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Predictors of Tanning Dependence in White Non-Hispanic Females and Males

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Abstract

Background—Growing evidence suggests that some individuals may exhibit symptoms of dependence on ultraviolet (UV) light, a known carcinogen, in the context of tanning; however, few studies have investigated predictors of tanning dependence (TD).

Objective—To identify predictors of tanning dependence (TD).

Methods—Non-Hispanics of European-ancestry who had previously participated in a case-control study of early-onset basal cell carcinoma completed an online survey to ascertain TD and other behaviors (alcohol dependence, nicotine dependence, seasonal affective disorder (SAD), exercise 'addiction', and depression). Information on host factors, such as skin and eye color and history of sunbathing and indoor tanning, was obtained from a study in which the participants were previously enrolled. Lifetime TD was assessed using the modified Cut down, Annoyed, Guilty, Eye-opener (mCAGE) and the modified Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (mDSM-IV-TR) questionnaires. Participants were classified as 'TD' if positive on both questionnaires and not TD if negative on both questionnaires.

Results—In total, 499 individuals completed the online survey (81.9% participation rate), 24.4% were classified as 'TD'. In the multivariate model, women were more likely to be TD (odds ratio (OR) 6.93; 95% Confidence Intervals (95% CI) (3.36–14.27)) than men. Alcohol dependence (OR 6.55: 95% CI 3.19–13.42), SAD (OR 2.77; 95% CI 1.26–6.09) and exercise 'addiction' (OR 5.47; 95% CI 1.15–26.06) were all significant predictors for TD.

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Conclusion—Increased knowledge of those at risk for TD will allow appropriate interventions to be designed.

Keywords

Tanning dependence; Ultraviolet light; Skin Cancer

INTRODUCTION

Ultraviolet (UV) light is a Class I carcinogen and the primary environmental risk factor for melanoma and non melanoma skin cancer [1] -- cancers with increasing incidence rates in the United States [2, 3] and globally [4–8]. Despite knowledge of the harmful effects of UV, individuals continue to expose themselves to UV via exposure to the sun and use of indoor tanning beds. The motivation to tan has typically been thought to be preference for a tanned appearance; however, recent evidence suggests that some individuals may become dependent on UV tanning, analogous with substance dependence [9] where, for example, individuals continue to tan despite experienced or known adverse consequences, such as skin cancer.

Supportive evidence for UV dependence includes a double-blind study in frequent tanners that observed a physiologic preference for UV-emitting tanning beds compared to non-UV light in 95% of participants, indicating tanning might have reinforcing properties [10]. Results from a similarly designed double-blind study in fibromyalgia patients found a significant positive association between mood (positive effect, well-being, relaxation) and UV light [11]. In addition, increased activity in the brain regions associated with the experience of reward was observed in subjects when using a UV tanning bed, but not when using a sham tanning bed without UV light, suggesting that UV light may have centrally rewarding properties [12, 13]. This has come to be known as tanning dependence (TD) in the literature.

A proposed mechanism for TD is the production of beta-endorphin in response to UV light exposure. Briefly, UV light induces p53 protein expression, which results in increased levels of beta-endorphin and adrenocorticotrophic hormone (ACTH), via stimulation of the pro-opiomelanocortin (POMC) gene promoter [14]. A randomized study showed that administration of naltrexone, an opioid antagonist, diminished preference for UV light and induced withdrawal symptoms in frequent tanners as compared to placebo, implicating an opiodergic pathway [15]. Similarly, work done with rodents shows that ‘opioid blockade also elicits withdrawal signs after chronic UV exposure’ and that ‘this effect was sufficient to guide operant behavioral choices to avoidance of opioid withdrawal’ [16].

TD has been assessed in several populations with two substance-related disorder questionnaires modified for tanning, namely the modified-Cut down, Annoyed, Guilty, Eye-opener (mCAGE) and the modified Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (mDSM-IV-TR) questionnaires [17]; however, limited research is available on behaviors and factors associated with TD [18–20]. In this report, we explore predictors of TD in a large sample of women and men with a history of volitional exposure to UV light.

METHODS

The individuals in this study had participated in a case-control study of early-onset basal cell carcinoma (BCC) among individuals under age 40 in Connecticut [21, 22]. As part of the case-control study, subjects completed an in-person structured interview pertaining to skin cancer risk factors.

For these analyses, we recruited a subset of participants from the case-control study to complete an online survey assessing TD and other behaviors. The survey was conducted after the case-control study by which time some subjects were aged over 40. Of the original 767 non-Hispanic European-ancestry subjects in the case-control study, six who were aged under 18 were not eligible for this online survey. Of the remaining 761 individuals (374 BCC cases and 387 controls), a total of 669 (87.9%) subjects indicated a willingness to be recontacted for additional studies. We approached these subjects by mail, requesting they complete an online survey hosted by Qualtrics©. A paper survey was sent to the small number of subjects who did not have internet access or did not want to complete the survey online. A total of 548 subjects completed the TD survey (81.9% response rate).

Assessment and Classification of Lifetime TD

Of the 548 individuals who accessed the online TD survey, 49 reported never having sunbathed or used a tanning bed (i.e. volitionally tanned), so were not eligible to complete the TD questions. The remaining 499 individuals completed two established TD scales assessing lifetime TD: the mCAGE [17, 23] and the mDSM-IV-TR-analogous questionnaire [17, 23] (i.e. not a part of any version of the DSM, but designed analogously). Individuals with two or more affirmative responses to the four questions on the mCAGE scale were classified as TD [17, 18, 23]. For the mDSM-IV-TR, individuals with three or more affirmative responses to the nine items met TD criteria [17, 18] for that scale. Participants were classified as TD if they were positively identified as TD on both scales using the criteria described above (n = 122). Similarly, participants were classified as not TD if they were identified as not TD on both scales (n = 255). This restrictive classification of TD based on a combination of two different scales was used to reduce overestimation of TD [24].

Assessment of Behavior and Lifestyle Factors

Seasonal Affective Disorder (SAD)—SAD symptoms were assessed using the Seasonal Pattern Assessment Questionnaire (SPAQ) [25, 26].

Nicotine Dependence—Participants who reported smoking more than 100 cigarettes in their lifetime were asked to complete the Fagerstrom Test for Nicotine Dependence (FTND) and were instructed to ‘Think about the period lasting a month or more when you were smoking the most.’ Respondents were categorized as either low dependence (0–5) or high dependence (6–10) [27].

Symptoms of alcohol abuse/dependence—Participants who had consumed three or more alcoholic drinks within a three-hour period on three or more occasions during their

lifetimes were directed to complete questions from the alcohol section of the Mini International Neuropsychiatric Interview (MINI) Lifetime Version. Individuals were classified as 'No symptoms of alcohol abuse' or 'Symptoms of alcohol abuse' or 'Symptoms of alcohol dependence' [28].

Depression was assessed using the Center for Epidemiological Studies Depression Scale (CES-D) [29]. Participants were dichotomized as less than 16 (no depressive symptomatology) or 16 or greater (significant depressive symptomatology).

Exercise 'addiction'—This has been described as "a morbid pattern of behavior in which the habitually exercising individual loses control over his or her exercise habits and acts compulsively, exhibits dependence, and experiences negative consequences to health as well as in his or her social and professional life" [30]. A score of 24 or above on the six item exercise 'addiction' inventory (which, like TD, is not a standard DSM diagnosis) was considered at risk for exercise 'addiction' [31].

Drug use—Ever use of the following drugs was assessed: cannabis, cocaine, prescription stimulants, methamphetamine, inhalants, sedatives or sleeping pills, hallucinogens, street opioids, and prescription opioids. Use was categorized into 'Never use,' 'Marijuana use only' or 'Use of drug other than Marijuana'.

Skin Cancer Risk Factors—Data on sociodemographics, host characteristics (e.g. eye color, skin color, etc.), lifetime indoor tanning sessions, sunburns from outdoor exposure, and lifetime alcohol consumption were available from the case-control study structured interview [22].

Statistical Analysis

Univariate associations between TD and other behaviors and host factors were evaluated using the chi-squared test, Fisher's exact test, and analysis of variance. Logistic regression models were used to assess predictors of TD using 'not tanning dependent' as the comparison group. Multivariate models were built using backward selection to construct the most parsimonious model for predictors of the TD retaining variables with a p-value < 0.05. The variables which were evaluated in building the multivariate models were those that were statistically significant at the 0.05 level in univariate analyses. Data were analyzed using SAS 9.4 software (SAS Institute Inc., Cary, NC).

Ethics

Our study was approved by the Yale University Institutional Review Board and Human Subjects Committee (Protocol #0612002107, Approved: 02/02/2007). Subjects provided written informed consent.

RESULTS

The majority of the 499 participants was female (75%), and the average age at completion of the survey was 38.5±4.8 years. The concordance of TD as assessed by the mCAGE and the mDSM-IV-TR is shown in Table 1. 122 (24.5%) participants (29.1% of females and 10.4%

of males) were classified as having ‘TD’ (positive for TD on both scales) and 225 participants (45.1% of females and 69.3% of males) were classified as not tanning dependent. Those who were positive on only one scale (n=122) were excluded from the analysis.

Those who were ‘TD’ reported engaging in the more lifetime indoor tanning sessions than those who were not TD (424 vs. 46; p<0.0001) (Table 2). A similar pattern was seen for sunbathing sessions (706 vs. 303; p<0.0001) (Table 2). In the univariate analysis, skin reaction with prolonged sun exposure was significantly associated with TD, with those who reported their reaction as ‘Very brown, deeply tanned’ being more likely to be ‘TD’ (p=0.005) (Table 2). A history of symptoms of alcohol addiction (p<0.001), SAD (p=0.001) and a history of risk of exercise addition (p=0.01) were associated with TD (Table 3).

In the multivariate regression model, sex (odds ratio (OR) 6.93; 95% Confidence interval (95% CI) 3.36–14.27), SAD (OR 2.77; 95% CI 1.26–6.09), a history of symptoms of alcohol abuse (OR 6.55; 95% CI 3.19–13.42), and history of risk of exercise ‘addiction’ (OR 5.47; 95% CI 1.15–26.06) were significantly associated with having ‘TD’ compared to not TD (Table 4).

DISCUSSION

In our study of non-Hispanic white young women and men who reported volitional tanning during their lifetime, we found that 24.5% had ‘TD’. We identified several predictors of TD, including a history of symptoms of alcohol addiction, SAD, a history of risk of exercise ‘addiction’ and female sex.

Though several studies have examined predictors of TD, comparisons across studies are hampered by the use of differing definitions of TD, a result of the use of different instruments to assess TD and differing study eligibility criteria. For example, some studies did not assess volitional tanning in the study population [17], while other studies only recruited active indoor tanners [18]. However, our findings regarding the positive association between TD and symptoms of alcohol dependence and alcohol use are in concordance with those of other researchers [19]. For example, in a group of over 300 female college students aged 18–25 years, those who were classified as TD were three times more likely to have symptoms of alcohol abuse or dependence compared to those who were not tanning dependent [19].

To our knowledge, we are the first to examine exercise ‘addiction’ as a predictor of TD, finding that those who were TD were three times as likely to have a history of risk of exercise ‘addiction’, respective to those who were not TD. Heckman et al. [32] reported a borderline positive association between moderate anaerobic exercise (p=0.07) and TD. It is possible that individuals who are at risk for exercise ‘addiction’ may be driven by exercise’s impacts on appearance, and the concern for one’s appearance has been related to tanning behaviors [33][34]. Recent research in a nationally representative samples of adolescents suggests a link between unhealthy weight control behaviors and indoor tanning in both males and females [35], further supporting a role of an appearance driven motivation to tan,

with neurotic temperament hypothesized as a common causative factor [36]. However, further research is required to gain a better understanding of this relationship.

SAD and symptoms of SAD have previously been reported to be more common in female college students who indoor tanned more frequently [37]. However, in a recent study of 306 female university students, 24.5% of whom were tanning dependent, SAD was not significantly associated with TD [19]. In contrast, we found that SAD was almost three times more frequent in those who had 'TD' compared to those who were not tanning dependent. In these subjects, we hypothesize that light exposure might be sought to improve depressive symptoms and be viewed as "self-medication."

Smoking has generally not been associated with TD [18, 19, 23]. Similarly, we found no association between nicotine dependence and TD. As in reports from other studies [18, 19], depression was not associated with TD in our population. While drug use was also not associated with TD in our study, marijuana use in the prior 30 days has been associated with TD [18]; however, there was no association with other addictive disorders (e.g. nicotine, alcohol and illicit drugs) in a group of indoor tanners recruited from the community [23].

Few studies have evaluated sex as a predictor of TD. Heckman et al [32] reported a non-significant 1.37 odds of females being tanning dependent compared to males and in a group of indoor tanners recruited from the community [32]. In our study, we found that females were almost 7 times more likely to have 'TD' compared to males.

Our study has several strengths, including a large sample size and exclusion of individuals who had not volitionally tanned. Previous studies have not restricted enrollment based on history of volitional tanning, so include those who have never sought out UV exposure and are likely unable to accurately complete the questionnaires designed to assess TD leading to misclassification in this group. All the assessments for TD and other addictive behaviors in our study were online, which may be less susceptible to social desirability bias than in-person or telephone data collection. Our study also has some potential weaknesses including assessment of lifetime TD (asking subjects to think back over their lifetime), rather than assessment of current TD, and so TD may be susceptible to poor recall. However, the percentages of our population who met the criteria for TD based on the mCAGE (29.1%) and mDSM-IV-TR (44.3%) separately are very similar to those reported for other studies of volitional tanners. An additional potential limitation is the inclusion of patients diagnosed with BCC, as this skin cancer diagnosis may have affected responses to the TD scales, thus limiting the generalizability of the study. However, all the tanning behavior questions and the TD scales asked individuals to think about lifetime exposure and attitudes to minimize any difference by BCC case status.

Although recent reports of the declining use of indoor tanning by adolescents and adults in the US [38, 39] are encouraging, an estimated 9.7 million adults in the US continue to indoor tan [39]. Individuals who are tanning dependent may require additional targeted interventions to reduce indoor tanning and sunbathing behaviors. The predictors of TD we identified may be useful in modifying skin cancer prevention messages and interventions for these subgroups [40]. For example, since SAD was associated with an increased risk of TD,

encouraging treatments for SAD that do not involve exposure to UV light, such as light therapy delivered via a light box, may reduce UV exposure in individuals with SAD who are tanning dependent. Also, our finding on the association between risk of exercise 'addiction' and TD warrants further research; particularly as unsupervised indoor tanning facilities are available in many gyms

CONCLUSION

Our work showing associations between TD, some addictions including alcohol addiction, and SAD suggests that assessment of these conditions is important in excessive tanners, as these conditions may need to be addressed to achieve a reduction in UV exposure.

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Table 1

mCAGE	mDSM-IV-TR		Total N (%)
	Tanning Dependent	Not Tanning Dependent	
Tanning Dependent	122 (24.5)	23 (4.6)	145 (29.1)
Not Tanning Dependent	99 (19.8)	255 (51.1)	354 (69.9)
Total	**221 (44.3)**	**278 (55.7)**	**499**

Table 2

	Not TD[2] (*N* = 255) *N* (%) or Mean (SD)	TD[2] (*N* = 122) *N*(%) or Mean (SD)	*P*-value
Age at survey	38.6 (5.1)	39.0 (4.3)	0.53
Females	169 (66.3)	109 (89.3)	<0.0001
Education:			0.44
9–12th Grade	20 (7.8)	8 (6.5)	
Post HS training	52 (20.4)	34 (27.9)	
College/College Grad	110 (43.1)	47 (38.5)	
> Some graduate school	73 (28.6)	33 (27.0)	
BMI:			0.12
<25	143 (56.1)	82 (67.2)	
25–<30	67 (26.3)	23(18.8	
>30	45 (16.6)	17 (13.9)	
Prior Basal Cell Carcinoma	126 (49.4)	71 (58.2)	0.11
Skin color:			0.41
Olive	26 (10.2)	11 (9.0)	
Fair	147 (57.6)	79 (64.7)	
Very Fair	82 (32.2)	32 (26.2)	
Skin reaction with prolonged sun exposure:			0.0005
Very brown, deeply tanned	31 (12.2)	25 (20.5)	
Moderately tanned	125 (49.0)	66 (54.1)	
Mildly tanned peeling tendency/freckled no suntan	99 (38.8)	31 (25.6)	
Skin reaction with first summer sun exposure:			0.01
Severe sunburn	9 (3.5)	9 (7.4)	
Painful sunburn followed by peeling	124 (48.8)	50 (41.0)	
Mildly burnt & some tanning/no sunburn	121 (47.6)	63 (51.6)	

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	Not TD[2] (*N* = 255) *N* (%) or Mean (SD)	TD[2] (*N* = 122) *N*(%) or Mean (SD)	*P*-value
Lifetime Indoor tanning sessions	46 (130)	424 (795)	<0.0001
Lifetime Sunbathing sessions	303 (339)	706 (467)	<0.0001

Table 3

	Not TD[2] (*N* = 255) *N* (%)	TD[2] (*N* = 122) *N* (%)	*P*-value
Illicit drug use:			0.10
Never use	98 (41.9)	35 (31.8)	
Marijuana only	56 (23.4)	25 (22.7)	
Poly drug use	80 (34.2)	50 (45.4)	
Symptoms of SAD	14 (5.5)	21 (17.8)	0.0002
History of Depression	63 (24.7)	41 (33.6)	0.07
History of Exercise Addiction	3 (1.18)	7 (5.7)	0.013
History of Alcohol addiction:			0.0001
No	159 (62.3)	47 (38.5)	
Abuse	65 (25.5)	43 (35.2)	
Dependence	31 (12.2)	32 (26.2)	
Nicotine addiction (current or past smokers only)	9 (9.0)	9 (17.3)	0.26

Table 4

	N	TD vs. Not TD OR (95% CI)
Sex		
Male	13/86	1.0
Female	109/169	6.93 (3.36–14.27)
SAD		
No	81/162	1.0
Yes	41/63	2.77 (1.26–6.09)
Alcohol		
No dependence or abuse	47/159	1.0
Dependence	43/65	6.55 (3.19–13.42)
Abuse	32/31	3.16 (1.81–5.51)
Risk of Exercise ‘Addiction’		
No	115/222	1.0
Yes	7/3	5.47 (1.15–26.06)