)	
30+	24.4 (2.3)	22.4 (3.5)	1.0 (0.6–1.7)	0.85 ^e
Physical activity level (min/wk)				
None	32.2 (2.3)	16.4 (3.0)	1.0 (Ref)	

	Recent sunburn^a		POR^c (95% CI)	P-value
	No, N=492	Yes, N=188		
	Wt % (SE)^b	Wt % (SE)^b		
<180	28.5 (2.3)	31.9 (4.0)	1.6 (0.9–2.8)	
180–<360	19.4 (2.0)	24.4 (3.5)	1.5 (0.8–2.3)	
360+	20.0 (1.9)	27.3 (3.5)	2.2 (1.2–4.1)	0.03 ^e
Previous full-body skin check				
No	25.7 (2.3)	35.5 (4.2)		
Yes	74.3 (2.3)	64.5 (4.2)	0.4 (0.3–0.7)	<0.001
Survey year				
2005	39.3 (2.4)	40.2 (3.9)	1.0 (Ref)	
2010	60.7 (2.4)	59.8 (3.9)	1.1 (0.8–1.7)	0.53

Analyses were conducted on a subset of non-Hispanic white subjects reporting a history of previous NMSC with complete data, using pooled data from the 2005 and 2010 National Health Interview Survey (NHIS).

^aAt least one sunburn reported in the last year

^bPercentages are weighted according to U.S. census data and reported with standard error (SE) measurements; weighted percentages (Wt %) may not add up to 100% due to rounding

^cThe model used to generate the prevalence odds ratio (POR) estimates included all listed covariates

^dCertain response categories were collapsed (sun sensitivity of “no sunburn” and “no change”; BMI of <18.5 and 18.5–<25.0) in this analyses for stable estimates

^eP-value for linear trend was computed using the Wald statistic, treating the categorized exposure variable as a continuous variable.

Weighted percentage (Wt %) and odds of recent sunburn^g according to sun-protective behaviors among non-Hispanic white subjects with a reported history of previous NMSC

Table 4

	Recent sunburn ^d					P-value
	No	Wt % (SE) ^b	Yes	Wt % (SE) ^b	POR ^c (95% CI)	
Sun avoidance ^d						
No	407	82.4 (2.2)	180	96.1 (1.6)	1.0 (Ref)	
Yes	85	17.6 (2.2)	8	4.0 (1.6)	0.3 (0.1–0.9)	0.03
Shade ^e						
Rare	68	16.4 (2.1)	44	23.0 (3.4)	1.0 (Ref)	
Sometimes	129	32.5 (2.7)	73	40.4 (3.9)	0.6 (0.3–1.1)	
Frequent	215	51.1 (2.9)	69	36.6 (3.8)	0.3 (0.2–0.6)	<0.001 ^g
Long sleeves ^e						
Rare	224	55.8 (2.8)	119	66.4 (3.8)	1.0 (Ref)	
Sometimes	77	19.8 (2.3)	38	21.2 (3.4)	0.8 (0.4–1.4)	
Frequent	106	24.4 (2.3)	23	12.4 (2.7)	0.5 (0.2–0.9)	0.02 ^g
Wide-brimmed hat ^e						
Rare	218	52.2 (2.7)	106	60.6 (4.2)	1.0 (Ref)	
Sometimes	69	18.2 (2.5)	41	21.1 (3.3)	1.0 (0.6–1.7)	
Frequent	120	29.7 (2.4)	33	18.3 (3.3)	0.6 (0.3–1.01)	0.06 ^g
Sunscreen ^e						
Rare	121	29.6 (2.5)	38	20.9 (3.4)	1.0 (Ref)	
Sometimes	63	16.0 (2.1)	38	21.4 (3.7)	1.3 (0.7–2.5)	
Frequent	223	54.4 (2.8)	104	57.7 (4.3)	1.0 (0.5–1.8)	0.75 ^g
Frequent protection ^f						
0 methods	74	19.2 (2.2)	45	26.3 (3.9)	1.0 (Ref)	
1 method	126	30.7 (2.7)	66	36.8 (4.2)	0.8 (0.4–1.4)	
2 methods	110	28.4 (2.7)	51	25.8 (3.5)	0.4 (0.2–0.9)	
3+ methods	97	12.7 (2.2)	18	11.1 (2.8)	0.3 (0.1–0.7)	0.001 ^g

Analyses were conducted on a subset of non-Hispanic white subjects reporting a history of previous NMSC for which there was a complete set of data, using pooled data from the 2005 and 2010 National Health Interview Survey (NHIS).

^a At least one sunburn reported in the last year

^b Percentages are weighted according to U.S. census data and reported with standard error (SE) measurements; weighted percentages (Wt %) may not add up to 100% as variables with missing responses are not reported.

^c Prevalence odds ratio (POR) estimates were adjusted for age (18–39, 40–49, 50–59, 60–69, 70–79, 80+ years), sex, region (Northeast, Midwest, South, West), family history of skin cancer, sun sensitivity (severe sunburn, moderate sunburn, mild sunburn, no sunburn), highest level of education (less than high school, high school diploma, some college, college degree or higher), BMI (<25.0, 25.0–30.0, 30.0+ kg/m²), physical activity level 0, <180, 180–<360, 360+ min/wk), previous full-body skin check, and survey year (2005, 2010).

^d Analysis among all subjects reporting previous NMSC with complete data; model not adjusted for sun sensitivity because this covariate was used to create the variable of sun avoidance.

^e Self-reported frequency of sun-protective practice on a warm sunny day; analysis among sun-exposed individuals reporting previous NMSC with complete data

^f Subjects who frequently used at least two of the four examined sun protection practices on a warm sunny day; analysis among sun-exposed individuals reporting previous NMSC with complete data

^g P-value for linear trend was computed using the Wald statistic, treating the categorized exposure variable as a continuous variable.