Research Article

Health Beliefs About UV and Skin Cancer Risk Behaviors

Cancer Control
Volume 27: 1-6

DOI: 10.1177/1073274819894008
journals.sagepub.com/home/ccx
SAGE

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Abstract

Our purpose was to examine the beliefs of college students about UV exposure and sunscreen use and their associations with skin cancer risk and protective behaviors in a cloudy climate. The sample was online survey participants (N = 334) recruited from a large university in Oregon. After fitting an initial measurement model, we fit a structural equation model including Health Beliefs About UV (HBAU) subscales (*Health Benefits of Tanning, Seasonal Effects, Tanning Through the Winter,* and *Sunscreen Toxicity*), outcome variables (sunscreen use, indoor tanning, and outdoor tanning), and covariates (eg, tanning and sunscreen use). A minority of participants held the beliefs represented by 3 HBAU subscales, but beliefs about negative health effects of the local weather (*Tanning Through the Winter*) were common. The measurement and adjusted models provided good fit to the data ($\chi^2 = 143.30$; $P = .29$; $df = 136$; Root-Mean Square Error of Approximation = .014; Comparative Fit Index = .992; Tucker-Lewis Index = .981). After adjusting for covariates, *Sunscreen Toxicity* predicted reduced sunscreen use ($\beta = -.12$, $P = .021$), *Health Benefits of Tanning* predicted outdoor tanning ($\beta = .43$, $P < .001$), and *Tanning Through the Winter* predicted indoor tanning ($\beta = .31$, $P = .02$). The small sample size, nonresponse rate, and cross-sectional nature of this study mean these findings should be interpreted cautiously. Beliefs about health benefits of sun exposure, the regional weather, and sunscreen safety play a role in skin cancer risk and protective behaviors.

Keywords

health beliefs, sunscreen, tanning, cancer prevention, measurement

Received July 26, 2019. Received revised October 16, 2019. Accepted for publication October 25, 2019.

Introduction

Intentional exposure to ultraviolet (UV) radiation via indoor and outdoor tanning is popular among young white adults, despite the associated risk of skin cancer, cataracts, and premature aging.[1] Incidence of melanoma is projected to be 96 480 for 2019.[2,3] Despite being a common sun protection behavior, consistent sunscreen use is low among adults (30%)[4] and in particular, men (14.3%-19%).[5] Although 1.6 million fewer women and .4 million fewer men in the United States tanned indoors in 2013 than in 2010,[6] intentional UV exposure remains a challenge for skin cancer prevention. Therefore, understanding determinants of UV exposure and protective behaviors is a public health priority.

The indoor tanning industry cites UV-induced vitamin D production to counteract public health messages about tanning risks.[7] Prevailing weather may increase the salience of beliefs about the health effects of UV exposure (eg, the belief that UV exposure effectively treats vitamin D deficiency). Concern about vitamin D production influences Australian UV exposure behaviors,[8] and, compared to Australian climate, cloudy climates may increase the salience of vitamin D-related messaging. Recently only 43.1% of US adults agreed that vitamin D sufficiency is possible by diet and supplementation alone, a belief that was associated with increased sun protection.[9] In contrast, the belief that tanning effectively increases vitamin

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D was associated with increased indoor and outdoor tanning. Further, seasonal depressive symptoms have been documented in 80% of frequent indoor tanners.[10] In regions with seasonally varying natural light, the beliefs that cloudy weather is detrimental to health and that sun exposure is therapeutic for seasonal depression may influence UV exposure.

Failure to use sunscreen, a primary sunburn prevention tool[11,12] adds to the challenge of preventing risky UV exposure. Barriers to sunscreen use—such as cost, smell, texture, and inconvenience—have been documented;[13] however, a societal shift toward preference for natural products may also portend concern that sunscreen contains harmful ingredients as an emerging reason for disuse of sunscreen.

North American consumers associate natural origin with positive attributes such as health,[14] and natural-inspired sunscreens now claim to be free from chemical photofilters, "toxins," and gluten. Indeed, consumer reports recently found that most sunscreen buyers desire a "natural" product.[15] Further, nanotechnology in sunscreen may be perceived by laypeople as highly risky;[16] nanotechnology labeling on sunscreen reduces perceived benefits of sunscreen use and increased perceived risks.[17] Thus, beliefs about health benefits of sun exposure and concerns about health harms of sunscreen use may also influence UV exposure.

This study examines the UV-related health beliefs of college students and their associations with UV exposure and sunscreen use. To measure health beliefs, we used the Health Beliefs About UV (HBAU) scale.[18] This scale was developed using expert feedback, cognitive interviews, and pilot data from a sample of 115 students from a large university in the Pacific Northwest to guide item refinement. The measure was validated in a sample of 335 students. We hypothesized that (1) health beliefs about tanning would be associated with tanning, and (2) concern about sunscreen safety would be negatively associated with sunscreen use. Cloudy regions and populations with risky UV exposure[1,6] are important to the study of health beliefs about UV exposure. Thus, college students in western Oregon are an appropriate population for our study.

Methods

Design

We collected data between March and July of 2016 using a Qualtrics online survey that contained 125 items and took, on average, 17 minutes to complete. One $50 gift card incentive was raffled for every 75 participants. The Oregon State University Institutional Review Board approved this protocol as an exempt study.

Sample

Students were recruited from online and campus sections of core undergraduate courses at a large university in western Oregon. Out of 1406 contacted, 383 students attempted the survey. Informed consent documentation was included on the first page of the survey, with participants indicating their consent by clicking forward into the survey. Eligibility criteria, which were explained at the beginning of the online survey, were enrollment in a participating course section, aged 18 years or older, English fluency, and US nationality. Forty-eight of the 383 students did not continue past the eligibility criteria, yielding a final sample of 335 (23.8% of those contacted).

Measures

Health beliefs about UV scale. The 11-item HBAU scale measures health beliefs that may promote UV exposure and reduce sunscreen use.[18] Response options ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). The HBAU subscales *Sunscreen Toxicity* (3 items), *Health Benefits of Tanning* (3 items), *Seasonal Effects* (3 items), and *Tanning Through the Winter* (2 items) have demonstrated acceptable to good internal consistency (McDonald Omega $\omega = 0.65$-0.85).

Ultraviolet exposure and sunscreen use. We measured UV exposure in 2 ways: indoor tanning (ever/never) and outdoor tanning (frequency during past 12 months). Sunscreen use frequency on a warm sunny day was measured on a scale ranging from 1 (*never*) to 5 (*always*), or "I don't go in the sun," (treated as missing).[19] We also measured the following forms of UV protection: wearing a wide-brimmed hat, wearing sunglasses, using an umbrella, and wearing a long-sleeve shirt.

Physical appearance and sociocultural reasons to tan. The attractiveness subscale of the Physical Appearance Reasons to Tan Scale (PARTS; $\alpha = .91$-$.95$) measured appearance motivation to tan; [20] a sample item is "I tan because it makes me look better." The media subscale of the PARTS ($\alpha = .89$) measured sociocultural reasons to tan (eg, I wish I were as tan as the people in magazines).

Covariates. We measured susceptibility and severity of skin cancer by assessing level of agreement with the statements "I am likely to be diagnosed with skin cancer" and "It would be very bad to be diagnosed with skin cancer." Response options ranged from 1 (*strongly disagree*) to 5 (*strongly agree*), or "I don't know" (treated as missing). We also measured demographic variables including age, gender, year in college, parental educational attainment, untanned skin color (Fitzpatrick 1988), and sun sensitivity.

Analysis

We fit a preliminary confirmatory factor analysis of the HBAU, including covariances among all covariates and between the covariates and all latent factors. We then added structural elements to model indoor tanning, outdoor tanning, and sunscreen use as outcomes, omitting redundant covariances as necessary. Criteria for assessing model fit were a Root-Mean Square Error of Approximation[21,22] (RMSEA) of .05 for a very good fit and less than .08 for a reasonable fit[23] and the Comparative Fit

Index[24] (CFI) and Tucker-Lewis Index[25] (TLI) greater than .95. The χ^2 test statistic, which is sensitive to sample size,[26] is reported for completeness but was not used to assess model fit. We then trimmed 3 paths that were hypothesized a priori to be nonsignificant, conducting a $\Delta\chi^2$ test after each deletion to check impact on model fit. Participants responded to the outdoor tanning outcome variable using grouped frequencies that consisted of unequal intervals. As such, we treated this variable as ordinal and predicted it using WLSMV estimation and polychoric correlations in MPlus version 7.1.[27] Correlations were calculated using Stata version 12.1.[28]

Results

Table 1 presents participant characteristics and UV exposure behaviors. Student scores on the HBAU subscales indicated, on average, low endorsement of sunscreen toxicity concerns (see Table 2). A minority of participants (10%-16%) believed that sunscreen ingredients are toxic or probably cause cancer. Additionally, 20% believed that getting a base tan before sun exposure is protective against skin cancer, and nearly 40% believed tanning is a more natural source of vitamin D than supplementation. Beliefs that the weather has negative health effects in general (47.5%), on mood (61.7%) and on vitamin D production (37.9%) were common.

To assess model fit, we used a combination of absolute and comparative indices of fit, considering the RMSEA, the CFI, and the TLI. Cutoffs for acceptable fit were an RMSEA of less than .05, and CFI and TLI of greater than .95 for very good fit. Chi-square test statistic, which is sensitive to changes in sample size, is reported for completeness but was not used to assess model fit. The measurement model revealed significant loadings for all scale items and excellent model fit ($\chi^2 = 143.30$; $P = .29$; $df = 136$; RMSEA = .014; CFI = .992; TLI = .981). Next, we added the structural elements of the model, incorporating the 4-factor scale, UV exposure and protection outcome variables, and covariates. As expected, this model presented identical fit to the data ($\chi^2 = 143.30$; $P = .29$; $df = 136$; RMSEA = .014; CFI = .992; TLI = .981) because it specified the same measurement structure and included the same variables. We then removed nonsignificant paths between *Health Benefits of Tanning*, *Seasonal Effects,* and *Tanning Through the Winter* based on our a priori hypothesis that paths between the subscales would not be significant; the revision did not significantly impact model fit ($\Delta\chi^2(3) = 1.01$, $P = .81$), indicating that this revision did not degrade the model in terms of how well it fit the data. As we had hypothesized, the higher score on the *Tanning Through the Winter* subscale was positively associated with indoor tanning status, whereas higher score on the *Health Benefits of Tanning* subscale was positively associated with outdoor tanning. *Sunscreen Toxicity* subscale scores were negatively associated with sunscreen use, supporting our second hypothesis. Gender and appearance motive to tan were highly associated with both indoor and outdoor

Table 1. Participant Characteristics and UV-Related Behaviors.[a]

Variable	n (%)
Age, mean (SD)	21.5 (4.07)
Range	18-51
Gender	
Mens	106 (33%)
Women	211 (67%)
Year in college	
First	41 (13%)
Second	61 (19%)
Third	120 (37%)
Fourth	99 (31%)
Parental educational attainment	
Less than high school diploma	10 (3%)
High school graduate	35 (11%)
Some college	75 (24%)
College graduate	135 (43%)
Graduate degree	61 (19%)
Untanned skin color	
Very fair	52 (16%)
Fair	138 (43%)
Olive	75 (23%)
Light brown	50 (15%)
Dark brown	4 (1%)
Very dark	2 (1%)
Skin response to 1 hour in the sun	
Burns, no tan	35 (11%)
Burns, then tans	67 (21%)
Burns slightly, tans easily	74 (24%)
Tans easily, no burn	96 (31%)
No change	40 (13%)
Indoor tanning (ever/never)	
Yes	90 (27%)
No	245 (73%)
Outdoor tanning (past 12 months)	
None	82 (24%)
1-2	77 (23%)
3-9	91 (27%)
10-19	48 (14%)
20-39	22 (7%)
40+	15 (5%)
Using Sunscreen	
Never	28 (8%)
Rarely	88 (26%)
Sometimes	105 (32%)
Often	93 (28%)
Always	19 (6%)
Wearing a wide-brimmed hat	
Never	152 (46%)
Rarely	94 (28%)
Sometimes	61 (18%)
Often	22 (7%)
Always	4 (1%)
Wearing sunglasses	
Never	16 (5%)
Rarely	43 (13%)
Sometimes	74 (22%)
Often	141 42%)
Always	59 (18%)

(continued)

Table 1. (continued)

Variable	n (%)
Using an umbrella	
Never	37 (11%)
Rarely	91 (27%)
Sometimes	141 (42%)
Often	58 (17%)
Always	6 (2%)
Wearing a long-sleeved shirt	
Never	15 (5%)
Rarely	50 (15%)
Sometimes	101 (30%)
Often	131 (39%)
Always	36 (11%)
Susceptibility to cancer	
I am likely to be diagnosed with skin cancer	
Strongly disagree	19 (6%)
Disagree	80 (25%)
Neither agree nor disagree	94 (30%)
Agree	105 (33%)
Strongly agree	17 (5%)
Severity of cancer	
It would be very bad to be diagnosed with skin cancer	
Strongly disagree	11 (3%)
Disagree	6 (2%)
Neither agree nor disagree	26 (8%)
Agree	43 (13%)
Strongly agree	234 (73%)
	Mean (SD)
PARTS-Appearance	3.30 (.97)
PARTS-Media	2.34 (.97)

Abbreviations: PARTS, Physical Appearance Reasons to Tan Scale; SD, standard deviation.
[a]N = 335, not all percentages may sum to 100 due to rounding. Due to missing data, N for these variables has a range 316-335.

tanning status. Path coefficients and standard errors for the final model are presented in Table 3.

Discussion

This study examines the prevalence of UV-related health beliefs and their relationships with UV exposure and sunscreen use in a sample of Oregon college students. Endorsement of HBAU beliefs was low overall; however, these beliefs have the potential to counter public health messaging about the risk associated with UV exposure and the benefits of sunscreen use. Individuals holding such views, while in the minority, may be an important focus for future sun safety campaigns.

Beliefs about the climate and health impact of UV exposure were associated with risky UV-related behaviors, even after adjusting for gender, skin type, appearance, sociocultural motives to tan, and risk perception. Future research should build on these findings to examine how these relationships differ by indoor or outdoor UV exposure. The belief that tanning has inherent health benefits (such as providing "base" protection or "naturally" supporting vitamin D sufficiency) was associated with increased outdoor but not indoor tanning. In contrast, the belief that tanning can help one overcome the effects of winter was associated with increased indoor tanning but was unrelated to outdoor tanning behaviors. Thus, our first hypothesis was partially supported, a finding that is consistent with high levels of seasonal depressive symptoms found among high-frequency indoor tanners.[10] Further research should examine whether students experiencing seasonal mood disruption begin indoor tanning to assuage these symptoms.

Our finding that beliefs about sunscreen ingredients being toxic, harmful, or carcinogenic were related to less-frequent

Table 2. Subscale and Item Distributions, Means and Standard Deviations.[a]

HBAU Item	Strongly Disagree (%)	Disagree (%)	Neither Agree Nor Disagree (%)	Agree (%)	Strongly Agree (%)	M (SD), Overall, (%)
Subscale—Sunscreen Toxicity						2.36 (.81)
Sunscreen ingredients are toxic	12.8	47.1	24.6	14.1	1.4	2.55 (.93)
Most sunscreen is full of harmful chemicals	12.1	47.1	24.1	15.1	1.6	2.49 (.94)
Sunscreen lotions probably cause cancer	23.1	45.9	20.8	9.5	.7	2.19 (.92)
Subscale—Seasonal Effects						3.21 (.85)
The cloudy weather in Western Oregon negatively affects me	8.3	28.7	15.4	32.4	15.1	3.17 (1.23)
In Oregon, a bad mood in the winter can be because there is no sun	5.7	34.4	22.1	31.9	6.0	3.50 (1.01)
Because of the cloudy weather in Oregon, my body can't produce enough vitamin D	3.0	17.6	17.6	50.1	11.6	2.98 (1.06)
Subscale—Health Benefits of Tanning						2.52 (.84)
Tanning is a healthy treatment for low vitamin D	11.7	27.5	23.6	32.0	5.2	2.28 (1.05)
Getting a base tan before going in the sun is protective against skin cancer	25.4	38.8	19.3	15.0	1.5	2.36 (1.11)
Tanning is a more natural way to get your vitamin D than taking a pill	24.3	38.2	17.4	17.4	2.8	2.92 (1.12)
Subscale—Tanning Through the Winter						2.82 (.89)
Tanning can help you get through the Oregon winter	8.3	34.5	31.6	23.3	2.2	2.77 (.97)
Tanning can help you stay positive during the winter	7.3	33.1	27.4	30.6	1.6	2.86 (.99)

Abbreviations: HBAU, Health Beliefs About UV; SD, standard deviation.
[a]Range for all items was 1-5. Scale scores were calculated as the average of the items on the scale. *Seasonal Effects* and *Tanning Through the Winter* observed range: 1-5, and *Sunscreen Toxicity* and *Health Benefits of Tanning* observed range: 1-4.67.

Table 3. Final Model Standardized Path Coefficients and Standard Errors.

	Indoor Tanning		Outdoor Tanning		Sunscreen Use	
	Coeff.	SE	Coeff.	SE	Coeff.	SE
HBAU—Sunscreen Toxicity	.016	.098	−.082	.059	−.123[a]	.053
HBAU—Seasonal Effects	−.01	.117	−.074	.079	-	-
HBAU—Health Benefits of Tanning	−.005	.182	.428[b]	.116	-	-
HBAU—Tanning Through the Winter	.312[a]	.141	−.035	.098	-	-
Susceptibility to skin cancer	.077	.077	.020	.057	.082	.051
Severity of skin cancer	−.011	.074	.057	.046	−.072	.058
Appearance motivation to tan	.244[c]	.086	.420[b]	.059	.024	.058
Sociocultural motivation to tan	.013	.080	−.069	.062	−.114	.063
Complementary protection: Wear hat	.003	.085	−.073	.055	.160[c]	.051
Complementary protection: Wear shirt	.025	.081	−.114[c]	.046	.031	.053
Complementary protection: Umbrella	−.085	.074	−.100[a]	.050	.187[b]	.046
Complementary protection: Wear shades	.063	.081	.133[c]	.053	.179[b]	.044
Parental education	−.143	.083	.006	.051	.168[b]	.046
Skin color	−.086	.097	.029	.058	−.040	.041
Gender	.362[b]	.092	.237[b]	.067	.256[b]	.049

Abbreviations: HBAU, Health Beliefs About UV; SE, standard errors.
[a]$P < .05$.
[b]$P < .001$.
[c]$P < .01$.
[d]Gender was coded M = 0, F = 1; the positive association between gender and indoor tanning reflects the greater rate of tanning among women.

sunscreen use, even after adjusting for potential confounders, supports our second hypothesis. Further, no relationship emerged between these beliefs and complementary UV protection such as umbrella use, suggesting that concern about sunscreen is not associated with increased compensatory protection measures. Consumers of natural health products value perceived naturalness over product efficacy,[29] so individuals who are concerned about sunscreen safety may discontinue using sunscreen products altogether, select less effective or untested formulations,[29] or apply sunscreen so sparingly as to render it ineffective. Most consumers already fail to apply adequate sunscreen to achieve the advertised protection,[30] so this possibility is quite troubling. Individuals concerned about sunscreen safety are an important target for sun safety interventions and should be counseled to adopt an approach that combines multiple sun safety behaviors depending on context.[31]

This study has several limitations. The small, cross-sectional student sample and single data collection site limit generalizability and causal inference. We did not collect information on individuals who chose not to participate or who read the informed consent but chose not to proceed with the study, therefore we were unable to assess the impact of nonresponse on our findings. Furthermore, unmeasured covariates of tanning and sunscreen use may potentially confound these findings. Our measure of indoor tanning does not capture potential differences in frequency and occasion of tanning, which may influence HBAU constructs. Additionally, seasonal variation during data collection may have biased the detection of effects toward the null.[32] Despite these limitations, our study offers insights into skin cancer risk behaviors, accounts for many known covariates of UV exposure, and suggests potential avenues for future research.

The factors measured by the HBAU merit validation in more diverse samples. Our findings that health beliefs about UV are associated with increased intentional tanning and decreased sunscreen use are consistent with those of Holman and colleagues[9] related to vitamin D; the absence of corresponding compensatory UV protection efforts such as wearing a long-sleeved shirt increase the public health impact of those findings. Geographic variation in the role of HBAU constructs is likely, however, and future research should examine geographic differences in these constructs (with HBAU items revised to reflect the climate of each region under study). Our study suggests that beliefs about health effects of UV exposure and protection behaviors influence skin cancer risk behaviors in regions with predominantly cloudy weather. Including information about local climate, vitamin D, seasonal depression, and sunscreen safety may improve UV exposure prevention materials.

Author Note

This study was conducted at Oregon State University and the manuscript completed at the National Cancer Institute.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The National Cancer Institute is funding the *costs* of publication of the article.

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