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Hat, shade, long sleeves, or sunscreen? Rethinking US sun protection messages based on their relative effectiveness

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Abstract

Background—Sun protection messages in the United States emphasize sunscreen use, although its efficacy in skin cancer prevention remains controversial.

Methods—We used data from NHANES 2003–2006, restricted to adult whites (n = 3,052) to evaluate how Americans protect themselves from the sun. Participants completed questionnaires on the frequency with which they used sunscreen, wore a hat, long sleeves, or stayed in the shade, in addition to the number of sunburns in the past year.

Results—Although using sunscreen is the most common sun protective behavior (30%), frequent sunscreen use was not associated with fewer sunburns. However, the odds of multiple sunburns were significantly lower in individuals who frequently avoided the sun by seeking shade (OR = 0.70, $p < 0.001$) or wearing long sleeves (OR = 0.73, $p = 0.01$).

Conclusions—Our findings suggest that shade and protective clothing may be more effective than sunscreen, as typically used by Americans.

Keywords

Sunprotection; Sunscreen; Skin cancer; Sunburn

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Impact These findings highlight the need for comprehensive prevention strategies given the persistent rising rates of skin cancer in the United States.

Introduction

Sun protection messages in the United States have emphasized sunscreen use [1–3], more than sun avoidance or wearing protective clothing. However, the efficacy of sunscreen for skin cancer prevention remains controversial. International sun protection programs including the successful Australian SunSmart program have emphasized sun avoidance and protective clothing with sunscreen use complementing but not replacing these methods [4, 5]. Although it is clear that sunscreen is effective in blocking UVB and preventing sunburn in controlled conditions and can prevent actinic damage and squamous cell carcinoma (SCC) [6, 7], it is unclear how effective sunscreen is as typically used by the general population. Assessing the efficacy of sunscreen or skin cancer prevention is further complicated by the fact that sunscreen is often applied prior to prolonged outdoor sun exposure[8–10] and by individuals with risk factors such as fair skin or a personal or family history of skin cancer.

To our knowledge, no study to date has examined how Americans protect themselves from the sun or the relative effectiveness of different sun protective behaviors on sunburns. Our objectives were (a) to describe the prevalence of sun protective behaviors in the US and (b) to evaluate the association between sunburn and different sun protective behaviors including wearing sun protective clothing, shade use, and sunscreen, as typically used by Americans.

Materials and methods

The National Health and Nutrition Examination Survey (NHANES) is a biennial, nationally representative, cross-sectional survey including data collected via household interviews and standardized physical examinations conducted in specially equipped mobile examination centers [11]. We restricted our analysis to adult participants (aged 20–60) during two NHANES cycles 2003–2004 and 2005–2006 where self-reported sun protection information was collected. A total of 20,470 individuals were surveyed by NHANES, and the dermatology questionnaire was administered to a random subset (n = 6,549). We restricted our analysis to non-Hispanic whites (n = 3,052). Complete data were available for 2,338 individuals.

Participants were asked the following questions; “When you go outside on a very sunny day, for more than 1 h, how often do you: (a) stay in the shade? (b) wear a hat that shades your face ears and neck? (c) wear a long sleeved shirt? (d) use sunscreen?.” Possible answers included are as follows: never, rarely, sometimes, most of the time, or always. In order to have intuitive categories and stable estimates, we collapsed these responses into three prespecified frequency categories: rare (never or rarely), moderate (sometimes), and frequent (most of the time or always). Participants were also asked “How many times in the past year have you had a sunburn?” These were divided into 0, 1, and ≥2 (multiple).

Logistic regression comparing multiple to no sunburns was performed using each of the sun protection variables as exposure variables. Multivariate analyses were adjusted for age, gender, BMI, sun sensitivity, physical activity compared to peers, income, education, season, and binge alcohol drinking. p values are two sided. All analyses were adjusted for weighted sampling technique (STATA 10.0 SVY) making results applicable to the entire US population. Missing data were excluded.

Results

The most common sun protective behavior used by white adult Americans is sunscreen, with over 30% of individuals reporting frequently using sunscreen when in the sun for more than 1 h. While 25% of Americans frequently stay in the shade, only 16% regularly wear a hat, and 6% report frequently wearing long sleeves. Over half of white Americans report at least one sunburn, and 26% reported two or more sunburns in the past year. Table 1 shows the demographic and sun protection characteristics of white Americans according to number of sunburns.

Table 2 presents the multivariate-adjusted odds ratio of multiple sunburns, among individuals who frequently engaged in sun protective behaviors compared to those who rarely did so. The odds of multiple sunburns were significantly lower in individuals who frequently avoided the sun by seeking shade (OR = 0.70, 95% CI 0.58, 0.83, $p < 0.001$) and in those who frequently wore long sleeves (OR = 0.73, 95% CI 0.57, 0.93, $p = 0.01$). Frequent sunscreen use was associated with higher odds of multiple sunburns (OR = 1.23, 95% CI 1.06, 1.42, $p = 0.01$). Hat use was not associated with multiple sunburns (OR = 0.91, 95% CI 0.78, 1.07, $p = 0.15$).

Discussion

Our results indicate that despite being the most common sun protective behavior used by white Americans, sunscreen use is not associated with fewer sunburns. On the other hand, frequent shade and long sleeve use are associated with fewer self-reported burns in this population. These results raise important questions about the relative efficacy of these sun protective behaviors.

The major limitations of this study are the cross-sectional design and the lack of information on individual sun exposure habits. For example, pale individuals who are more susceptible to sunburn could very plausibly also use more sunscreen. Although we did not have information on individual sun exposure habits, we attempted to reduce the impact of these potential sources of bias by restricting our analysis to whites, adjusting for sun sensitivity, physical activity, and other socioeconomic factors. Furthermore, because all sun protective behaviors examined were self-reported by the same participants, we would expect any bias due to sun exposure habits to apply to all four behaviors. Our findings persisted despite these adjustments, which could suggest that the differences noted are more likely to be real.

These findings add to the literature by providing comparative data on sun protective behaviors and are consistent with prior studies of the determinants of sunburn and prevalence of sun protection behaviors in the US [12–14]. Previous analyses in NHANES demonstrated an inverse association of frequent shade and long sleeve use with lower serum 25-hydroxyvitamin D levels, which is a proxy for UV exposure. Interestingly, frequent sunscreen use was directly associated with *higher* vitamin D levels (Linos et al. submitted), which further supports the present findings. Prior studies have shown that sunscreen is rarely applied as thickly as recommended (2 mg/cm^2) and that sunscreen use associated with higher sun exposure [8–10]. Taken together, these findings could suggest that shade and long sleeve use may be more effective at reducing UV exposure than sunscreen, as typically used by the American population.

The goal of any health policy should be to reduce overall burden of disease, and hence both the risks of skin cancer (especially melanoma) and benefits of vitamin D [15] must be considered when making sun protection recommendations. This trade-off has been explored in a thoughtful way by several scientists [16–18]. Although both UVA and UVB are

involved in skin carcinogenesis, only UVB is required for vitamin D synthesis, so it may be possible to take advantage of this difference to create tailored sun protection recommendations for different latitudes, times of day, or seasons [19–21]. Interestingly, a recent study showed that shade use may differentially filter UVA over UVB light, making this another optimal way to sun protect while ensuring adequate vitamin D synthesis [22].

While sunscreen use may be effective in preventing SCC [7], its efficacy for melanoma prevention remains controversial [23–25], so sunscreen should not be the sole recommended agent used for sun protection. Since barrier methods including clothing and shade are generally more effective than sunscreen in reducing exposure to solar UV, greater emphasis should be placed on these approaches. Adopting comprehensive prevention strategies such as SunSmart are a high priority to reduce excessive sun exposure given the continuing increase in melanoma [26, 27] and non-melanoma skin cancer [28]. Future strategies must go beyond education alone and address practical, environmental, and behavioral barriers to sustainable sun protection [29].

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Table 1

Demographic characteristics according to number of sunburns, NHANES 2003–2006

	Overall N (%)	Number of sunburns		
		0% (range)	1% (range)	2 + % (range)
Overall		44.3%	29.4%	26.4%
Age				
20–29	835 (22.3)	31 (26–35)	34 (30–37)	36 (32–40)
30–39	775 (23.8)	38 (33–44)	30 (26–33)	32 (28–35)
40–49	743 (29.2)	43 (39–48)	31 (27–34)	26 (23–29)
50–59	699 (24.7)	63 (59–67)	24 (20–27)	13 (11–16)
Gender				
Male	1,429 (49.4)	39 (35–43)	32 (29–35)	30 (26–33)
Female	1,623 (50.6)	49 (46–53)	27 (25–30)	23 (21–26)
Sun Sensitivity				
Severe burn	515 (16.2)	37 (32–42)	25 (21–30)	38 (34–41)
Mild burn	1,209 (40.4)	35 (32–39)	32 (29–36)	32 (29–35)
Tan	454 (14.9)	58 (52–63)	27 (22–31)	16 (12–20)
Nothing	849 (28.5)	53 (48–57)	30 (25–34)	17 (14–21)
Shade				
Rare	1, 019 (33.5)	41 (36–45)	31 (28–34)	28 (24–32)
Moderate	1,263 (41.9)	39 (35–42)	33 (30–36)	28 (26–30)
Frequent	769 (24.6)	58 (54–63)	21 (17–25)	21 (17–24)
Long sleeves				
Rare	2,471 (80.6)	42 (39–46)	30 (27–32)	28 (26–29)
Moderate	8,392 (13.8)	47 (40–55)	30 (25–35)	23 (17–28)
Frequent	161 (5.5)	57 (47–66)	25 (17–32)	19 (12–26)
Sunscreen use				
Rare	1,384 (44.4)	50 (47–53)	29 (26–32)	21 (18–23)
Moderate	733 (25.4)	34 (30–38)	32 (28–36)	34 (31–38)
Frequent	907 (30.2)	43 (40–47)	29 (26–32)	28 (25–31)
Hat				
Rare	2,105 (68.2)	44 (40–47)	29 (27–32)	27 (24–29)
Moderate	460 (15.8)	41 (36–47)	33 (28–39)	25 (22–29)
Frequent	459 (16.0)	47 (43–51)	26 (23–30)	26 (23–30)
Income				
$0–19.9 k	407 (9.9)	55 (49–61)	23 (17–29)	22 (18–26)
$20–39 k	697 (22.7)	46 (41–51)	29 (26–32)	25 (21–28)
$40–59 k	530 (19.6)	46 (43–50)	28 (24–31)	26 (22–30)
$60–69 k	225 (8.6)	38 (29–47)	33 (26–40)	29 (22–36)
$70+	1,042 (39.2)	41 (37–44)	32 (29–35)	28 (25–31)
Education				
Did not graduate High school	308 (8.4)	53 (46–59)	28 (23–33)	19 (14–25)

	Overall N (%)	Number of sunburns		
		0% (range)	1% (range)	2 + % (range)
High school	796 (26.4)	45 (41–50)	30 (26–33)	25 (20–30)
Some college	1,044 (35.1)	43 (39–46)	32 (28–35)	26 (23–29)
College graduate or higher	900 (30.1)	43 (39–47)	27 (24–30)	30 (27–33)
Physical activity				
Less activity than others	777 (24.0)	51 (48–54)	25 (21–28)	24 (22–27)
Same	1,276 (42.8)	44 (39–48)	31 (28–34)	26 (22–29)
More activity than others	977 (33.2)	40 (37–44)	31 (27–34)	29 (26–32)
Binge drinking				
No	2,163 (82.8)	43 (40–46)	29 (27–32)	28 (26–30)
Yes	449 (17.2)	44 (40–49)	31 (26–37)	24 (20–28)

Table 2

Odds ratio (OR) of multiple sunburns according to sun protective behaviors (Frequent use vs rare use) among US whites, 2003–2006 (*n* = 2,338).

	OR (95% CI)	*p* trend
Shade	0.70 (0.58, 0.83)	<0.001
Long sleeves	0.73 (0.57, 0.93)	0.01
Sunscreen	1.23 (1.06, 1.42)	0.01
Hat	0.91 (0.78, 1.07)	0.15

Multivariate model adjusted for age, gender, BMI, income, education, season, sun sensitivity, alcohol intake, physical activity