

Indoor Tanning Dependence in Young Adult Women

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Abstract

Background: There is mounting evidence that young people can develop a dependence on indoor tanning, but research on factors associated with indoor tanning dependence remains limited.

Methods: This cross-sectional study investigated factors associated with indoor tanning dependence in a community sample of 389 non-Hispanic white young adult women ages 18 to 30 who had indoor tanned ≥ 1 time in the past year. Participants completed measures of indoor tanning dependence, including the modified CAGE and modified Diagnostic and Statistical Manual for Mental Disorders-IV psychiatric screening assessments, indoor tanning behavior and beliefs, and behavioral and psychiatric comorbidity.

Results: Overall, 22.6% of the sample screened positive for indoor tanning dependence. In multivariable analyses, indoor tanning dependence was associated with younger age of indoor

tanning initiation [adjusted odds ratio (aOR) = 0.79; $P = 0.017$], indoor tanning ≥ 20 times in the past year (aOR = 3.03; $P = 0.015$), stronger beliefs about the benefits of tanning (aOR = 2.15; $P = 0.004$), greater perceived susceptibility to indoor tanning risks (aOR = 2.72; $P < 0.001$), stronger beliefs about physical appearance (aOR = 1.73; $P = 0.037$), and depressive symptoms (aOR = 3.79; $P < 0.001$).

Conclusions: Indoor tanning dependence among young, non-Hispanic white women is associated with behaviors that increase the risk of skin cancer, beliefs favoring the perceived benefits of tanning, and comorbid risks such as stronger beliefs about physical appearance and depressed mood.

Impact: Comprehensive skin cancer prevention efforts should address indoor tanning dependence among young women and its leading risk factors. *Cancer Epidemiol Biomarkers Prev*; 26(11); 1636–43. ©2017 AACR.

Introduction

Indoor tanning is an established risk factor for melanoma and nonmelanoma skin cancer, accounting for approximately 10% of cases in the United States annually (1) at substantial economic cost (2). As little as a single indoor tanning exposure increases the risks of melanoma by approximately 20% and nonmelanoma skin cancer by 29% to 67%; these risks increase with more frequent exposure (3, 4). Among U.S. adults, indoor tanning is most prevalent among non-Hispanic white women ages 18–30 years, where an estimated 15% indoor tan each year (5, 6). Indoor tanning early in life further increases the risk of skin cancer and is associated with early-onset disease (7, 8).

Although many young people indoor tan seasonally or episodically for discrete events (9), there is evidence some may develop a dependence on indoor tanning (i.e., tanning in a compulsive, addictive manner). One hypothesis is that synthe-

sis of β -endorphin as a byproduct of ultraviolet (UV) radiation exposure may produce opioid-like drug response (10). Evidence from preclinical (10) and clinical studies (11–16) supports this model of indoor tanning addiction.

Indoor tanning dependence symptoms have typically been measured using screening instruments adapted from other types of substance abuse (e.g., alcohol), such as tanning despite knowing risks, increased tolerance, and withdrawal symptoms (17). Use of other abusable substances and psychiatric comorbidities are more prevalent among those screening positive for tanning dependence in some studies. However, most have focused on convenience samples of college students (9, 14, 15, 17–22), excluding young adults who may indoor tan but are not enrolled in a college/university. Other research has examined tanning dependence in skin cancer patients through retrospective reports subject to recall biases (23). Theories such as Health Belief Model and Theory of Reasoned Action also indicate behavioral beliefs, including perceived risks (severity, susceptibility) associated with a behavior, perceived benefits of a behavior, and positive behavioral attitudes, are factors influencing risk behavior engagement and are important intervention targets (24–26). Some studies have assessed associations between behavioral beliefs and indoor tanning behavior (27–30), but there is little research on how such beliefs relate to indoor tanning dependence when examined alongside potential psychiatric comorbidities. This evidence is critical to develop interventions for skin cancer prevention.

The objective of this study was to examine factors associated with indoor tanning dependence in a community sample of non-Hispanic white women ages 18 to 30 years who indoor tan,

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including demographics, other known skin cancer risk factors, indoor tanning behavior and beliefs, and behavioral and psychiatric comorbidity.

Materials and Methods

Sample and setting

Details of study recruitment and procedures were reported previously (31). Eligibility criteria included: young adult women 18 to 30 years of age; non-Hispanic white race/ethnicity; and indoor tanning at least once in the past 12 months. Given the relatively limited research on indoor tanning dependence and its correlates, the study focused on this group because it has the highest prevalence of indoor tanning in the U.S. adult population (6). Participants were recruited from September 2013 to December 2016 from the Washington, DC, metropolitan area through Internet classifieds, advertisements in local periodicals, and community flyers. Eligibility criteria were assessed by telephone among those who contacted study personnel in response to recruitment materials. Eligible participants provided written informed consent to complete enrollment and were emailed a link to complete a self-report assessment online. Research staff followed-up with participants to ensure timely completion. Participants received a \$25 gift card for completing the study. All procedures were approved by the Georgetown University Institutional Review Board.

Measures

Demographics. Demographics included age, household income, and educational attainment (5). Season of participation was also recorded (spring/summer/fall/winter; ref. 21).

Skin cancer risk factors. Risk factors for melanoma and non-melanoma skin cancer (32, 33) assessed included skin reactivity to sun exposure (always/usually burn, rarely/never burn), hair color (red/blonde, brown/black), and family history of melanoma (first-degree relative, yes/no). Intentional outdoor tanning and sunburns were captured using items from epidemiologic surveys (34–36). Frequency of intentional outdoor tanning was measured with an item assessing how often participants spend time in the sun to get a tan with response options ranging from 1 (never) to 5 (always). Sunburn was captured by asking how often in the past 12 months participants experienced red or painful sunburn that lasted a day or more, with response options ranging from 0 to 5 or more.

Indoor tanning behavior and beliefs. Past-year frequency of indoor tanning including sunlamps, tanning beds, and tanning booths (1 or 2, 3–9, 10–19, 20 or more times) and age of indoor tanning initiation were measured using valid items (5). Opioid-like reactions to indoor tanning were measured with a 4-item scale assessing how often participants feel relaxation, pain relief, stress relief, and euphoria when they tan, with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Responses were averaged to create a score with higher values indicating stronger opioid-like reactions (Cronbach $\alpha = 0.83$; ref. 9).

Measures of indoor tanning beliefs captured constructs from theoretical frameworks of health risk behavior and behavior change (24–26). A 10-item scale assessed beliefs that the benefits of indoor tanning outweigh the risks (27). Responses

were averaged to create a score with higher values indicating perceived beliefs benefits outweighing potential risks (Cronbach $\alpha = 0.77$). Positive attitudes toward indoor tanning were assessed with a 10-item scale (37, 38) with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Responses were averaged to create a score with higher values indicating more positive attitudes (Cronbach $\alpha = 0.84$).

Perceived severity of the risks of indoor tanning was measured using a 5-item scale assessing how serious participants perceived the risks associated with indoor tanning to be (39). Examples include "skin cancer isn't very serious" and "skin cancer is always curable" with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Responses were summed to create a score indicating higher perceived severity (Cronbach $\alpha = 0.73$). Perceived susceptibility to the risks of indoor tanning was measured with a 7-item scale capturing how likely participants perceived the risks associated with indoor tanning to be (39). Example items include "compared with other females my age, I have a high chance of developing skin cancer" and "I am likely to develop skin cancer at some point" with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Responses were averaged to create a score indicating higher perceived susceptibility (Cronbach $\alpha = 0.73$).

Behavioral and psychiatric comorbidity. Alcohol and tobacco use were measured using items from epidemiologic surveys (40, 41). Past 30-day alcohol use in the sample was common (94%), so we analyzed binge drinking (≥ 4 drinks on one or more occasion, yes/no) in the past 30 days (41). Current cigarette smoking (yes/no) was defined as smoking at least 100 lifetime cigarettes and now smoking every day or some days (40).

Measures of psychiatric comorbidity were based on prior studies of indoor tanning behavior and dependence (18, 37, 42, 43). Sensation seeking was measured using an 8-item scale assessing participants' proclivity for risk-taking (44). Response options ranged from 1 (strongly disagree) to 5 (strongly agree) and were averaged to create a score with higher values indicating greater sensation seeking (Cronbach $\alpha = 0.81$). Self-esteem was captured with a 10-item scale with response options ranging from 1 (strongly agree) to 4 (strongly disagree) (45). Items were averaged to create a score indicative of higher self-esteem (Cronbach $\alpha = 0.91$). Beliefs about physical appearance were measured with a 12-item scale capturing physical appearance orientation, or the value participants' place on their appearance. Items were averaged to create a score with higher values indicating stronger beliefs about physical appearance (Cronbach $\alpha = 0.86$; ref. 46). Finally, depressive symptoms were measured using the 20-item Center for Epidemiologic Studies Depression scale (Cronbach $\alpha = 0.91$). A cutoff score of ≥ 16 was used to indicate a positive screen for depressive symptoms (yes/no; ref. 47).

Indoor tanning dependence. Two psychiatric screening instruments modified from other forms of addiction assessed indoor tanning dependence: the modified CAGE (mCAGE) and the modified Diagnostic and Statistical Manual for Mental Disorders-IV (mDSM) screeners (17, 18, 48). We chose these screeners because they have demonstrated reliability and validity and evidence indicates use of their cutoff points in combination to define indoor tanning dependence performs similarly

Mays et al.

to other available measures, such as the Tanning Addiction Pathology Scale and Structured Interview for Tanning Abuse and Dependence (17). Some researchers have also expressed concern that when administered alone the mCAGE may overestimate the prevalence of indoor tanning dependence (49), leading others to recommend using the combination of screeners to address limitations of using a single measure alone (23, 50). The mCAGE includes 4 items (Cut Down, Annoyed, Guilty, Eye Opener), and endorsing ≥ 2 items affirmatively indicates dependence symptoms. The mDSM includes 8 items and endorsing 3 or more affirmatively indicates dependence symptoms. Total scores on the mCAGE and mDSM were moderately correlated ($r = 0.37$, $P < 0.001$) indicating they capture unique dependence symptoms. Indoor tanning dependence was defined as screening positive on both the mCAGE and mDSM (yes/no; refs. 23, 50).

Statistical analysis

Participant characteristics were described overall and by indoor tanning dependence, and two-sample t tests and Pearson χ^2 tests were conducted to examine associations between all independent variables measured and indoor tanning dependence. Pair-wise correlations were also examined among all independent variables measured; all were at most weakly correlated ($r < 0.30$), indicating ignorable collinearity in multivariable models. Unadjusted and adjusted logistic regression models were applied where indoor tanning dependence was regressed on a subset of independent variables that showed associations with indoor tanning dependence at $P < 0.10$ in bivariate analyses. We chose this threshold for inclusion in multivariable analyses because we aimed to choose from a large set of candidate covariates that would comprise the optimal multivariable model. This purposeful variable selection is shown to have the capability of retaining important confounding variables in multivariable analysis (51). Unadjusted and adjusted odds ratios (aOR) and 95% confidence intervals (CI) are reported. Goodness of fit for the multivariable model was confirmed using the Hosmer–Lemeshow χ^2 test (52). To examine how sensitive our multivariable estimates were to the choice of independent variables, an adjusted logistic regression model including all independent variables was also created as a supplementary analysis. All statistical analyses were performed using SAS 9.3 (SAS Institute).

Results

Sample characteristics

In total, 563 individuals were assessed for eligibility, 433 (76.9%) met eligibility criteria, and 389 (89.8% of those eligible) completed study procedures. Overall, 22.6% ($n = 88$) of participants screened positive for indoor tanning dependence. Participant characteristics overall and by indoor tanning dependence are shown in Table 1. Overall, 46.7% ($n = 181$) of participants were current college or university students, indicating the recruitment approach was successful reaching young adults in the community and in college settings. The prevalence of indoor tanning dependence symptoms assessed in the full sample and by indoor tanning dependence screening is shown in Table 2.

In bivariate analyses, those screening positive for indoor tanning dependence were less likely to be college educated

($P = 0.040$), reported intentional outdoor tanning more frequently ($P = 0.028$), initiated indoor tanning at a younger age on average ($P < 0.001$), and reported more frequent indoor tanning in the past year ($P < 0.001$) compared with those screening negative for indoor tanning dependence (Table 1). Compared with those screening negative for indoor tanning dependence, those screening positive also reported stronger opioid-like reactions to indoor tanning ($P = 0.002$), attitudes and beliefs valuing the perceived benefits of indoor tanning ($P < 0.001$), and greater perceived susceptibility to the risks of indoor tanning ($P < 0.001$). Finally, those screening positive for indoor tanning dependence endorsed poorer self-esteem ($P < 0.001$), were more strongly oriented to their appearance ($P < 0.001$), and were more likely to screen positive for depressive symptoms ($P < 0.001$) compared with those screening negative for indoor tanning dependence (Table 1).

Unadjusted and adjusted logistic regression analyses of variables associated with indoor tanning dependence are shown in Table 3. Unadjusted models mirrored results of bivariate analyses. The adjusted multivariable model fit the data well [Hosmer–Lemeshow χ^2 (8 df) = 5.18, $P = 0.738$]. After adjustment for remaining variables, the estimated odds of indoor tanning dependence decreased with increasing age of indoor tanning initiation (aOR = 0.85; 95% CI = 0.74–0.97; $P = 0.017$) and the estimated odds were three times greater among those reporting indoor tanning ≥ 20 or more times in the past year (aOR = 3.03; 95% CI = 1.11–8.32; $P = 0.015$) compared with those reporting indoor tanning 1 or 2 times in the past year (Table 3). The estimated odds of indoor tanning dependence showed a 2-fold increase with beliefs valuing the benefits of indoor tanning over the risks (aOR = 2.15; 95% CI, 1.28–3.61; $P = 0.004$) and increased with greater perceived susceptibility to the risks of indoor tanning (aOR = 2.72; 95% CI, 1.67–4.42; $P < 0.001$). Finally, the estimated odds of indoor tanning dependence increased with stronger appearance orientation (aOR = 1.73; 95% CI, 1.03–2.90; $P = 0.037$) and were nearly four times greater for those screening positive for depressive symptoms (aOR = 3.79; 95% CI, 1.90–7.57; $P < 0.001$) relative to those screening negative for depressive symptoms. We also fitted the adjusted logistic model by regressing indoor tanning dependence onto all variables shown in Table 1 and the results were consistent with those displayed in Table 3 (Supplementary Table S1).

Discussion

Growing evidence supports the hypothesis that some young people develop behavioral addiction to indoor tanning. In pre-clinical models, prolonged exposure to UV light in mice leads to elevated plasma β -endorphin and increased pain tolerance, and when removed opioid withdrawal symptoms and conditioned choice behavior to mitigate withdrawal occur (10). These effects are absent in mice exposed to non-UV light, β -endorphin knock-out mice, and with pharmacologic opioid antagonism (10). In clinical studies, frequent indoor tanners endorse subjective preference for UV light over sham light when blinded to the source (12, 16), and this preference diminishes with pharmacologic opioid antagonism (16). Exposure to UV light among frequent tanners has been shown to activate reward-based brain regions (13) and to produce increased dopamine response (11) similar to other forms of addiction. Frequent indoor tanners have also been

Table 1. Sample characteristics overall and by indoor tanning (IT) dependence

	Sample N = 389	+ IT Dependence N = 88	- IT Dependence N = 301	P
Demographics				
Age, mean (SD), range 18-30, y	23.3 (3.0)	22.9 (2.8)	23.4 (3.1)	0.113
≥College education	244 (62.7)	47 (53.4)	197 (65.5)	0.040
<College education	145 (37.3)	41 (46.6)	104 (34.5)	
Income ≥ \$50,000	198 (50.9)	49 (55.7)	149 (49.5)	0.308
Income < \$50,000 or not reported	191 (49.1)	39 (44.3)	152 (50.5)	
Season of study participation				
Spring	102 (26.2)	21 (23.9)	81 (26.9)	0.929
Summer	112 (28.8)	25 (28.4)	87 (28.9)	
Fall	114 (29.3)	27 (30.7)	87 (28.9)	
Winter	61 (15.7)	15 (17.1)	46 (15.3)	
Skin cancer risk factors				
Always/usually burn	93 (24.0)	20 (22.7)	73 (24.3)	0.756
Rarely/never burn	296 (76.0)	68 (77.3)	227 (75.7)	
Red/blonde hair	145 (37.3)	31 (35.2)	114 (37.9)	0.652
Brown/black hair	244 (62.7)	57 (64.8)	187 (62.1)	
FDR w/melanoma	61 (15.7)	15 (17.1)	46 (15.3)	0.689
No FDR w/melanoma	328 (84.3)	73 (82.9)	255 (84.7)	
Intentional outdoor tanning, mean (SD), range 1-5	3.4 (0.83)	3.5 (0.84)	3.3 (0.83)	0.028
Past 12-month sunburns, mean (SD), range 0-5	2.6 (1.3)	2.8 (1.3)	2.5 (1.3)	0.103
IT Behavior				
Age IT initiation, mean (SD), range 8-28, y	17.1 (2.6)	16.2 (2.2)	17.4 (2.6)	<0.001
Past year IT frequency				
1 or 2 times	74 (19.0)	8 (9.1)	66 (21.9)	<0.001
3-9 times	145 (37.3)	27 (30.7)	118 (39.2)	
10-19 times	75 (19.3)	16 (18.2)	59 (19.6)	
≥20 times	95 (24.2)	37 (42.0)	58 (19.3)	
Opioid-like IT reactions, mean (SD), range 1-5	3.5 (0.93)	3.8 (1.0)	3.4 (.89)	0.002
IT Beliefs				
Benefits of IT, mean (SD), range 1-5	2.8 (0.66)	3.0 (0.77)	2.7 (0.61)	<0.001
Attitudes, mean (SD), range 1-5	3.9 (0.59)	4.2 (0.49)	3.8 (0.59)	<0.001
Perceived susceptibility risks, mean (SD), range 1-5	3.2 (0.69)	3.4 (0.70)	3.1 (0.67)	<0.001
Perceived severity risks, mean (SD), range 1-5	3.8 (0.70)	3.7 (0.72)	3.8 (0.70)	0.092
Alcohol & tobacco				
Current cigarette smoker	73 (18.8)	15 (17.0)	58 (19.3)	0.638
Nonsmoker	316 (81.2)	73 (83.0)	243 (80.7)	
Past 30-day binge drinking	278 (71.5)	59 (67.0)	219 (72.8)	0.297
No past 30-day binge drinking	111 (28.5)	29 (33.0)	82 (27.2)	
Psychologic risk factors				
Sensation seeking, mean (SD), range 1-4	2.7 (0.67)	2.8 (0.67)	2.6 (0.67)	0.109
Self-esteem, mean (SD), range 0-3	22.3 (5.5)	20.3 (6.0)	22.9 (5.3)	<0.001
Appearance orientation, mean (SD), range 1-5	3.8 (0.63)	4.0 (0.60)	3.7 (0.62)	<0.001
Depressive symptoms				
Screen + depressive symptoms	185 (47.6)	66 (75.0)	119 (39.5)	<0.001
Screen - depressive symptoms	204 (52.4)	22 (25.0)	182 (60.5)	

NOTE: Cells display no. (%) unless noted in the row label. Some variables do not sum to total sample size due to sporadic missing data (<1% for any given variable). Abbreviation: FDR, first-degree relative.

observed to endorse responses characteristic of drug exposure after tanning, such as improved mood and euphoria (14, 15).

This study contributes to this research by assessing factors associated with indoor tanning dependence in a community sample of non-Hispanic white young adult women. More than 1 of 5 women in the sample met screening criteria for indoor tanning dependence, and as expected based on prior research (15, 18, 48, 53) indoor tanning dependence was associated with an earlier age of indoor tanning initiation and more frequent indoor tanning behavior. This indicates women who develop indoor tanning dependence are at a high risk of skin cancer based on their behavioral profile (3, 4, 7, 8). Our study also shows that, in addition to these behavioral features, indoor tanning dependence is associated with psychiatric risk factors, including stronger physical appearance orientation and depressive symptoms, and beliefs favoring the perceived benefits of indoor tanning.

Research with female college/university students has shown that indoor tanning dependence is associated psychiatric comorbidities including anxiety (20) and obsessive compulsive (18) disorders and that frequent indoor tanning is associated with seasonal affective disorder (54). Our work extends this evidence by demonstrating indoor tanning dependence is associated with depressive symptoms in young adults in the community who are likely to be encountered in clinical settings other than college health centers. The strength of association was greater than studies reporting comorbidities associated with nondependent tanning behavior and comparable with those reported for indoor tanning dependence (18, 20, 54). This evidence, in conjunction with research indicating indoor tanning can produce mood-enhancing effects (11, 14, 15), suggests a potential mechanism whereby young women experiencing depressed mood or other psychologic distress may indoor tan because it alleviates such symptoms. However, there remains a need for research to understand how

Mays et al.

Table 2. Frequency of reported IT dependence symptoms overall and by IT dependence

	Sample, N = 389	+ IT Dependence N = 88	- IT Dependence N = 301	P
mCAGE				
Cut down: have you tried to stop tanning, but still continue?	65 (16.7)	53 (60.2)	12 (4.0)	<0.001
Annoyed: do you ever get annoyed when people tell you not to tan?	179 (46.0)	75 (85.2)	104 (34.6)	<0.001
Guilty: do you ever feel guilty that you tan too much?	130 (33.4)	63 (71.6)	67 (22.3)	<0.001
Eye opener: when you wake up in the morning, do you want to tan?	49 (12.6)	35 (40.2)	14 (4.7)	<0.001
≥2 CAGE Symptoms	111 (28.5)	88 (100)	23 (20.7)	<0.001
mDSM				
Tolerance: do you feel that you need to spend more time tanning in order to maintain your tan?	169 (43.4)	64 (72.7)	105 (34.9)	<0.001
Withdrawal: do you feel unattractive or anxious to tan if you do not maintain your tan?	173 (44.7)	68 (78.2)	105 (34.9)	<0.001
Should decrease/stop: do you think you should stop tanning or decrease the time you spend tanning?	150 (38.6)	61 (69.3)	89 (29.6)	<0.001
Unsuccessful quitting: have you tried to stop tanning, but still continue?	64 (16.5)	53 (60.9)	11 (3.6)	<0.001
Missed obligations: have you ever missed a social engagement, work, school, or other recreational activities because you went tanning instead?	34 (8.7)	16 (18.2)	18 (6.0)	<0.001
Trouble at work or home: have you ever gotten into trouble at work, with family, or with friends due to tanning?	22 (5.7)	13 (14.8)	9 (3.0)	<0.001
Tan despite knowing risks: Do you continue to tan despite knowing that it is bad for your skin?	325 (83.6)	86 (97.7)	239 (79.4)	<0.001
Tan despite personal/family history of skin cancer: have you ever had a skin cancer or do you have a first-degree relative (mother, father, sister, brother) who has had skin cancer?	72 (18.6)	17 (19.5)	55 (18.3)	0.799
≥3 mDSM Symptoms	191 (49.1)	88 (100)	103 (34.2)	<0.001
Positive Screen for IT Dependence	88 (22.6)	88 (100)	0 (0)	n/a

NOTE: Positive screen for IT dependence defined as ≥2 mCAGE and ≥3 mDSM symptoms endorsed. Cells display no. (%).

Abbreviations: mCAGE, modified CAGE; mDSM, modified Diagnostic and Statistical Manual of Mental Disorders-IV.

psychiatric comorbidity, affect-oriented motives, and indoor tanning dependence unfold over time.

Our findings demonstrating an association between stronger physical appearance orientation and indoor tanning dependence build on research indicating frequent sun exposure and

infrequent sun protection are associated with similar beliefs among young adults (42). This result is also consistent with evidence indicating the perceived appearance-related benefit is a motivating factor for indoor tanning among young people (30, 55). Our data suggest this association may extend beyond

Table 3. Unadjusted and adjusted logistic regression model of correlates of IT dependence

	Unadjusted OR (95% CI)	P	aOR (95% CI)	P
Demographics				
Education				
<College education	Ref.		Ref.	
≥College education	0.60 (0.37-0.97)	0.037	0.84 (0.47-1.50)	0.548
Melanoma risk factors				
Intentional outdoor tanning	1.39 (1.03-1.87)	0.029	1.29 (0.91-1.85)	0.152
IT Behavior				
Age of IT initiation, y	0.79 (0.71-0.89)	<0.001	0.85 (0.74-0.97)	0.017
Past year IT frequency				
1 or 2 times	Ref.		Ref.	
3-9 times	1.89 (0.81-4.39)	0.495	1.80 (0.67-4.81)	0.774
10-19 times	2.24 (0.89-5.61)	0.902	1.45 (0.49-4.30)	0.612
≥20 times	5.26 (2.27-12.21)	<0.001	3.03 (1.11-8.32)	0.015
Opioid-like reactions	1.57 (1.18-2.10)	0.002	1.06 (0.76-1.47)	0.738
IT Beliefs & perceptions				
Benefits of IT	2.22 (1.52-3.25)	<0.001	2.15 (1.28-3.61)	0.004
Attitudes	3.43 (2.14-5.51)	<0.001	1.25 (0.67-2.31)	0.478
Perceived susceptibility to risks	2.19 (1.52-3.17)	<0.001	2.72 (1.67-4.42)	<0.001
Perceived severity of risks	0.75 (0.53-1.05)	0.092	0.88 (0.57-1.34)	0.549
Psychologic risk factors				
Self-esteem	0.92 (0.88-0.96)	<0.001	1.01 (0.95-1.07)	0.724
Appearance orientation	2.68 (1.73-4.17)	<0.001	1.73 (1.03-2.90)	0.037
Depressive symptoms				
Screen - depressive symptoms				
Screen - depressive symptoms	Ref.		Ref.	
Screen + depressive symptoms	4.59 (2.69-7.83)	<0.001	3.79 (1.90-7.57)	<0.001
Hosmer-Lemeshow χ^2	—		5.18 (8 df)	0.738

NOTE: Variables correlated with IT dependence at $P < 0.10$ in two-sample comparisons in Table 1 were included in regression models.

the direct benefits perceived to be gained from indoor tanning to an underlying preoccupation with appearance. Some research has also demonstrated that nondependent indoor tanning behavior among female college/university students is associated with lower perceived risks and greater perceived benefits of indoor tanning (19, 30). To our knowledge, this study is among the first to show that beliefs about the benefits and risks of indoor tanning demonstrate a similar strength of association with indoor tanning dependence even when accounting for other associated factors. In the sample, indoor tanning dependence was associated with a pattern of beliefs indicating young women recognize their tanning behavior increases susceptibility to risks such as skin cancer, but believe the perceived benefits of indoor tanning outweigh the risks.

Some of our findings differ from previous research, particularly those relating to alcohol and tobacco use, which we did not find to be associated with indoor tanning dependence. Other studies have shown that indoor tanning dependence is associated with alcohol use disorders (20), more frequent alcohol use (22), and cigarette smoking (53). Differences in measurement approaches (e.g., brief epidemiologic items versus clinical alcohol use disorder assessments) and samples (e.g., students vs. students and non-students) may contribute to these variable findings.

Our study points to the need to develop clinical approaches for effectively identifying and intervening with young women who endorse frequent indoor tanning, may meet criteria for dependence, and are likely to experience distress, depression, and other comorbidities. Studies have investigated the validity of measures of indoor tanning dependence other than those used here (56, 57), but the optimal screening approach is yet to be identified. Measures such as those used in this study have been adapted from other forms of addiction but will need refinement as research uncovers unique features of indoor tanning dependence, including comorbid factors and potential biological underpinnings (50, 58).

Interventions have targeted young adults generally and those with any history of indoor tanning using web- and print-based education to address perceived risks and benefits of tanning and appearance-based motives (38, 59–62). Although interventions aimed at affecting perceived risks and benefits of health behaviors have promising effects generally (26, 63) and in some studies of indoor tanning (61, 64), our findings suggest this approach alone may be insufficient to promote behavior change among young adults endorsing indoor tanning dependence. A recent review proposes skills-based cognitive behavioral and motivational interventions that have shown promise for addressing other behavioral addictions could be adapted to address "excessive tanning" (65). However, evidence on the design and delivery of interventions targeting young adults endorsing indoor tanning dependence, which our data indicate is characterized by frequent indoor tanning, protanning beliefs, and psychiatric comorbidity, is extremely limited. Our findings highlight a need to develop and test intervention strategies targeting a constellation of factors associated with indoor tanning dependence that may be distinct from those associated with indoor tanning behavior generally, including approaches addressing underlying psychiatric comorbidity.

This study is one of the largest community samples to characterize correlates of indoor tanning dependence in non-Hispanic white young adult women to date. However, the findings should be interpreted in light of study limitations. The data are self-report

and subject to potential reporting biases, and the cross-sectional design does not provide evidence on the causal associations with indoor tanning dependence. The convenience sample from a single geographic location and study inclusion criteria limit generalizability to broader populations, including young women of other racial/ethnic groups and young men. The prevalence of indoor tanning dependence in our sample is higher than some previous studies; however, most have involved general samples not young women with a history of indoor tanning in the past year (18, 20, 43). We observed a higher prevalence of indoor tanning dependence on the mDSM than the mCAGE, which is contrary to criticisms of the mCAGE (49) and may be a reflection of differences in performance of tanning dependence measures in general samples versus those who have recently indoor tanned. Although the study used reliable and valid measures of indoor tanning dependence, identification of correlates of indoor tanning dependence may depend on the measures used and future studies examining correlates using other measures such as the Tanning Addiction and Pathology Scale and the Structured Interview for Tanning Abuse and Dependence (17) are needed.

Despite these limitations, the study findings indicate indoor tanning dependence among non-Hispanic white young adult women is associated with a behavioral profile indicating an elevated risk of skin cancer, protanning beliefs, and psychiatric comorbidity. The findings highlight a critical need to develop models for effectively identifying and intervening with this high-risk group in clinical and community settings.

Disclosure of Potential Conflicts of Interest

M.B. Atkins is a consultant/advisory board member for Bristol-Myers Squibb, Novartis, Merck, Roche, and Pfizer. No potential conflicts of interest were disclosed by the other authors.

Disclaimer

The study sponsors had no role in the study design; in the collection, analysis and interpretation data; in the writing of the report; and in the decision to submit the paper for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the study sponsors.

Authors' Contributions

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Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): D. Mays
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): D. Mays, J. Ahn, K.P. Tercyak
Writing, review, and/or revision of the manuscript: D. Mays, M.B. Atkins, J. Ahn, K.P. Tercyak
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): D. Mays
Study supervision: D. Mays, K.P. Tercyak

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Mays et al.

References

- Wehner MR, Chren MM, Nameth D, Choudhry A, Gaskins M, Nead KT, et al. International prevalence of indoor tanning: a systematic review and meta-analysis. *JAMA Dermatol* 2014;150:390-400.
- Waters HR, Adamson A. The health and economic implications of the use of tanning devices. *J Cancer Policy* 2017; [Epub ahead of print].
- Boniol M, Autier P, Boyle P, Gandini S. Cutaneous melanoma attributable to sunbed use: systematic review and meta-analysis. *BMJ* 2012;345:e4757.
- Wehner MR, Shive ML, Chren MM, Han J, Qureshi AA, Linos E. Indoor tanning and non-melanoma skin cancer: systematic review and meta-analysis. *BMJ* 2012;345:e5909.
- Guy GP, Berkowitz Z, Watson M, Holman DM, Richardson LC. Indoor tanning among young non-Hispanic white females. *JAMA Intern Med* 2013;173:1920-2.
- Guy GP, Berkowitz Z, Holman DM, Hartman AM. Recent changes in the prevalence of and factors associated with frequency of indoor tanning among US adults. *JAMA Dermatol* 2015;151:1256-9.
- Ferrucci LM, Cartmel B, Molinaro AM, Leffell DJ, Bale AE, Mayne ST. Indoor tanning and risk of early-onset basal cell carcinoma. *J Am Acad Dermatol* 2012;67:552-62.
- Lazovich D, Isaksson VR, Weinstock MA, Nelson HH, Ahmed RL, Berwick M. Association between indoor tanning and melanoma in younger men and women. *JAMA Dermatol* 2016;152:268-75.
- Hillhouse J, Turrisi R, Shields AL. Patterns of indoor tanning use: implications for clinical interventions. *Arch Dermatol* 2007;143:1530-5.
- Fell GL, Robinson KC, Mao J, Woolf CJ, Fisher DE. Skin beta-endorphin mediates addiction to UV light. *Cell* 2014;157:1527-34.
- Aubert PM, Seibyl JP, Price JL, Harris TS, Filbey FM, Jacobe H, et al. Dopamine efflux in response to ultraviolet radiation in addicted sunbed users. *Psychiatry Res* 2016;251:7-14.
- Feldman SR, Liguori A, Kucenic M, Rapp SR, Fleischer AB, Lang W, et al. Ultraviolet exposure is a reinforcing stimulus in frequent indoor tanners. *J Am Acad Dermatol* 2004;51:45-51.
- Harrington CR, Beswick TC, Graves M, Jacobe HT, Harris TS, Kourosh S, et al. Activation of the mesostriatal reward pathway with exposure to ultraviolet radiation (UVR) vs. sham UVR in frequent tanners: a pilot study. *Addict Biol* 2012;17:680-6.
- Heckman C, Darlow S, Cohen-Filipic J, Kloss J. Mood changes after indoor tanning among college women: associations with psychiatric/addictive symptoms. *Health Psychol Res* 2016;4:5453.
- Hillhouse JJ, Baker MK, Turrisi R, Shields A, Stapleton J, Jain S, et al. Evaluating a measure of tanning abuse and dependence. *Arch Dermatol* 2012;148:815-9.
- Kaur M, Liguori A, Lang W, Rapp SR, Fleischer AB, Feldman SR. Induction of withdrawal-like symptoms in a small randomized, controlled trial of opioid blockade in frequent tanners. *J Am Acad Dermatol* 2006;54:709-11.
- Heckman CJ, Darlow S, Kloss JD, Cohen-Filipic J, Manne SL, Munshi T, et al. Measurement of tanning dependence. *J Eur Acad Dermatol Venereol* 2014;28:1179-85.
- Ashrafioun L, Bonar EE. Tanning addiction and psychopathology: Further evaluation of anxiety disorders and substance abuse. *J Am Acad Dermatol* 2014;70:473-80.
- Banerjee SC, Hay JL, Greene K. Cognitive rationalizations for tanning-bed use: a preliminary exploration. *Am J Health Behav* 2013;37:577-86.
- Heckman CJ, Cohen-Filipic J, Darlow S, Kloss JD, Manne SL, Munshi T. Psychiatric and addictive symptoms of young adult female indoor tanners. *Am J Health Promot* 2014;28:168-74.
- Heckman CJ, Darlow SD, Kloss JD, Munshi T, Manne SL. Contextual factors, indoor tanning, and tanning dependence in young women. *Am J Health Behav* 2015;39:372-9.
- Mosher CE, Danoff-Burg S. Addiction to indoor tanning: relation to anxiety, depression, and substance use. *Arch Dermatol* 2010;146:412-7.
- Cartmel B, Bale AE, Mayne ST, Gelernter JE, DeWan AT, Spain P, et al. Predictors of tanning dependence in white non-Hispanic females and males. *J Eur Acad Dermatol Venereol* 2017;31:1223-8.
- Fishbein M. A theory of reasoned action: some applications and implications. *Nebr Symp Motiv* 1980;27:65-116.
- Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. *Health Educ Q* 1988;15:175-83.
- Sheeran P, Harris PR, Epton T. Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychol Bull* 2014;140:511-43.
- Banerjee SC, Hay JL, Greene K. College students' cognitive rationalizations for tanning bed use: an exploratory study. *Arch Dermatol* 2012;148:761-2.
- Carcioppolo N. When does perceived susceptibility to skin cancer influence indoor tanning? The moderating role of two risk perception beliefs. *J Health Commun* 2016;21:1170-8.
- Hillhouse J, Turrisi R, Cleveland MJ, Scaglione NM, Baker K, Florence LC. Theory-driven longitudinal study exploring indoor tanning initiation in teens using a person-centered approach. *Ann Behav Med* 2016;50:48-57.
- Noar SM, Myrick JG, Morales-Pico B, Thomas NE. Development and validation of the comprehensive indoor tanning expectations scale. *JAMA Dermatol* 2014;150:512-21.
- Mays D, Murphy SE, Bubly R, Atkins MB, Tercyak KP. Support for indoor tanning policies among young adult women who indoor tan. *Transl Behav Med* 2016;6:613-21.
- Davies JR, Chang YM, Bishop DT, Armstrong BK, Bataille V, Bergman W, et al. Development and validation of a melanoma risk score based on pooled data from 16 case-control studies. *Cancer Epidemiol Biomarkers Prev* 2015;24:817-24.
- Khalesi M, Whiteman DC, Tran B, Kimlin MG, Olsen CM, Neale RE. A meta-analysis of pigmentary characteristics, sun sensitivity, freckling and melanocytic nevi and risk of basal cell carcinoma of the skin. *Cancer Epidemiol* 2013;37:534-43.
- Cust AE, Armstrong BK, Goumas C, Jenkins MA, Schmid H, Hopper JL, et al. Sunbed use during adolescence and early adulthood is associated with increased risk of early-onset melanoma. *Int J Cancer* 2011;128:2425-35.
- Glanz K, Yaroch AL, Dancel M, Saraiya M, Crane LA, Buller DB, et al. Measures of sun exposure and sun protection practices for behavioral and epidemiologic research. *Arch Dermatol* 2008;144:217-22.
- Williams HA, Fritschi L, Beauchamp C, Katris P. Evaluating the usefulness of self-reported risk factors in a skin cancer screening program. *Melanoma Res* 2006;16:341-5.
- Banerjee SC, Greene K, Bagdasarov Z, Campo S. 'My friends love to tan': examining sensation seeking and the mediating role of association with friends who use tanning beds on tanning bed use intentions. *Health Educ Res* 2009;24:989-98.
- Hillhouse J, Turrisi R, Stapleton J, Robinson J. A randomized controlled trial of an appearance-focused intervention to prevent skin cancer. *Cancer* 2008;113:3257-66.
- Greene K, Brinn LS. Messages influencing college women's tanning bed use: statistical versus narrative evidence format and a self-assessment to increase perceived susceptibility. *J Health Commun* 2003;8:443-61.
- Nguyen KH, Marshall L, Brown S, Neff L. State-specific prevalence of current cigarette smoking and smokeless tobacco use among adults - United States, 2014. *MMWR Morb Mortal Wkly Rep* 2016;65:1045-51.
- Tan CH, Denny CH, Cheal NE, Sniezek JE, Kanny D. Alcohol use and binge drinking among women of childbearing age - United States, 2011-2013. *MMWR Morb Mortal Wkly Rep* 2015;64:1042-6.
- Blashill AJ, Williams A, Grogan S, Clark-Carter D. Negative appearance evaluation is associated with skin cancer risk behaviors among American men and women. *Health Psychol* 2015;34:93-6.
- Blashill AJ, Oleski JL, Hayes R, Scully J, Antognini T, Olendzki E, et al. The association between psychiatric disorders and frequent indoor tanning. *JAMA Dermatol* 2016;152:577-9.
- Hoyle RH, Stephenson MT, Palmgreen P, Lorch EP, Donohew RL. Reliability and validity of a brief measure of sensation seeking. *Pers Individ Dif* 2002;32:401-14.
- Robins RW, Hendin HM, Trzesniewski KH. Measuring global self-esteem: construct validation of a single-item measure and the Rosenberg Self-Esteem Scale. *Pers Soc Psychol Bull* 2001;27:151-61.
- Cash TF, Henry PE. Women's body images: the results of a national survey in the U.S.A. *Sex Roles* 1995;33:19-28.
- Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1977;1:385-401.
- Harrington CR, Beswick TC, Leitenberger J, Minhajuddin A, Jacobe HT, Adinoff B. Addictive-like behaviours to ultraviolet light among frequent indoor tanners. *Clin Exp Dermatol* 2011;36:33-8.

49. Schneider S, Schirmbeck F, Bock C, Greinert R, Breitbart EW, Diehl K. Casting shadows on the prevalence of tanning dependence: an assessment of mCAGE criteria. *Acta Derm Venereol* 2015;95:162–8.
50. Cartmel B, Dewan A, Ferrucci LM, Gelernter J, Stapleton J, Leffell DJ, et al. Novel gene identified in an exome-wide association study of tanning dependence. *Exp Dermatol* 2014;23:757–9.
51. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source Code Biol Med* 2008;3:17.
52. Tabachnick BG, Fidell LS. *Using multivariate statistics*. 5th ed. Boston, MA: Pearson; 2006.
53. Heckman CJ, Egleston BL, Wilson DB, Ingersoll KS. A preliminary investigation of the predictors of tanning dependence. *Am J Health Behav* 2008;32:451–64.
54. Hillhouse J, Stapleton J, Turrisi R. Association of frequent indoor UV tanning with seasonal affective disorder. *Arch Dermatol* 2005;141:1465.
55. Cafri G, Thompson JK, Jacobsen PB, Hillhouse J. Investigating the role of appearance-based factors in predicting sunbathing and tanning salon use. *J Behav Med* 2009;32:532–44.
56. Ashrafioun L, Bonar EE. Development of a brief scale to assess frequency of symptoms and problems associated with tanning. *J Am Acad Dermatol* 2014;70:588–9.
57. Stapleton JL, Hillhouse JJ, Turrisi R, Baker K, Manne SL, Coups EJ. The behavioral addiction indoor tanning screener (BAITS): an evaluation of a brief measure of behavioral addictive symptoms. *Acta Derm Venereol* 2016;96:552–3.
58. Flores KG, Erdei E, Luo L, White KA, Leng S, Berwick M, et al. A pilot study of genetic variants in dopamine regulators with indoor tanning and melanoma. *Exp Dermatol* 2013;22:576–81.
59. Heckman CJ, Darlow SD, Ritterband LM, Handorf EA, Manne SL. Efficacy of an intervention to alter skin cancer risk behaviors in young adults. *Am J Prev Med* 2016;51:1–11.
60. Mays D, Tercyak KP. Framing indoor tanning warning messages to reduce skin cancer risks among young women: implications for research and policy. *Am J Public Health* 2015;105:e70–e76.
61. Mays D, Zhao X. The influence of framed messages and self-affirmation on indoor tanning behavioral intentions in 18- to 30-year-old women. *Health Psychol* 2016;35:123–30.
62. Stapleton JL, Manne SL, Darabos K, Greene K, Ray AE, Turner AL, et al. Randomized controlled trial of a web-based indoor tanning intervention: acceptability and preliminary outcomes. *Health Psychol* 2015;34S:1278–85.
63. Sheeran P, Maki A, Montanaro E, Avishai-Yitshak A, Bryan A, Klein WM, et al. The impact of changing attitudes, norms, and self-efficacy on health-related intentions and behavior: A meta-analysis. *Health Psychol* 2016;35:1178–88.
64. Mays D, Evans WD. The effects of gain-, loss-, and balanced-framed messages for preventing indoor tanning among young adult women. *J Health Commun* 2017;22:604–611.
65. Stapleton JL, Hillhouse J, Levonyan-Radloff K, Manne SL. Review of interventions to reduce ultraviolet tanning: need for treatments targeting excessive tanning, an emerging addictive behavior. *Psychol Addict Behav* 2017 Jun 22. [Epub ahead of print].

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