

Sunless and Indoor Tanning Among U.S. Non-Hispanic White Women Ages 18–49 Years

Andrew B. Seidenberg, Anne K. Julian, Anne M. Hartman, and Dawn M. Holman

ABSTRACT: The use of indoor ultraviolet tanning devices (also known as “indoor tanning”) has declined in recent years. Less is known about use of dihydroxyacetone-containing products used for tanning (also known as “sunless tanning”). We analyzed data from the 2015 National Health Interview Survey. Analysis was limited to non-Hispanic white women ages 18–49 years. We estimated the proportion of women reporting spray tanning, self-applied lotion tanning, and indoor tanning and used weighted multivariable logistic regression models to examine the relationships between sociodemographic characteristics, skin cancer risk factors, and other cancer risk factors with sunless and indoor tanning. Overall, 17.7% of women reported sunless tanning. Lotion tanning was more common (15.3%) than spray tanning (6.8%), whereas 12.0% of women engaged in indoor tanning. Among sunless tanners, 23.7% also engaged in indoor tanning. Younger

age, ever having a skin examination, skin reactions to the sun, binge drinking, and being at a healthy weight were associated with sunless tanning. Although sunless tanning may be less harmful for skin cancer risk than indoor tanning, the frequency with which the two behaviors co-occur suggests that efforts to address societal pressures for women to alter their skin color may have important public health benefits.

Key words: Skin Cancer, Tanning, Sunless Tanning, Tanning Beds, Women

BACKGROUND

Skin exposure to ultraviolet (UV) radiation, from either the sun or artificial sources (e.g., indoor tanning devices), causes skin darkening by stimulating melanocytes to produce melanin (Gilchrest, 2011; Gilchrest & Eller, 1999). However, this process also induces DNA damage and increases the risk of skin cancer (Armstrong & Kricke, 2001). In the United States, skin cancer is the most commonly diagnosed cancer, with nearly 5 million Americans treated for the disease annually, costing an estimated \$8.1 billion (Guy et al., 2015; U.S. Department of Health and Human Services, 2014). Moreover, exposure to UV radiation is the leading modifiable risk factor for skin cancer (U.S. Department of Health and Human Services, 2014).

Sunless tanning is an alternative way to cosmetically create the appearance of a tan without exposing the skin to UV radiation (S. Pagoto, 2012). The most common method of sunless tanning is the application of products containing dihydroxyacetone (DHA), a three-carbon sugar (Braunberger et al., 2018; S. Pagoto, 2012). When applied to the skin, DHA reacts with amino acids located in the stratum corneum to form brown-colored pigments (melanoidins). This method is driven by the Maillard reaction and is not removed with soap and water, but only through pigment loss from skin sloughing (S. Pagoto, 2012; Rogers, 2005). The U.S. Food and Drug Administration (FDA)

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has approved DHA for topical application, and the chemical is found in many self-applied, over-the-counter sunless tanning lotions. DHA is also frequently an ingredient in spray tanning formulations, despite not being FDA approved for such application. According to the FDA, safety information to support the use of DHA in spray tanning formulations has not been submitted to the agency for review (FDA, 2022b). Nonetheless, the FDA recommends using eye, mouth, and nose protection when undergoing a spray tan to prevent DHA inhalation, ingestion, and exposure to mucous membranes (FDA, 2022b). In addition, DHA use before UV exposure may increase production of damaging reactive oxygen species, which has implications for skin cancer risk (Jung et al., 2008). The market for self-tanning products was estimated to reach \$386.1 million in 2021 in the United States (Cision PR Newswire, 2021).

The prevalence of the use of indoor tanning devices (referred to as “indoor tanning” throughout this article) among Americans has significantly declined over time. Between 2010 and 2015, indoor tanning among adult women declined from 8.6% to 5.2% (Guy et al., 2017). Among non-Hispanic white women ages 18–21 years, the group with the highest prevalence of use, indoor tanning declined from 31.8% to 20.4% during the same period (Guy et al., 2017). The number of indoor tanning facilities in some U.S. jurisdictions is also declining (2012–2019; Seidenberg et al., 2019). Several factors may be contributing to this prepandemic trend, including increased awareness of the health risks of indoor tanning, increased pricing (e.g., through taxation), and restrictions on youth access to indoor tanning devices (Holman et al., 2013; Seidenberg et al., 2015; Watson et al., 2013). However, despite these declines, social pressures for tanned skin may still exist. Consequently, women may be turning to sunless tanning to cosmetically darken their skin.

Few studies have examined the prevalence and predictors of the use of sunless tanning products that contain DHA (referred to as “sunless tanning” throughout this article). Furthermore, among the existing research, several studies are >15 years old. For instance, Stryker et al. analyzed nationally representative telephone survey data collected in 2005 and found that 11% of U.S. adults reported past-year use of sunless tanning products (Stryker et al., 2007). Similarly, Cokkinides et al. found that 10.8% of U.S. adolescents reported sunless tanning in 2004 (Cokkinides et al., 2010). A more recent analysis of the National Health Interview Survey (NHIS) data published by Dodds et al. found that 6.4% of U.S. adults engaged in sunless tanning in 2015 (Dodds et al., 2018). Although sunless tanning products may be used to replace indoor tanning, Dodds et al. found sunless tanning to be associated with indoor tanning (Dodds et al., 2018). Both behaviors may be driven by similar psychosocial processes related to appearance and attractiveness.

Monitoring sunless tanning behaviors, which include spray tanning and use of tanning lotions, may help advance

understanding of the cultural pressure women may experience to have a tanned appearance. In addition, although previous research has tended to combine use of self-applied tanning products (e.g., lotions) and spray tanning into a single sunless tanning category (Dodds et al., 2018; Stryker et al., 2007), separately examining these behaviors may provide important insight. For instance, one study found that use of tanning lotions is associated with sunburn, whereas spray tanning is not (Holman et al., 2018). The purpose of this study is to identify the prevalence of and factors associated with sunless tanning behaviors among non-Hispanic white women, the demographic with the highest prevalence of tanning behaviors. In this study, we additionally examine indoor tanning as a comparison and potentially co-occurring behavior.

METHODS

Data Description

We analyzed data from the 2015 NHIS, a nationally representative, cross-sectional survey of civilian, noninstitutionalized adults and children in the United States. NHIS uses a complex, multistage area probability sampling design that allows for representative sampling of households and noninstitutionalized group quarters. NHIS is conducted using computer-assisted personal interviewing within respondents' homes and sometimes by telephone.

Data on the use of sunless and indoor tanning came from the NHIS Cancer Control Supplement. Cancer Control Supplement data were merged with the NHIS's Sample Adult and Person files (which contain sociodemographic information), using household, family, and person record identifiers. The final unconditional response rate for the 2015 Sample Adult module was 55.2% (National Center for Health Statistics, 2016), and 33,672 adults completed the Cancer Control Supplement. The 2015 NHIS is the same data source analyzed in Dodds et al. (Dodds et al., 2018), but our study focuses on a different population, includes different covariates, and provides results separately for spray tanning and tanning lotion. To our knowledge, the 2015 NHIS is the most recent national survey data available that measured sunless tanning behaviors in the United States.

Measures

All participants were asked about two forms of sunless tanning: use of self-applied sunless tanning products (here forward referred to as lotion tanning) and spray tanning. To assess use of lotion tanning products, participants were asked: “During the past 12 months, have you used self-applied sunless tanning products, also known as self-tanning or fake tanning?” Similarly, spray tanning use was assessed by asking, “During the past 12 months, have you gotten a spray-on or mist tan at a tanning salon or other business?” Indoor tanning use was measured by asking, “During the past 12 months, have you used an

indoor tanning device such as a sunlamp, sunbed, or tanning booth even one time? Do not include times you have gotten a spray-on tan.”

In addition, participants responded to a variety of items measuring relevant sociodemographic characteristics (i.e., age, marital status, education, race/ethnicity, gender), skin cancer risk factors, and other cancer risk factors (i.e., smoking status, alcohol use, body mass index [BMI]). Skin cancer risk factors included number of past-year sunburns (coded as ≥ 1 or 0), ever having a full-body skin examination for skin cancer (coded as yes/no), and frequency of sunscreen use on a warm sunny day (coded as always/most of the time, sometimes/rarely, never, or don't go out in the sun). In addition, two measures of respondents' perceptions of their skin's reaction to sun exposure were included. Short-term skin reactions were measured by asking, “...if you went out in the sun for an hour without sunscreen, a hat, or protective clothing, which one of these best describes what would happen to your skin?” (coded as darker/nothing, severe/moderate/mild burn, or don't go out in the sun). Longer-term skin reactions were measured by asking, “Next, consider that you were out in the sun repeatedly, such as every day for two weeks, without sunscreen, a hat, or protective clothing. Which one of these best describes what your skin would LOOK like?” (coded as freckle or burn, very dark/dark/mild tan, or don't go out in the sun).

Analyses

All analyses were performed using Stata v16.1. Weighted population estimates (with Korn–Graubard 95% confidence intervals; Ward, 2019) were calculated for each type of sunless tanning and indoor tanning. In addition, a composite sunless tanning variable was created for engaging in either spray or lotion tanning. Because of low prevalence of sunless tanning among men (1.2%), nonwhite women (e.g., Asian Americans [1.3%], African Americans [0.8%]), Hispanics (2.8%), and older adults (ages 51–65 years: 6.1%; ages >65 years: 3.3%), analyses were limited to non-Hispanic white women ages 18–49 years (Dodds et al., 2018). All analyses were weighted by applying the survey's sample weight (WTFA), and design-adjusted standard errors were calculated by applying the survey's primary sampling unit (PSU_P) and strata (STRAT_P) variables using the Taylor series approximation. Estimates were also calculated for a variety of subpopulations (e.g., by sociodemographic characteristics, skin cancer risk factors). We used Stata's “subpop” command for all subpopulation estimates and used design-corrected Pearson chi-square with second-order correction of Rao and Scott to examine bivariate relationships with a critical value of .05. For all weighted proportions, we used the `kg_nchs` postestimation Stata command to evaluate the estimate's reliability (Ward, 2019). The `kg_nchs` command flags estimates not meeting the National Center for Health Statistics data presentation standards for proportions (Ward,

2019). Estimates not meeting the National Center for Health Statistics standards were suppressed.

To further identify factors associated with sunless tanning, weighted multivariable logistic regression models were estimated with the following dependent variables: past-year lotion tanning, spray tanning, and any sunless (i.e., either lotion or spray) tanning. For comparative purposes, we also estimated a multivariable logistic regression model for past-year indoor tanning. All models included sociodemographic characteristics (age, marital status, education, U.S. census region), skin cancer risk factors (sunburn in the past year, ever had skin examination, sunscreen use, short- and longer-term reactions to the sun), and other cancer risk factors (smoking, alcohol use, BMI). We used Stata's “collin” command to look for the presence of multicollinearity, and valence inflation factors ranged from 1.01 to 1.29 (mean = 1.11). Missingness ranged from 0% to 6.83% for independent variables and from 5.98% to 6.00% for dependent variables from the analytic sample (Supplemental Table 1, available at <http://links.lww.com/JDNA/A13>). List-wise deletion was used for all analyses.

RESULTS

Table 1 includes weighted prevalence estimates for any sunless tanning, lotion tanning, spray tanning, and indoor tanning by sociodemographic characteristics, skin cancer risk factors, and other cancer risk factors. Overall, 17.7% of non-Hispanic white women ages 18–49 years reported sunless tanning use. Lotion tanning was more common (15.3%) than spray tanning (6.8%). In comparison, 12.0% of women engaged in indoor tanning. In addition, engaging in dual-tanning behaviors was common. Among women engaging in spray tanning, 64.6% also reported lotion tanning, and 31.8% reported indoor tanning. Furthermore, among women reporting lotion tanning, 28.4% and 22.0% also spray tanned and indoor tanned, respectively. Among users of any type of sunless tanning, 23.7% also engaged in indoor tanning. Finally, among current indoor tanners, 28.2% and 17.9% also engaged in lotion tanning and spray tanning, respectively.

Over one fifth (21.2%) of younger women (ages 18–29 years) reported any sunless tanning, compared with 16.5% and 14.9% of those ages 30–39 and 40–49 years, respectively ($p = .004$). Women ages 18–29 years had a higher prevalence of spray tanning (9.1%) and indoor tanning (15.9%), compared with women ages 40–49 years (spray tanning: 4.4%; indoor tanning: 8.9%). By education, less educated women had lower prevalence of any sunless, lotion tanning, and spray tanning, compared with more educated women ($p \leq .005$). For instance, 17.6% of women with a bachelor's degree or greater lotion tanned, compared with 11.2% of women with a high school diploma or less. The reverse trend was found for indoor tanning, where prevalence was highest among women with a high school diploma or less (14.6%) and lowest among those with a bachelor's degree or higher (8.6%). Census region and

TABLE 1. Weighted Unadjusted Proportions of Engaging in Any Sunless Tanning, Lotion Tanning, Spray Tanning, or Indoor Tanning in Past 12 Months Among U.S. Non-Hispanic White Women Ages 18–49 Years, United States, 2015

	Sunless (Lotion or Spray)		Lotion Tanning		Spray Tanning		Indoor Tanning	
	Weighted %	p Value	Weighted %	p Value	Weighted %	p Value	Weighted %	p Value
Total	17.7 (16.1, 19.4)		15.3 (13.9, 16.9)		6.8 (5.7, 7.9)		12.0 (10.7, 13.5)	
Sociodemographic factors								
Age (years)								
18–29	21.2 (17.8, 24.8)	.004	17.6 (14.7, 20.9)	.064	9.1 (7.0, 11.8)	<.001	15.9 (13.3, 18.7)	<.001
30–39	16.5 (14.2, 18.9)		14.3 (12.2, 16.7)		6.3 (5.0, 8.0)		10.6 (8.8, 12.6)	
40–49	14.9 (12.7, 17.4)		13.7 (11.5, 16.1)		4.4 (3.1, 6.0)		8.9 (7.0, 11.0)	
Marital status								
Married/living with partner	16.8 (15.0, 18.9)	.150	14.7 (12.9, 16.6)	.322	6.0 (4.9, 7.3)	.195	10.8 (9.2, 12.6)	.031
Never married	20.3 (16.8, 24.3)		17.2 (13.9, 20.8)		8.2 (5.7, 11.4)		14.3 (11.7, 17.2)	
Widowed, divorced, separated	16.6 (12.6, 21.2)		14.5 (10.8, 19.0)		7.9 (4.7, 12.3)		13.6 (10.3, 17.6)	
Education								
High school diploma or less	12.4 (9.8, 15.4)	<.001	11.2 (8.8, 14.2)	.004	3.7 (2.2, 5.9)	.005	14.6 (12.0, 17.6)	<.001
Some college or associate degree	19.0 (16.3, 22.0)		15.5 (13.1, 18.3)		8.0 (6.2, 10.2)		14.1 (11.7, 16.8)	
Bachelor's degree or higher	19.8 (17.4, 22.4)		17.6 (15.3, 20.0)		7.5 (6.0, 9.3)		8.6 (6.9, 10.5)	
US Census region								
Northeast	16.6 (12.3, 21.7)	.298	13.9 (10.2, 18.2)	.207	6.3 (3.3, 10.6)	.701	9.0 (6.4, 12.2)	<.001
Midwest	17.7 (14.6, 21.1)		14.7 (12.0, 17.8)		6.8 (4.8, 9.3)		15.9 (13.2, 18.9)	
South	16.7 (14.2, 19.3)		14.8 (12.5, 17.4)		6.3 (4.8, 8.0)		13.2 (10.8, 15.9)	
West	20.9 (17.4, 24.8)		18.6 (15.3, 22.4)		8.0 (5.9, 10.7)		7.3 (4.9, 10.3)	
Skin cancer risk factors								
Sunburn in the past year								
No	13.3 (11.2, 15.7)	<.001	11.3 (9.3, 13.5)	<.001	5.2 (3.8, 6.8)	.013	10.7 (8.7, 12.9)	.085
Yes	20.8 (18.5, 23.2)		18.2 (16.1, 20.5)		7.8 (6.4, 9.4)		12.9 (11.3, 14.7)	
Ever had a skin examination								
No	15.7 (14.1, 17.6)	<.001	13.5 (12.0, 15.2)	<.001	6.0 (4.9, 7.2)	.005	12.9 (11.2, 14.6)	.012
Yes	23.9 (20.2, 27.8)		21.0 (17.5, 24.9)		9.1 (7.0, 11.7)		9.1 (7.0, 11.5)	
Sunscreen use on a warm sunny day								
Always/most of the time	19.1 (16.9, 21.5)	<.001	16.9 (14.9, 19.0)	.002	7.5 (6.0, 9.2)	.270	8.6 (7.2, 10.1)	<.001
Sometimes/rarely	19.2 (16.2, 22.4)		16.2 (13.4, 19.5)		6.5 (4.9, 8.6)		15.4 (12.5, 18.6)	
Never	12.3 (9.3, 15.9)		10.1 (7.5, 13.3)		5.1 (3.2, 7.7)		19.4 (15.6, 23.7)	
Don't go out in the sun	–		–		–		–	
Short-term reactions to the sun ^a								
Darker or nothing	12.3 (9.8, 15.2)	<.001	10.4 (8.0, 13.2)	<.001	4.4 (3.0, 6.2)	.006	15.1 (12.2, 18.5)	.001
Severe/moderate/mild burn	19.9 (17.9, 22.0)		17.3 (15.5, 19.2)		7.7 (6.4, 9.2)		11.4 (9.9, 13.0)	
Don't go out in the sun	–		–		–		–	

(continues)

TABLE 1. Weighted Unadjusted Proportions of Engaging in Any Sunless Tanning, Lotion Tanning, Spray Tanning, or Indoor Tanning in Past 12 Months Among U.S. Non-Hispanic White Women Ages 18–49 Years, United States, 2015, Continued

	Sunless (Lotion or Spray)		Lotion Tanning		Spray Tanning		Indoor Tanning	
	Weighted %	p Value	Weighted %	p Value	Weighted %	p Value	Weighted %	p Value
Longer-term reactions to the sun ^b								
Freckle or burn	17.0 (13.9, 20.5)	.006	14.9 (12.0, 18.2)	.027	6.7 (4.8, 9.0)	.250	5.3 (4.0, 7.0)	<.001
Very dark/dark/ mild tan	18.9 (17.0, 20.9)		16.2 (14.4, 18.2)		7.1 (5.9, 8.4)		15.5 (13.6, 17.6)	
Don't go out in the sun	–		–		–		–	
Other cancer risk factors								
Current smoker								
No	18.6 (16.8, 20.5)	.020	16.3 (14.6, 18.0)	.008	7.0 (5.8, 8.3)	.439	11.0 (9.5, 12.7)	.001
Yes	14.1 (11.2, 17.5)		11.4 (8.7, 14.7)		5.9 (3.9, 8.5)		16.2 (13.4, 19.4)	
Alcohol use								
Nondrinker	15.7 (13.3, 18.3)	<.001	13.4 (11.2, 15.9)	<.001	5.4 (3.9, 7.2)	<.001	9.9 (8.2, 11.9)	<.001
Current drinking (no binge)	15.2 (13.0, 17.5)		13.3 (11.3, 15.5)		5.9 (4.6, 7.5)		11.0 (9.2, 13.0)	
Binge drinking ^c	29.5 (24.6, 34.8)		25.5 (20.9, 30.5)		12.2 (9.0, 16.2)		19.5 (15.8, 23.6)	
Body mass index								
<18.5 (underweight)	–	<.001	–	<.001	–	.140	–	.026
18.5–24.9 (healthy weight)	20.5 (18.1, 23.1)		17.5 (15.3, 19.9)		8.0 (6.3, 10.0)		12.9 (11.0, 15.1)	
25.0–29.9 (overweight)	19.6 (16.4, 23.1)		17.7 (14.5, 21.1)		6.7 (4.8, 8.9)		13.7 (11.0, 16.8)	
≥30.0 (obese)	11.9 (9.4, 14.7)		9.9 (7.6, 12.6)		4.8 (3.5, 6.5)		9.2 (7.0, 12.0)	

^aShort-term reactions to the sun were measured by asking participants, "...if you went out in the sun for an hour without sunscreen, a hat, or protective clothing, which one of these best describes what would happen to your skin?" ^bLonger-term reactions to the sun were measured by asking, "Next, consider that you were out in the sun repeatedly, such as every day for two weeks, without sunscreen, a hat, or protective clothing. Which one of these best describes what your skin would LOOK like?" ^cBinge drinking = consuming five or more drinks in a day (men) or four or more drinks in a day (women) in the past year. Estimates failing to meet the National Center for Health Statistics standards for proportions have been suppressed.

marital status did not reach statistical significance for their association with sunless tanning behaviors.

Past-year sunburning, ever having a skin examination, sunscreen use, and short- and longer-term skin reactions to the sun were all associated with sunless tanning. Women reporting a sunburn in the past year had a higher prevalence of both lotion tanning (18.2% vs. 11.3%; $p < .001$) and spray tanning (7.8% vs. 5.2%; $p = .013$), compared with women not experiencing a sunburn. Women who reported ever having a full-body skin examination also had a higher prevalence of lotion tanning (21.0% vs. 13.5%; $p < .001$) and spray tanning (9.1% vs. 6.0%; $p = .005$), compared with those with no skin examination. Women who reported wearing sunscreen always/most of the time (16.9%) or sometimes/rarely (16.2%) had a higher prevalence of lotion tanning compared with those who never wear sunscreen (10.1%). The association between wearing sunscreen and spray tanning did not reach statistical significance.

Engaging in lotion tanning and spray tanning was both associated with short-term reactions to sun exposure ($p \leq .006$),

with the highest tanning prevalence among women whose skin would burn (lotion tanning: 17.3%; spray tanning: 7.7%), compared with women whose skin would darken/ nothing happens (lotion tanning: 10.4%; spray tanning: 4.4%). Longer-term reactions to the sun were also associated with lotion tanning ($p = .027$), but not spray tanning ($p = .250$). Moreover, women who currently do not smoke had a higher prevalence of lotion tanning (16.3%) compared with women who smoke (11.4%; $p = .008$), whereas smoking status was not associated with spray tanning ($p = .439$). Compared with the sunless tanning prevalence among women who do not drink alcohol (15.7%) and those who drink alcohol but do not binge drink (15.2%), women who binge drank had nearly twice the prevalence of any sunless tanning (29.5%; $p < .001$). Women who binge drank reported a higher prevalence of lotion tanning (25.5%), spray tanning (12.2%), and indoor tanning (19.5%), relative to nondrinking individuals (lotion tanning: 13.4%; spray tanning: 5.4%; indoor tanning: 9.9%) and women who drank but did not binge drink (lotion tanning: 13.3%; spray tanning: 5.9%; indoor

tanning: 11.0%; all $ps < .001$). Women with obesity had a lower prevalence of lotion tanning (9.9%) compared with women who are overweight (17.7%) and healthy-weight women (17.5%; $p < .001$). There was no statistically significant bivariate relationship between BMI and spray tanning.

In adjusted logistic regression models, age and multiple skin cancer risk factors were associated with sunless tanning. Women ages 40–49 years had lower odds for any sunless tanning (adjusted odds ratio [aOR] = 0.65, 95% CI [0.47, 0.88]) and spray tanning (aOR = 0.41, 95% CI [0.26, 0.64]), compared with women ages 18–29 years. Moreover, women ages 40–49 years had lower odds for indoor tanning (aOR = 0.51, 95% CI [0.36, 0.73]). Past-year sunburning was associated with greater odds of lotion tanning (aOR = 1.34, 95% CI [1.01, 1.78]), but not spray tanning (aOR = 1.19, 95% CI [0.79, 1.78]). Women reporting ever having a full-body examination for skin cancer had higher odds of any sunless tanning (aOR = 1.70, 95% CI [1.31, 2.20]), lotion tanning (aOR = 1.66, 95% CI [1.24, 2.21]), and spray tanning (aOR = 1.74, 95% CI [1.23, 2.47]), but not indoor tanning (aOR = 0.99, 95% CI [0.70, 1.40]).

Compared with women who reported their skin turns darker/nothing happens after 1 hour in the sun unprotected, women whose skin would burn (severe/moderate/mildly) had greater odds of any sunless tanning (aOR = 1.71, 95% CI [1.26, 2.30]), lotion tanning (aOR = 1.68, 95% CI [1.23, 2.31]), and spray tanning (aOR = 1.81, 95% CI [1.12, 2.94]), but not indoor tanning (aOR = 1.05, 95% CI [0.75, 1.48]). In addition, women whose skin would tan (very dark/dark/mild) after being in the sun repeatedly without protection had greater odds of any sunless tanning (aOR = 1.33, 95% CI [1.02, 1.72]) and indoor tanning (aOR = 2.72, 95% CI [1.89, 3.91]), but not lotion tanning (aOR = 1.30, 95% CI [0.99, 1.72]) or spray tanning (aOR = 1.22, 95% CI [0.83, 1.80]), compared with women whose skin would freckle/burn.

In addition, women who reported binge drinking had higher odds of any sunless tanning (aOR = 1.90, 95% CI [1.40, 2.58]), lotion tanning (aOR = 1.90, 95% CI [1.38, 2.61]), spray tanning (aOR = 1.98, 95% CI [1.25, 3.13]), and indoor tanning (aOR = 2.18, 95% CI [1.55, 3.08]), compared with women who do not drink alcohol. Moreover, women with obesity had significantly lower odds of any sunless tanning (aOR = 0.59, 95% CI [0.45, 0.77]), lotion tanning (aOR = 0.58, 95% CI [0.43, 0.79]), and indoor tanning (aOR = 0.61, 95% CI [0.42, 0.88]), but not spray tanning (aOR = 0.72, 95% CI [0.49, 1.05]). In the adjusted models, we found that marital status, census region, sunscreen use, and current smoking status were not associated with sunless tanning (Table 2).

DISCUSSION

Nearly 18% of non-Hispanic white women reported sunless tanning in 2015, which exceeded use of indoor tanning beds (12.0%). Lotion tanning (15.3%) was more

prevalent than spray tanning (6.8%). Moreover, engaging in both sunless tanning and indoor tanning was common. Factors associated with sunless tanning included age, ever having a skin examination, skin reactions to the sun, binge drinking, and BMI.

The finding that many women engaged in both sunless tanning and indoor tanning in the past year is consistent with previous findings (Brooks et al., 2006; Dodds et al., 2018; Sahn et al., 2012) and has implications for public health and skin cancer interventions. Such dual-tanning behaviors may represent more entrenched internalization of tanned beauty ideals, which may be more difficult to change than single-form tanning behavior. A previous study from the United Kingdom found increases in Google search terms for spray tanning after youth indoor tanning was banned, suggesting interest in spray tanning as an alternative to indoor tanning (Reed et al., 2014). Another study surveyed a sample of spray tanners and found sunless tanning was associated with self-reported decreases in indoor tanning (Sheehan & Leshner, 2005). Moreover, Pagoto et al. conducted a randomized trial testing the impact of an intervention promoting sunless tanning as an alternative to sunbathing among a sample of beachgoing women. At 1-year postintervention, significant declines in sunbathing and increases in sunless tanning were found in the intervention group, relative to the control group. However, the authors reported no differences in sunburn between the intervention and control groups (S. L. Pagoto et al., 2010). Further research could help to determine if sunless tanning is an effective harm-reduction intervention for reducing UV radiation exposure.

For spray tanning, indoor tanning, and any sunless tanning, but not lotion tanning, women ages 40–49 years had lower odds of engaging in these tanning behaviors compared with women ages 18–29 years. This finding suggests younger women may be most sensitive to beauty ideals and pressures for darker skin. In addition, interventions attempting to normalize natural skin color could maximize impact by focusing on these younger women. This relationship between age and sunless tanning may be explained by women embracing their natural skin color as they get older. Alternatively, sunless tanning products have improved over time (Ciriminna et al., 2018), which could also explain why younger age groups are more likely to use them.

Women who reported developing severe/moderate/mild burning after short-term unprotected sun exposure had greater odds of lotion and spray tanning, compared with women whose skin turns darker/has no reaction. Thus, women whose skin may be most sensitive to the sun may be more susceptible to sunless tanning. Importantly, sunless tanning offers little to no protection from the sun and may provide a false sense of protection. In fact, this study found past-year sunburn was associated with increased odds of lotion tanning. Furthermore, application of DHA before UV exposure may increase the

TABLE 2. Weighted Adjusted Odds of Engaging in Any Sunless Tanning, Lotion Tanning, Spray Tanning, or Indoor Tanning in the Past 12 Months Among U.S. Non-Hispanic White Women Ages 18–49 Years, United States, 2015

	Sunless (Lotion or Spray)		Lotion Tanning		Spray Tanning		Indoor Tanning	
	aOR (95% CI)	p Value	aOR (95% CI)	p Value	aOR (95% CI)	p Value	aOR (95% CI)	p Value
Sociodemographic factors								
Age (years)								
18–29	Ref	–	Ref	–	Ref	–	Ref	–
30–39	0.75 (0.56, 1.00)	.049	0.81 (0.60, 1.11)	.190	0.65 (0.44, 0.95)	.025	0.72 (0.53, 0.98)	.039
40–49	0.65 (0.47, 0.88)	.006	0.76 (0.54, 1.06)	.105	0.41 (0.26, 0.64)	<.001	0.51 (0.36, 0.73)	<.001
Marital status								
Married/living with partner	Ref	–	Ref	–	Ref	–	Ref	–
Never married	1.06 (0.82, 1.37)	.671	1.09 (0.82, 1.44)	.551	1.04 (0.69, 1.56)	.847	1.12 (0.84, 1.50)	.445
Widowed, divorced, separated	1.11 (0.76, 1.62)	.584	1.08 (0.72, 1.61)	.703	1.42 (0.78, 2.59)	.248	1.41 (1.00, 1.99)	.048
Education								
High school diploma or less	Ref	–	Ref	–	Ref	–	Ref	–
Some college or associate degree	1.27 (0.91, 1.77)	.165	1.08 (0.76, 1.54)	.654	1.89 (1.06, 3.35)	.031	1.03 (0.72, 1.46)	.882
Bachelor's degree or higher	1.15 (0.82, 1.63)	.416	1.06 (0.74, 1.53)	.735	1.58 (0.87, 2.88)	.134	0.67 (0.46, 0.98)	.038
US Census region								
Northeast	Ref	–	Ref	–	Ref	–	Ref	–
Midwest	1.09 (0.76, 1.56)	.635	1.08 (0.75, 1.55)	.682	1.15 (0.62, 2.14)	.663	1.55 (1.05, 3.00)	.029
South	1.06 (0.75, 1.49)	.730	1.14 (0.80, 1.63)	.454	1.05 (0.58, 1.91)	.869	1.35 (0.91, 2.00)	.140
West	1.15 (0.80, 1.65)	.456	1.25 (0.87, 1.79)	.232	1.15 (0.60, 2.18)	.674	0.64 (0.39, 1.07)	.091
Skin cancer risk factors								
Sunburn in the past year								
No	Ref	–	Ref	–	Ref	–	Ref	–
Yes	1.29 (0.99, 1.69)	.062	1.34 (1.01, 1.78)	.045	1.19 (0.79, 1.78)	.403	1.24 (0.93, 1.64)	.140
Ever had a skin examination								
No	Ref	–	Ref	–	Ref	–	Ref	–
Yes	1.70 (1.31, 2.20)	<.001	1.66 (1.24, 2.21)	.001	1.74 (1.23, 2.47)	.002	0.99 (0.70, 1.40)	.975
Sunscreen use on a sunny day								
Always/most of the time	Ref	–	Ref	–	Ref	–	Ref	–
Sometimes/rarely	1.13 (0.88, 1.44)	.344	1.10 (0.84, 1.43)	.505	0.95 (0.64, 1.41)	.791	1.59 (1.18, 2.15)	.002
Never	0.90 (0.64, 1.26)	.530	0.86 (0.60, 1.22)	.388	0.94 (0.55, 1.59)	.814	1.90 (1.28, 2.81)	.001
Don't go out in the sun	0.34 (0.06, 2.15)	.252	0.37 (0.06, 2.37)	.295	1.33 (0.30, 5.85)	.707	0.44 (0.59, 3.27)	.420
Short-term reactions to the sun^a								
Darker or nothing	Ref	–	Ref	–	Ref	–	Ref	–
Severe/moderate/mild burn	1.71 (1.26, 2.30)	.001	1.68 (1.23, 2.31)	.001	1.81 (1.12, 2.94)	.016	1.05 (0.75, 1.48)	.756
Don't go out in the sun	2.55 (0.97, 6.72)	.058	2.79 (1.01, 7.70)	.048	1.24 (0.38, 4.07)	.716	0.36 (0.06, 2.11)	.255
Longer-term reactions to the sun^b								
Freckle or burn	Ref	–	Ref	–	Ref	–	Ref	–

(continues)

TABLE 2. Weighted Adjusted Odds of Engaging in Any Sunless Tanning, Lotion Tanning, Spray Tanning, or Indoor Tanning in the Past 12 Months Among U.S. Non-Hispanic White Women Ages 18–49 Years, United States, 2015, Continued

	Sunless (Lotion or Spray)		Lotion Tanning		Spray Tanning		Indoor Tanning	
	aOR (95% CI)	p Value	aOR (95% CI)	p Value	aOR (95% CI)	p Value	aOR (95% CI)	p Value
Very dark/dark/ mild tan	1.33 (1.02, 1.72)	.032	1.30 (0.99, 1.72)	.062	1.22 (0.83, 1.80)	.320	2.72 (1.89, 3.91)	<.001
Don't go out in the sun	0.38 (0.14, 1.03)	.057	0.39 (0.14, 1.12)	.079	0.49 (0.20, 1.19)	.116	2.48 (0.53, 11.51)	.245
Other cancer risk factors								
Current smoker								
No	Ref	—	Ref	—	Ref	—	Ref	—
Yes	0.87 (0.64, 1.19)	.376	0.78 (0.56, 1.09)	.149	1.10 (0.68, 1.80)	.690	1.25 (0.94, 1.66)	.122
Alcohol use								
Nondrinker	Ref	—	Ref	—	Ref	—	Ref	—
Current drinker (no binge)	0.94 (0.72, 1.21)	.614	0.96 (0.72, 1.27)	.763	1.15 (0.79, 1.67)	.473	1.38 (1.02, 1.87)	.039
Binge drinking ^c	1.90 (1.40, 2.58)	<.001	1.90 (1.38, 2.61)	<.001	1.98 (1.25, 3.13)	.004	2.18 (1.55, 3.08)	<.001
Body mass index								
18.5–24.9 (healthy weight)	Ref	—	Ref	—	Ref	—	Ref	—
<18.5 (underweight)	0.73 (0.32, 1.67)	.455	0.91 (0.40, 2.05)	.815	0.85 (0.21, 3.48)	.818	0.48 (0.23, 1.01)	.054
25.0–29.9 (overweight)	1.00 (0.77, 1.30)	.976	1.08 (0.82, 1.43)	.568	0.90 (0.61, 1.33)	.598	1.05 (0.78, 1.41)	.745
≥30.0 (obese)	0.59 (0.45, 0.77)	<.001	0.58 (0.43, 0.79)	.001	0.72 (0.49, 1.05)	.090	0.61 (0.42, 0.88)	.008

^aShort-term reactions to the sun were measured by asking participants, "...If you went out in the sun for an hour without sunscreen, a hat, or protective clothing, which one of these best describes what would happen to your skin?" ^bLonger-term reactions to the sun were measured by asking, "Next, consider that you were out in the sun repeatedly, such as every day for two weeks, without sunscreen, a hat, or protective clothing. Which one of these best describes what your skin would LOOK like?" ^cBinge drinking = consuming five or more drinks in a day (men) or four or more drinks in a day (women) in the past year. aOR = adjusted odds ratio.

production of damaging reactive oxygen species in the skin, which is problematic if the products are being used without sunscreen, or in addition to indoor or outdoor UV exposure (Jung et al., 2008). Little is known about the types of products used, quantity and frequency of application, combination of multiple products, and characteristics of sunless tanners (Daniel & Gassman, 2018). Currently, the FDA requires a warning statement on the label of sunless tanning products that do not contain sunscreen ingredients, informing users that the product does not contain sunscreen and will not protect against sunburn or the cumulative effects of nonburning UV exposure (FDA, 2022a).

Notably, some sunless tanning products are formulated with sunscreen active ingredients, which could give users a false sense of security (FDA, 2022b). Although sunless tanning products are generally intended to be applied once in a very thin layer to achieve an even color that can last for days to weeks, sunscreens require a thicker and more frequent application to ensure the intended protective effects. The presence of DHA in sunscreen products may discourage thick application and reapplication, which is

necessary for sunscreen effectiveness. Thus, sunless tanners may benefit from education about the need to protect their skin from the sun to reduce risk of future sunburn and skin damage.

Strengths of the present study include the use of a large nationally representative data set and stratifying analysis by sunless tanning product type. Our study also focused on young non-Hispanic white women, the population with highest prevalence of tanning, which maximized sample sizes for all types of sunless tanners. However, because we limited analysis to this population, this study was unable to examine sunless tanning behaviors among other groups. Some respondents reported both indoor tanning and sunless tanning, and because of the cross-sectional design of the study, we were unable to determine the temporality or contemporaneousness of tanning behaviors. Furthermore, this study analyzed data collected in 2015 and may not reflect current sunless tanning behaviors. However, to our knowledge, the 2015 NHIS is the most recent national data set with sunless and indoor tanning measures. Finally, the 2015 NHIS did not collect data on outdoor sun tanning. Future research could examine the

relationship between outdoor tanning and different methods of sunless tanning and how each relates to sunburn risk.

In summary, among young, non-Hispanic white women, sunless tanning is a popular mode to achieve tanned skin and is often paired with indoor tanning. Much is still unknown about sunless tanning, including the psychosocial characteristics of sunless tanners and the potential effectiveness of sunless tanning as a harm-reduction strategy (e.g., transitioning UV tanners to sole sunless tanning). Finally, both indoor and sunless tanning arise from a desire to achieve tanned skin, and social norms that promote and idealize tanned skin are at the root of these behaviors. Use of sunless tanning products may perpetuate these norms and consequently increase the likelihood that young women (and the next generation of young girls) will continue to engage in risky tanning behaviors. Future research could identify strategies to minimize pressures for women to alter their skin color. ■

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