The epidemiology of sunburn in the US population in 2003

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Background: Sunburn is a major preventable risk factor for skin cancer.

Objective: We investigated risk factors for sunburn in the United States based on the 2003 Behavioral Risk Factor Surveillance System.

Design and methods: A random sample of 207,776 respondents provided data for the population-based survey. The main outcome measure was any report of sunburn within the previous 12 months.

Results: Overall, 39% of respondents had at least one sunburn. The strongest factors associated with sunburn were age and socioeconomic factors. Sunburn prevalence was greatest in respondents 18 to 24 years old (61%). This group was more likely to have a sunburn than respondents 45 to 54 years of age (odds ratio [OR] = 2.76). Higher income and higher levels of education were positively associated with sunburn (OR 1.67 and 1.63, respectively). Individuals reporting recent binge drinking had a higher prevalence of sunburn (OR = 1.33).

Limitations: The Behavioral Risk Factor Surveillance System does not include data on skin type or sun protection behavior; therefore the impact of these factors was not assessed.

Conclusion: Sunburn occurs at a very high rate in the United States. (J Am Acad Dermatol 2006;55:577-83.)

Skin cancer is the most common malignancy in the United States.[1] Malignant melanoma, the deadliest form of skin cancer, is the most rapidly increasing malignancy in the United States. The risk of malignant melanoma developing in an American has now reached 1 in 87 (up more than 1800% since the 1930s).[2] In 2004, 59,100 new cases of malignant melanoma were diagnosed in the United States and 7910 deaths were attributed to melanoma.[3] The overall cost of melanoma treatment is expected to exceed $5 billion by 2010.[2] Nonmelanoma skin cancer (NMSC; basal cell and squamous cell carcinoma) have relatively minimal associated mortality, but are of substantial public health importance because they affect over one million Americans per year and are associated with potential disfigurement leading to impairment in health-related quality of life.[4] Additionally, NMSC creates substantial economic burden and is one of the top 5 most costly malignancies for Medicare.[5]

Abbreviations used:

BRFSS:	Behavioral Risk Factor Surveillance System
CASRO:	Council of American Survey Research Organizations
CATI:	computer-assisted telephone interview
CDC:	Center for Disease Control and Prevention
CI:	confidence interval
NMSC:	nonmelanoma skin cancer
OR:	odds ratio

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Epidemiologic and laboratory studies have consistently demonstrated that sun exposure is a major preventable risk factor for malignant melanoma and NMSC.[6-9] Individuals with a history of sunburn have an approximate two-fold increased risk of malignant melanoma compared with those with no history of sunburn.[10-14] Furthermore, history of sunburn has also been independently associated with NMSC.[15,16] Although the association between sunburn and squamous cell carcinoma is less consistent, reported odd ratios (ORs) associated with the risk of basal cell carcinoma have ranged from 1.3 in individuals reporting adult sunburns to 2.6 among individuals reporting childhood sunburns.[15-18] In addition, the acute morbidity associated with sunburn may contribute to lost workdays and can account for more than an estimated $10 million per year in wages lost.[19]

The purpose of this study is to determine the prevalence of and risk factors for sunburn in the United States using the Center for Disease Control and Prevention's (CDC) 2003 Behavioral Risk Factor Surveillance Survey (BRFSS).

METHODS

Questionnaire content

The CDC's BRFSS questionnaire includes questions about sociodemographic characteristics, general health status, physician encounters in the past year, smoking, alcohol use, diabetes, hypertension, and other leading diseases. In 2003, all states, the District of Columbia, and 3 territories included questions about behaviors associated with skin cancer in their survey. Questions addressed whether a respondent had experienced a sunburn (defined as any time when even a small part of the skin was red for more than 12 hours) in the 12 months preceding the interview and the number of sunburn events during that time. States are required to use standard procedures to administer the questionnaire and most interviewers use computer-assisted telephone interview (CATI) software to manage telephone dialing and data collection. The CATI standardized interview takes 10 to 20 minutes and responses are entered directly into the computer by interviewers.

Sampling techniques

A representative sample of the US population aged 18 years or older is interviewed each year to provide data for the BRFSS. Contacted households are randomly selected from a generated list of eligible telephone numbers in each state. In 2003, disproportionate stratified random sampling was implemented to conduct the BRFSS. With this method, telephone numbers are classified into either a high-density stratum (listed 1+ block telephone numbers) or a medium-density stratum (not listed 1+ block telephone numbers). The disproportionate stratified random sampling protocol was designed to yield the smallest standard error while maintaining an ideal sampling ratio consistent across states. Given the absence of data on the relative cost of interviews in the two strata, the BRFSS issued a sampling ratio of 1.5:1 (high-density:medium-density) for 2003 data, in which the listed are sampled at 1.5 times the rate of those not-listed. Participants are randomly selected from all adults aged 18 years and older who consider the household their home. Each respondent's data are weighted according to age, sex, race, region, and sampling strata. The CDC processes survey data, produces monthly and annual quality assurance reports, and provides online training for state-based BRFSS coordinators and interviewers.

The BRFSS calculated response rates based on completed and partial interviews in the numerator and eligible samples in the denominator. With the 2003 BRFSS data, response rate data were calculated and aggregated by state using two response rate methods, the Council of American Survey Research Organizations (CASRO) response rate and the overall response rate.[20] The CASRO rate calculation included partial interviews, defined as more than 50% of core questionnaire completed, while the overall response rate was more conservative and assumed that more unknown records were eligible for inclusion; thus a higher proportion of all numbers were included in the denominator. The CASRO median state response rate was 53.2%, but ranged from 34.4% to 80.5% across states. The overall median state response rate was 42.4%, with a range of 24.0% to 81.3% across states.

In terms of missing values, it should be noted that income was the variable in the survey data with the largest percentage of missing values. By state, the median percentage of respondents with income response "unknown," "refused," or both was 12.45%, with a mean of 13.21% ± 3.62%. In terms of questionnaire refusals, the BRFSS refusal rate was computed in a fashion similar to the response rates, with refused or terminated interviews before threshold considered partial interviews, and thus calculated in the numerator of the response rates, while the denominator was the same as the response rate. The median state refusal rate was 15.1%, with a range of 4.4% to 22.9% across states.

Statistical analysis

Statistical analyses were conducted using STATA for Windows 2000, Version 8.2. The main outcome measure was any report of sunburn in the 12 months

preceding the interview. The prevalence of sunburn was calculated by dividing the number of respondents reporting sunburn by the total number of respondents with adjustment for sampling procedure. The predictor variables for sunburn included sex, age, income, education, employment status, race, recent physician care, and behavior factors such as drinking and smoking. Assessment for magnitude of association was conducted using logistic regression and multivariable logistic regression with adjustment for sampling probabilities, age, gender, and appropriate variables. To determine the final regression model, F tests were used to assess which variables were significant contributors to sunburn risk. F test was used when the logistic regression was adjusted for survey sampling using weights. Variables with insufficient observations were excluded from the final regression model.

RESULTS

Characteristics of study population

In 2003, 248,042 respondents from the continental United States provided sunburn data for the BRFSS. Of these individuals, 84.4% self-identified as white and these individuals were included in the analysis. The characteristics of the whites in the BRFSS population are shown in Table I. The sample consisted of 40% men and 60% women, with a mean age of 50 years (range, 18-99 years). Each respondent's data are weighted according to age, sex, race, region, and sampling strata. After weighting the data, the sample represented 48.2% male and 51.8% female subjects, with a mean age of 46.7 years. A median of 53.2% (minimum 34.4%, maximum 80.5%) of eligible households completed an interview in its entirety or up to the threshold required for a partial interview. Eligible households include units with active telephone numbers (businesses and nonworking numbers are excluded) in the United States. Of the households contacted, the median refusal rate was 15.1% (minimum 4.4%, maximum 22.9%). Of those persons who agreed to be surveyed, 99.6% answered the question about sunburn.

Table I. Characteristics of BRFSS population (N = 207,776)

Variable	No.	Unweighted %	Weighted %
Sex			
Male	83,273	39.7	48.2
Female	126,693	60.3	51.8
Mean age, y (SD/SE)		50.1 (17.5)	46.7 (0.07)
Age (y)			
18-24	12,884	6.1	11.8
25-34	29,466	14.0	16.6
35-44	40,074	19.1	19.9
45-54	44,664	21.3	19.1
55-64	34,673	16.5	14.0
65-74	26,548	12.6	9.4
≥ 75	21,657	10.3	9.1
Region			
Northeast	49,871	23.8	21.1
Southeast	34,513	16.4	18.0
South	24,206	11.5	13.3
Midwest	53,768	25.6	25.9
West	47,608	22.7	21.7
Interview season			
Winter	49,522	23.6	23.6
Spring	56,913	27.1	27.5
Summer	51,454	24.5	24.4
Fall	52,077	24.8	24.6
Education			
Did not graduate HS	19,058	9.1	10.3
Graduated HS	64,143	30.6	30.3
Some college	57,493	27.4	27.3
Graduated college	68,892	32.9	32.1
Income			
$0 to <$20,000	19,054	10.4	9.4
$20,000 to <$25,000	31,625	17.3	16.0
$25,000 to <$35,000	26,017	13.3	13.5
$35,000 to <$50,000	33,764	18.5	17.9
≥ $50,000	72,057	39.5	43.2
Employment status			
Unemployed	18,322	8.8	9.0
Student	5,095	2.4	4.1
Homemaker	17,465	8.3	8.4
Retired	45,323	21.6	17.8
Employed	123,292	58.9	60.8

HS, High school; *SD,* standard deviation; *SE,* standard error.

Prevalence of sunburn

In 2003, 39% of respondents from the continental United States reported having at least one sunburn in the 12 months before the interview. In addition, 26% of BRFSS respondents had two or more sunburns in the previous 12 months, 15% had 3 or more sunburns, and 9% had 4 or more sunburns. Sunburn prevalence was highest in respondents between 18 and 24 years old and was lowest in respondents 75 years of age or older (61.1%, $P < .001$ and 5.8%, $P < .001$, respectively) (Table II). A total of 44.2% male respondents reported at least one sunburn compared with 34.1% of female respondents ($P < .001$). In addition, participants questioned during the summer months and respondents from the Midwest had the highest prevalence of sunburn (42.0%, $P < .001$ and 43.8%, $P < .001$, respectively). Individuals in the highest income strata and educational strata had the highest report of sunburn (47.7%, $P < .001$ and 43.8%, $P < .001$, respectively) (Table II). Participants reporting high levels of alcohol use and smokers had a higher prevalence of sunburn than their

Table II. Prevalence of sunburn by age, sex, regional and seasonal characteristics, socioeconomic (race, education, income, employment) status, and by health-associated behavioral characteristics

Variable	Sunburn % (No.)
BRFSS respondents	38.9 (74,313)
Sex*	
Male	44.2 (34,323)
Female	34.1 (39,990)
Age (y)*	
18-24	61.1 (7,955)
25-34	54.8 (16,560)
35-44	50.5 (20,328)
45-54	38.1 (16,780)
55-64	24.4 (8,121)
65-74	14.2 (3,392)
≥ 75	5.8 (1,177)
Region*	
Northeast	38.8 (17,805)
Southeast	35.8 (10,475)
South	33.8 (7,404)
Midwest	43.8 (20.107)
West	39.3 (18,522)
Interview season*	
Winter	36.1 (16,194)
Spring	37.3 (19,185)
Summer	42.0 (19,531)
Fall	40.3 (19,403)
Education*	
Did not graduate HS	25.2 (4,105)
Graduated HS	35.5 (20,319)
Some college	42.2 (21,757)
Graduated college	43.8 (28,065)
Income*	
$0 to <$20,000	28.3 (4,512)
$20,000 to <$25,000	30.5 (8,816)
$25,000 to <$35,000	35.6 (8,791)
$35,000 to <$50,000	42.2 (13,422)
≥ $50,000	47.7 (32,237)
Employment status*	
Unemployed	33.0 (5,369)
Student	63.1 (3,086)
Homemaker	29.8 (5,279)
Retired	12.8 (5,417)
Employed	47.1 (55,044)
Saw doctor 12 mo ago†	
Yes	39.6 (4,489)
No	40.8 (2,143)
Heavy drinking*	
Yes	50.3 (5,073)
No	38.2 (68,772)
Binge drinking*	
Yes	56.9 (14,823)
No	35.5 (59,083)
Smoking*	
Current smokers	42.3 (16,842)
Former and never smoked	38.0 (57,349)

BRFSS, Behavioral Risk Factor Surveillance System; *HS,* high school.
*$P < .001$.
†$P = .375$ (χ^2 test).

counterparts (56.9% vs 35.5%, $P < .001$ and 42.3% vs 38.0%, $P < .001$, respectively) (Table II).

Risk factors for sunburn

The final regression model was based on 177,819 subjects with complete data for all variables in the model (85.6% of sunburn respondents). The strongest factors associated with sunburn were age and socioeconomic factors (education, income, and employment status). Although the associations with education, income, and employment status were attenuated after adjusting for confounders such as age and alcohol use, they were still positively associated with sunburn (Table III). Individuals in the highest income strata (≥ $50,000) were more likely to report sunburn than those in the lowest income strata (<$20,000) (OR 1.67, 95% confidence interval [CI]: 1.52-1.84) and respondents with a college degree were more likely to report sunburn than those without a high school degree (OR, 1.63; 95% CI, 1.48-1.79). Students were more likely to sunburn than those who were unemployed (OR, 1.44; 95% CI, 1.23-1.67), and employed respondents were slightly more likely to report sunburn than unemployed respondents (OR, 1.19; 95% CI, 1.09-1.29). Although in univariable analysis retired respondents were less likely to sunburn than those unemployed, there was no difference between retired and unemployed respondents in the adjusted model. There was no effect of having seen a doctor in the past 12 months on the odds of sunburn (OR, 0.95; 95% CI, 0.85-1.69) in univariable analyses. The impact of having seen a physician on the odds of experiencing a sunburn was not determined using multivariable logistic regression as this question was included in less than 10% of those persons surveyed in 2003.

The association between alcohol use and sunburn was decreased after adjustment for other factors. Before adjustment, the association of heavy drinking (>2 drinks per day for men, and 1 drink per day for women) and binge drinking (at least one episode of >5 drinks in one night within the past 30 days) with sunburn was 1.64 (95% CI, 1.52-1.76) and 2.40 (95% CI, 2.29-2.52), respectively. The association of sunburn with heavy drinking was decreased (OR, 1.10; 95% CI, 1.00-1.21) and was also decreased for respondents reporting recent binge drinking (OR, 1.33; 95% CI, 1.25-1.41). In contrast, the association between age and sunburn prevalence increased after adjusting for other potential confounders. After adjustment for other factors, there was a greater association between the 18- to 24-year-old age group and sunburn than the 45- to 54-year-old age group (2.54 [95% CI, 2.37-2.74] to 2.76 [95% CI, 2.53-3.03]).

DISCUSSION

The results of this study demonstrate that sunburn is very common in the United States. These results are compelling as they are derived from interviews with almost 210,000 people who are broadly representative of the US population. On the basis of our finding of 39% sunburn prevalence, we estimate that more than 73 million Americans experienced at least one sunburn in 2003.[21] Sunburn prevalence was highest among individuals between 18 and 24 years old, men, students, alcohol users, and individuals in higher socioeconomic groups. The strongest predictors of sunburn behavior were age, education, income, and employment status. In a study of respondents to the 1999 BRFSS, the sunburn prevalence (at least one sunburn in the past year) was reported to be 31.7%.[22] Our finding of 39% sunburn prevalence demonstrates a 22% increase in the prevalence of sunburn in the 4 years since the 1999 BRFSS study, despite enhanced education efforts.[23-26]

The finding that sunburn prevalence was highest among the youngest age group (61% in 18- to 24-year-olds) is comparable to those findings of studies investigating sunburn prevalence among adolescents and sun exposure in large populations.[27,28] In 1999, the highest prevalence was also found among BRFSS respondents in the youngest age group and a Swedish study of 13- to 50-year-olds, found that 55% of adolescents reported a sunburn as a result of outdoor tanning during the 12 months preceding the study.[29] Although these studies indicate differences in sunburn prevalence based on age, a Denmark study evaluating ultraviolet radiation dosage among Copenhagen residents found no difference in cumulative yearly ultraviolet radiation exposure by 27 years of age. Our study also found that individuals in the highest income strata were more likely to report sunburn than those in the lowest income strata (OR, 1.67). This finding is consistent with the analysis of 1999 BRFSS data in which the highest income group reported the most sunburns (46%) and demonstrated the highest risk of sunburn (OR, 1.7).[22] In addition, a study of Illinois adolescents 11 to 19 years of age found that the high-income group (household income, ≥ $55,000) reported twice the number of sunburns in the past year than the low-income group (<$25,000 per year).[30]

Other socioeconomic factors indicating sunburn risk in our study population were education and employment status. Students and individuals with a college education demonstrated the largest increase prevalence of sunburn (OR, 1.44 and 1.63, respectively) compared with respondents without a high school diploma and unemployed respondents. The increased prevalence of sunburn in individuals from

Table III. Risk factors for sunburn

Variable	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Sex	1.53 (1.48-1.58)*	1.33 (1.28-1.39)†
Age (y)		
18-24	2.54 (2.37-2.74)*	2.76 (2.53-3.03)†
25-34	1.97 (1.86-2.08)*	1.99 (1.87-2.11)†
35-44	1.65 (1.57-1.74)*	1.64 (1.55-1.73)†
45-54	Referent	
55-64	0.52 (0.49-0.55)*	0.56 (0.52-0.59)†
65-74	0.27 (0.25-0.29)*	0.36 (0.33-0.40)†
≥ 75	0.10 (0.09-0.11)*	0.15 (0.13-0.18)†
Education		
Did not graduate HS	Referent	
Graduated HS	1.64 (1.52-1.76)*	1.42 (1.29-1.57)‡
Some college	2.17 (2.01-2.33)*	1.60 (1.45-1.76)‡
Graduated college	2.31 (2.15-2.48)*	1.63 (1.48-1.79)‡
Income		
$0 to <$20,000	Referent	
$20,000 to <$25,000	1.12 (1.02-1.22)*	1.05 (0.95-1.16)†
$25,000 to <$35,000	1.40 (1.28-1.53)*	1.23 (1.11-1.37)†
$35,000 to <$50,000	1.85 (1.71-2.02)*	1.44 (1.311.59)†
≥ $50,000	2.31 (2.14-2.49)*	1.67 (1.52-1.84)†
Employment status		
Unemployed	Referent	
Student	3.47 (3.07-3.91)*	1.44 (1.231.67)‡
Homemaker	0.86 (0.79-0.94)§	0.96 (0.86-1.06)‡
Retired	0.30 (0.28-0.32)*	0.97 (0.87-1.10)‡
Employed	1.80 (1.69-1.93)*	1.19 (1.09-1.29)‡
Region		
Northeast	Referent	
Southeast	0.88 (0.84-0.92)*	0.88 (0.83-0.93)†
South	0.80 (0.76-0.85)*	0.86 (0.80-0.93)†
Midwest	1.23 (1.18-1.28)*	1.25 (1.19-1.32)†
West	1.02 (0.97-1.08)‖	0.97 (0.91-1.04)†
Interview season		
Winter	Referent	
Spring	1.05 (1.00-1.10)¶	1.03 (0.91-1.04)†
Summer	1.28 (1.22-1.34)*	1.34 (1.27-1.42)†
Fall	1.19 (1.14-1.25)*	1.25 (1.18-1.32)†
Heavy drinking	1.64 (1.52-1.76)*	1.10 (1.00-1.21)#
Binge drinking	2.40 (2.29-2.52)*	1.33 (1.25-1.41)†
Current smokers	1.20 (1.15-1.25)*	0.93 (0.89-0.98)‡
Saw doctor 12 mo ago	0.95 (0.85-1.06)**	Insufficient observations

CI, Confidence interval; *HS,* high school; *OR,* odds ratio.
*$P < .001$.
†$P = .00$.
‡$P = .01$.
§$P = .001$.
‖$P = .477$.
¶$P = .035$.
#$P = .05$.
**$P = .375$.

higher socioeconomic strata may be explained by the tendency of these individuals to have greater opportunities to travel to tropical destinations than their counterparts, as discussed in a recent study of tourist attitudes toward the sun in northern Greece.[31]

The current study also demonstrates that individuals reporting recent binge drinking were more likely to sunburn than their counterparts (OR, 1.33). In a study of beachgoers in Galveston, Texas, 23% of the sunburned subjects reported alcohol use while at the beach and these individuals were more likely to have greater body surface area sunburned (42% vs 26%; $P = .001$), blistering (31% vs 5%; $P = .02$), and postsunburn analgesic use (69% vs 26%; $P = .007$) associated with their sunburn than individuals reporting no alcohol use.[19] Finally, our study demonstrates no association between having seen a doctor in the previous 12 months and having a sunburn during that time. This finding suggests that physicians are not successfully educating patients about the risks of sunburn and altering patient behavior. This observation is not surprising given the low physician-reported rates of skin cancer education administered by physicians and the low proportion of surveyors who report receiving skin cancer education from medical professionals.[4,32] Our finding of no association between physician visits and sunburn risk differs from the 1999 BRFSS analysis in which they found a very modest protective effect of physician visits on the likelihood of white respondents experiencing a sunburn (OR, 0.90).[22] This result is supported by a Canadian study examining barriers to sunburn protection that found compliance and knowledge about sun safety measures was increased when subjects were counseled by a physician about sun safety ($P < .025$).[33] Taken together, these studies indicate that greater efforts on behalf of physicians are necessary to promote behavioral change and compliance with safer sun exposure methods.

As with all studies, there are limitations to consider. Although we adjusted our analyses to include only white respondents, direct data on skin type were not collected. Therefore it is possible that some of the risk factors for sunburn behavior we identified may be confounded by skin type. Nevertheless, our observations are important for identifying individuals most likely to engage in sunburn behavior for prevention efforts. Second, a higher prevalence of sunburn among subjects interviewed during the summer months was observed, suggesting that recall bias may have occurred. It is likely that individuals interviewed during the winter and fall months underreported episodes of sunburn, thereby leading to an underestimation of the prevalence of sunburn in this population. The generalizability of the results to the entire US population may be limited by the BRFSS sampling procedure, requirement of having a telephone, and the overall response rate (52%). Additionally, we did not have complete data on income (missing in 12.45% of respondents); however, our results with respect to the impact of income on sunburn behavior are similar to those of previous reports.[22,30,31]

Sunburn occurs at a very high rate in the United States, demonstrating the need for greater efforts to reduce sun exposure. This study indicates that young adults, students, and individuals of high socioeconomic status should be targeted for educational campaigns, as they are most likely to engage in sunburn behavior. Greater efforts by public health officials and physicians are necessary to reduce the very high prevalence of sunburn in the United States and, it is hoped, will lead to a reduction in sunburn-associated costs, skin cancer incidence, and mortality associated with melanoma.

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