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Sunburn frequency and risk and protective factors: a cross-sectional survey

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Abstract

Skin cancer prevention is at the forefront of public health as morbidity increases. Limited data exists on effective interventions to reduce sunburn frequency and modifiable risk factors. This research aims to determine an association between 1) demographic characteristics and outdoor sunburn frequency, and 2) sunburn frequency and sun-related risk and protective factors in a nationally representative, cross-sectional household survey. Of 23,430 surveys sent, 4,883 respondents reported sunburn-related data. Association between sunburns and demographic, risk, and protective factors were examined. When assessing demographic factors, potential confounding was addressed using multivariable analysis. In multivariable models, younger, non-Hispanic White respondents were more likely to report sunburn. Those with higher income were more likely to report any sunburn, but less likely to sunburn frequently. Females were less likely to report frequent sunburns. Engagement in sporting events, outdoor events, and day-to-day activities during the most recent sunburn was more commonly reported by those with frequent sunburns as compared with those with infrequent sunburns. Sun-protection interventions targeting higher-risk demographics during time spent outdoors, at sporting events, and during other day-to-day activities may be beneficial. Further insight into risk and protective behaviors for those who did not burn could be useful to guide public health interventions.

Keywords: epidemiology, prevention, skin cancer, risk factors

Introduction

History of sunburn is commonly utilized as a proxy measure for skin cancer risk evaluation owing to the long latency period between UV exposure and skin cancer development [1]. Despite public health prevention efforts, skin cancer rates continue to rise. Between 2002-2006 and 2007-2011, the number of diagnosed cases in the US increased from 3.4 million to 4.9 million annually, with treatment costs reaching \$8.1 billion in 2011 [2].

The Surgeon General's Call to Action to Prevent Skin Cancer highlights the need for further research, surveillance, monitoring, and evaluation [3]. Prior sunburn research has primarily focused on sun-protection measures and intentional outdoor tanning [4-6]. Large-scale, nationally representative data on risk factors for outdoor sunburn is limited.

In 2019, the nationally representative Health Information National Trends Survey 5 (HINTS 5) Cycle 3 added questions directly related to participants' most recent sunburn and collected new information on sunburn risk factors as well as protective factors. The current study used the newly-available data to examine the association between 1) demographic characteristics and outdoor sunburn frequency, and 2) sunburn frequency and sun exposure-related behaviors.

Methods

The HINTS 5 cycle 3 data were collected from January 22 to April 30, 2019 using paper or web-based surveys, as detailed in the HINTS methodology

report [7]. Of the 23,430 surveys sent out, 5,590 were returned and 5,438 were deemed eligible after removal of duplicates and incomplete responses, with a participation rate of 30.3%. No institutional review was required for this analysis of non-identifiable publicly available data as determined by the Emory University Institutional Review Board.

Sunburn frequency was quantified based on the question "During the past 12 months, how many times have you had a sunburn (even a small part of your skin turns red or hurts for 12 hours or more) from too much sun exposure?" Responses were categorized as any versus no sunburn within the past 12 months. Respondents who reported sunburns were further subcategorized as having infrequent sunburns (1-3 times within the past 12 months) or frequent sunburns (4+ times within the past 12 months), [4].

Descriptive data included information on age, gender, marital status, annual income, cancer history, family cancer history, general health, and sexual orientation. Risk factors for sunburns were determined by the question "On the most recent time you were sunburned, what were you doing when you were sunburned?" Responses were categorized as outside work (at one's job, home or a family/friend's home), sunbathing, exercise (swimming or general exercise), and leisure (attending outdoor events and other day-to-day activities). Protective factors were determined by the question "The most recent time you got sunburned, were you doing any of the following things to protect yourself from the sun?" and included using sunscreen, staying in the shade, and/or wearing protective clothing. Alcohol use was determined by the question "Were you drinking alcohol at any of the times when you were sunburned?" Information on risk and protective factors was only collected for those who reported any sunburns.

Prevalence estimates for sunburns were calculated using jackknife replicate weights to provide nationally representative results. A quasi-randomization weighing approach, which is the most widely-accepted weighing approach for unit non-response, was used to adjust for household non-response [7]. Association between any sunburns and

demographic characteristics were examined using Rao-Scott chi-square test. Multivariable logistic regression models included all factors that were associated with sunburns with $P < 0.20$ in bivariate analyses. A backward stepwise approach was employed to reach parsimonious models that retained all factors significantly associated with sunburn with $P < 0.05$. Age, sex, and race/ethnicity were determined a priori as confounders and subsequently re-added to final models after the most parsimonious model was determined. First-order interaction terms were examined. Distributions of risk factors and protective factors for sunburns and alcohol use were compared between those with frequent and infrequent sunburns using Rao-Scott chi-square tests. Analyses were performed using SAS 9.4 (Cary, NC) with $P < 0.05$ in two-sided tests considered significant.

Results

Among 5,438 survey respondents, 4,883 (89.9%) reported sunburn data. Of these, 1,491 (weighed prevalence, 36.8%) reported any sunburn in the past 12 months. No significant differences in sunburn prevalence by paper and web-based survey methods were noted. Among those with any sunburn, 249 (18.9%) reported frequent sunburns in the past 12 months. Compared with respondents without sunburns, those who reported any sunburn were more likely to be younger, non-Hispanic White, not married, and in excellent or very good health. They also reported annual household income greater than \$75,000 and no previous history of cancer (each $P < 0.05$, [Table 1](#)). Respondents reporting frequent and infrequent sunburns differed with respect to age, marital status, and income.

In the multivariable analysis, higher odds of any sunburns were associated with younger age, non-Hispanic White ethnicity, higher income, and excellent self-reported health, whereas lower odds of any sunburns were associated with poor self-reported health ([Table 2](#)). Higher odds of frequent sunburns, as compared with infrequent sunburns, were associated with younger age, male sex, and higher income.

Exercise was the most common risk factor (47.6%, **Table 3**) and sunbathing was the least common risk behavior engaged in during the most recent sunburn (18.6%). Sunscreen was the most common protective factor utilized during the most recent burn (56.7%). Approximately 22% of participants reported alcohol use during a burn. Compared to

Table 2. Demographic factors associated with sunburn (any versus none) and (frequent versus infrequent) within the past 12 months.

Predictors	Any versus no sunburn ¹	Frequent versus infrequent sunburn ²
	OR (95% CI) ³	OR (95% CI)
Gender		
Male	ref	ref
Female	0.87 (0.65-1.16)	0.56 (0.34-0.94)
Age		
18-34	ref	ref
35-64	0.43 (0.30-0.61)	0.41 (0.26-0.65)
65+	0.12 (0.07-0.16)	0.50 (0.24-1.01)
Race/Ethnicity		
Non-Hispanic White	ref	ref
Non-Hispanic Black or Other	0.19 (0.13-0.30)	1.53 (0.27-8.67)
Hispanic	0.48 (0.32-0.72)	0.74 (0.35-1.55)
Income		
0-34,999	ref	ref
35,000-74,999	1.55 (1.03-2.32)	0.36 (0.17-0.79)
75,000+	2.58 (1.78-3.76)	0.26 (0.12-0.56)
General Health		
Excellent	ref	--
Very Good	1.71 (1.14-2.57)	--
Good	1.38 (0.90-2.12)	--
Fair	0.87 (0.52-1.46)	--
Poor	0.43 (0.12-1.48)	--

¹Parsimonious model with gender added based on a priori criteria.

²Parsimonious Model with race added based on a priori criteria.

³CI, confidence interval.

those with infrequent sunburns, those with frequent sunburns were more likely to report engaging in leisure activity during the most recent sunburn (P=0.01). Subgroup analysis showed significant associations for sporting events (P=0.04), outdoor events (P=0.04), and day-to-day activities (P≤0.001). No difference was found in protective factors or alcohol use between those with infrequent burns and those with frequent burns.

Discussion

In this nationally representative study, 36.8% of respondents reported any sunburn in the past 12 months overall, with notable differences by sociodemographic characteristics such as age, race/ethnicity, and income. Exercise was the most commonly reported risk factor, which aligns with prior research that has demonstrated an association between aerobic exercise and sunburn [5]. In addition, low levels of sunburn protection behaviors were found in outdoor athletes such as runners [8]. A novel finding is that leisure activity during the most recent burn was reported significantly more often in those who experienced frequent sunburns, thus providing a target for future public health interventions. Sparse data exist on current interventions for attending outdoor sporting events, outdoor events, and day-to-day activities [9]. Sunbathing was the least commonly reported risk factor among those with frequent sunburn, which may be influenced by survey administration occurring during the spring. Previous research suggests 9.5% of the population engage in intentional sun tanning [6]. Occupational exposure is a risk factor for squamous cell carcinoma [10]. Interventions such as the "Sun Safe Workplace" improved sun protection behaviors in workers [11].

Study limitations include cross-sectional design which limits causal inferences from the observed results. Self-reported data on sunburns and their determinants still require validation. In addition, future longitudinal investigation of behavioral risk and protective factors, both for those with and without sunburns, are warranted.

Table 3. Risk factors and protective factors reported by respondents who reported infrequent versus. frequent sunburns within the past 12 months.

Risk factor		Infrequent Sun-burner (1-3 burns)	Frequent Sun-burner (4+ burns)	P value
Outside Work	N (weighted %)	N (weighted %)	N (weighted %)	0.06
Yes	574 (38.5)	455 (35.9)	119 (49.5)	
No	908 (61.5)	783 (64.1)	125 (50.5)	
Sunbathing				0.29
Yes	257 (18.6)	204 (17.6)	53 (23.0)	
No	1225 (81.4)	1034 (82.4)	191 (77.0)	
Exercise				0.33
Yes	685 (47.6)	553 (46.2)	132 (53.5)	
No	797 (52.4)	685 (53.8)	112 (46.5)	
Leisure				0.0143
Yes	576 (35.2)	439 (32.7)	137 (46.4)	
No	906 (64.8)	799 (67.3)	107 (53.6)	
Protective Factors				
Sunscreen				0.97
Yes	828 (56.7)	690 (56.7)	138 (56.9)	
No	650 (43.3)	543 (43.3)	107 (43.1)	
Protective Clothing				0.45
Yes	312 (17.9)	251 (18.4)	61 (15.7)	
No	1166 (82.1)	982 (81.6)	184 (84.3)	
Shade				0.71
Yes	308 (20.3)	246 (20.0)	62 (21.6)	
No	1170 (79.7)	987 (80.0)	183 (78.4)	
Any				0.50
Yes	1015 (67.4)	810 (68.2)	175 (63.8)	
No	463 (32.6)	393 (31.8)	70 (36.2)	
None				0.33
Yes	320 (21.7)	267 (22.5)	53 (18.4)	
No	1158 (78.3)	966 (77.5)	192 (81.6)	
Alcohol Use				0.23
Yes	292 (21.9)	216 (20.8)	76 (26.7)	
No	1181 (78.1)	1013 (79.2)	168 (73.3)	

Conclusion

Sunburns occur frequently in this nationally representative sample. Promotion of behaviors that are protective against sunburn, such as use of sunscreen during exercise and outdoor leisure activities, may offer additional avenues for public health interventions to reduce sunburns and skin cancer risks.

Potential conflicts of interest

Dr. Yeung has previously received honorarium from

Syneos Health. Dr. Goodman, Mr. Adler, and Ms. Braun have no interests to disclose.

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Table 1. Demographic characteristics of respondents with never versus. any sunburn within the past 12 months and infrequent versus. Frequent sunburn within the past 12 months.

	Never sunburned within past 12 months	Any Sunburn within past 12 months		Infrequent Sunburners (1-3 sunburns within past 12 months)	Frequent Sunburners (4+ sunburns within past 12 months)	
	N (weighted %)	N (weighted %)	P value	N (weighted %)	N (weighted %)	P value
Total	3392 (63.2)	1491 (36.8)		1242 (81.1)	249 (18.9)	
Gender¹						
Male	1345 (47.2)	692 (51.0)	0.13	562 (49.3)	130 (58.3)	0.15
Female	2003 (52.8)	793 (49.0)		675 (50.7)	118 (41.7)	
Age¹			<0.0001			0.0017
18-34	277 (17.9)	366 (36.9)		281 (31.3)	85 (55.6)	
35-64	1572 (55.8)	874 (56.3)		750 (60.8)	124 (37.3)	
65+	1470 (26.3)	234 (7.8)		196 (7.9)	38 (7.1)	
Race/ethnicity¹			<0.0001			0.51
Non-Hispanic White	1766 (57.3)	1137 (79.0)		952 (79.2)	185 (78.2)	
Non-Hispanic Black or Other	821 (24.5)	117 (8.2)		93 (7.3)	24 (12.0)	
Hispanic	473 (18.2)	171 (12.8)		146 (13.5)	25 (9.8)	
Sexual orientation			0.10			0.07
Heterosexual, other or missing	3280 (96.6)	1416 (94.5)		1186 (95.5)	230 (90.4)	
Sexual Minority (gay, lesbian, bisexual)	112 (3.4)	75 (5.5)		56 (4.5)	19 (9.6)	
Marital status			0.0015			0.0015
Never Married or missing	738 (33.6)	398 (40.5)		307 (36.4)	91 (58.4)	
Ever Married	2654 (66.4)	1093 (59.5)		935 (63.6)	158 (41.6)	
Household income¹			<0.0001			0.0396
0-34,999	1068 (34.6)	243 (17.6)		181 (13.6)	62 (34.3)	
35,000-74,999	962 (32.6)	413 (28.0)		342 (28.5)	71 (26.0)	
75,000+	1001 (32.8)	735 (54.5)		631 (57.9)	104 (39.7)	
General health^{1,2}			<0.0001			0.92
Excellent	390 (13.4)	198 (12.2)		162 (12.1)	36 (12.6)	
Very Good	1136 (32.1)	648 (45.7)		551 (45.8)	97 (46.0)	
Good	1243 (36.2)	493 (33.7)		404 (33.5)	89 (34.6)	
Fair	482 (15.4)	131 (7.5)		109 (7.9)	22 (5.9)	
Poor	93 (2.9)	10 (0.7)		6 (0.6)	4 (0.9)	

Cancer history²			0.0007			0.54
None + missing	2786 (91.1)	1329 (94.8)		1106 (95.0)	223 (93.9)	
Melanoma and NMSC	186 (3.3)	69 (2.5)		59 (2.6)	59 (2.0)	
Non-skin cancers	328 (5.6)	70 (2.8)		57 (2.5)	13 (4.1)	
Family cancer history			0.07			0.33
Yes	2327 (67.2)	1131 (71.7)		949 (73.2)	182 (65.4)	
None + missing	1065 (32.8)	360 (28.3)		293 (26.8)	67 (34.6)	

¹Missing data for all covariates unless otherwise specified were less than <10%. We presented complete case analysis.

²Percentages may not add up to 100 due to rounding.