HHS Public Access

Author manuscript

Prev Med. Author manuscript; available in PMC 2018 June 01.

Published in final edited form as:

Prev Med. 2017 June ; 99: 326–331. doi:10.1016/j.ypmed.2017.03.007.

The association between beliefs about vitamin D and skin cancer risk-related behaviors

Dawn M. Holman[a,*], **Zahava Berkowitz**[a], **Gery P. Guy Jr**[a], **Natasha Buchanan Lunsford**[a], and **Elliot J. Coups**[b,c,d]

[a]Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, 4770 Buford Highway NE, MS F76, Atlanta, GA 30341, USA

[b]Rutgers Cancer Institute of New Jersey, Rutgers, The State University of New Jersey, New Brunswick, NJ, USA

[c]Department of Medicine, Rutgers Robert Wood Johnson Medical School, Rutgers, The State University of New Jersey, New Brunswick, NJ, USA

[d]Department of Health Education and Behavioral Science, Rutgers School of Public Health, Rutgers, The State University of New Jersey, 195 Little Albany Street, New Brunswick, NJ 08903, USA

Abstract

Major health organizations recommend obtaining most of one's vitamin D through dietary sources rather than from sun exposure, given the link between sun exposure and increased skin cancer risk. The purpose of this study is to examine the association between beliefs about vitamin D and skin cancer risk-related behaviors, a topic on which research is limited. We analyzed cross-sectional online survey data collected in the summer of 2015 from 4127 U.S. adults aged 18 years and older. Overall, 19.7% of adults believed that sun protection would put them at risk of not getting enough vitamin D. However, less than half (43.1%) thought they could get enough vitamin D from dietary sources. Individuals with this belief were more likely to protect their skin when spending time outdoors (71.3%) compared with those who were neutral or disagreed (56.5%; $P < 0.001$). Only 5.1% of adults believed that indoor tanning is an effective way to get vitamin D. Compared to those who disagreed or were neutral, those who thought it was effective were more likely to be outdoor tanners (45.1% vs. 28.5%; $P < 0.001$) and indoor tanners (13.8% vs 1.9%; $P < 0.001$). Beliefs about vitamin D were associated with skin cancer risk-related behaviors. Including information about vitamin D in skin cancer prevention messages may be beneficial.

Keywords

Vitamin D; Sun safety; Sun protection; Indoor tanning; Skin cancer prevention

[*]Corresponding author at: Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, 4770 Buford Highway NE, MS F76, Atlanta, GA 30341, USA., dholman@cdc.gov (D.M. Holman).

Conflict of interest

None.

Transparency document

The Transparency document associated with this article can be found, in online version.

1. Introduction

Reducing overexposure to ultraviolet (UV) radiation from the sun and from artificial sources (e.g., indoor tanning devices) is a national public health priority in the United States, with the ultimate goal of reversing current trends of increasing skin cancer incidence rates. To address this goal, the U.S. Department of Health and Human Services' *Healthy People 2020* included an objective to "increase the proportion of persons who participate in behaviors that reduce their exposure to harmful ultraviolet (UV) irradiation and avoid sunburn." (US Department of Health and Human Services, 2015). Further, in July 2014, the acting U.S. Surgeon General released *The Surgeon General's Call to Action to Prevent Skin Cancer,* which called on partners from community sectors across the nation to address skin cancer as a serious public health concern (US Department of Health and Human Services, 2014). With growing attention focused on skin cancer prevention in the United States, questions have been raised about the adequacy of vitamin D – an essential nutrient for health(Committee to Review Dietary Reference Intakes for Vitamin D and Calcium; Food and Nutrition Board; Institute of Medicine, 2011) – in the US population. UV exposure stimulates production of vitamin D in the skin; the amount of vitamin D produced and released into circulation within the body depends on a multitude of factors including personal characteristics (e.g., skin color, age, certain medical conditions such as obesity) and environmental factors (e.g., latitude, season, time of day) (Holick et al., 2011; National Institutes of Health Office of Dietary Supplements, 2014). Vitamin D can also be obtained through dietary sources such as fish, fish liver oils, beef liver, cheese, egg yolks, foods fortified with vitamin D (e.g., milk, breakfast cereals, and some brands of orange juice), and dietary supplements (Holick et al., 2011; National Institutes of Health Office of Dietary Supplements, 2014). Given the increased skin cancer risk associated with excessive UV exposure (International Agency for Research on Cancer World Health Organization, 2012), major health organizations currently recommend obtaining most vitamin D through dietary sources (Holick et al., 2011; National Institutes of Health Office of Dietary Supplements, 2014; Society for Adolescent and Medicine, 2013), and dietary references for vitamin D intake are based on the assumption of minimal sun exposure (Committee to Review Dietary Reference Intakes for Vitamin D and Calcium; Food and Nutrition Board; Institute of Medicine, 2011). However, some have encouraged the public to seek out UV exposure from the sun or indoor tanning devices to ensure adequate vitamin D and overall health (Baggerly et al., 2015; Levine et al., 2005).

While several studies have examined vitamin D beliefs among adults in other countries (Hamilton et al., 2016; Janda et al., 2007; Janda et al., 2010; Kung and Lee, 2006; Vu et al., 2010; Youl et al., 2009), most commonly Australia, only one study to date has examined the relationship between vitamin D beliefs and skin cancer risk-related behaviors among adults in the United States (Kim et al., 2012). That study used survey data collected in 2006 from outdoor aquatics staff and parents at outdoor swimming pools. In the current study, we aim to address this knowledge gap in the literature. Specifically, we examine the association between demographic characteristics and beliefs about vitamin D among U.S. adults and the association between beliefs about vitamin D and skin cancer risk-related behaviors, including sunburn, use of sun protection, outdoor tanning, and indoor tanning.

2. Methods

We analyzed data from the summer wave of Porter Novelli's 2015 *Styles* database ([dataset] Weber, 2015). Each year, the *Styles* database is built from a series of web-based surveys that gather insights about American consumers, including information about their health beliefs and behaviors. In 2015, the summer wave (*SummerStyles*) was conducted among adults aged 18 years or older who belong to GfK's Knowledge Panel®, the only online panel that is designed to be representative of the entire U.S. population (Weber, 2015). Panel members are randomly recruited using probability-based sampling by address to reach respondents regardless of whether or not they have landline phones or Internet access. If needed, households are provided with a laptop computer and access to the Internet. The *SummerStyles* survey was sent during June and July 2015 to 6172 adults who previously completed the spring wave. A total of 4127 surveys were returned, resulting in a response rate of 67%. The survey took approximately 22 min (median) to complete. Those who completed the survey received reward points worth approximately $5 and were entered into a monthly sweepstake. Respondents were not required to answer any of the questions and could exit the survey at any time. The CDC licensed the results of the 2015 *SummerStyles* survey post-collection from Porter Novelli. Institutional review board approval was not needed because CDC was not engaged in human subjects research and personal identifiers were not included in the data file.

Table 1 shows the wording, response options, and sources for the main variables of interest. We included three questions about vitamin D beliefs (Q1–Q3) and four questions about skin cancer risk-related behaviors, specifically sun protection (Q4), sunburn (Q5), outdoor tanning (Q6), and indoor tanning (Q7). Additional demographic variables of interest were gender, age, race/ethnicity, skin sensitivity to the sun, annual household income, education, marital status, and region.

2.1. Statistical analyses

We conducted the data analyses in 2016. We used descriptive statistics to summarize the demographic characteristics of the study population. We examined the unadjusted and adjusted (multivariable logistic regression) associations between demographic characteristics and agreement (i.e., responding "somewhat agree" or "strongly agree") with each of the vitamin D belief statements. We also calculated the adjusted association between agreement with each of the three vitamin D belief statements and each of the skin cancer-risk related behaviors. We described the associations with the third vitamin D belief statement (indoor tanning is an effective way to get vitamin D) and indoor tanning use with only unadjusted percentages given the small number of respondents agreeing with the statement (Q3) and reporting indoor tanning (Q7). We presented the adjusted percentages as predictive margins (Graubard, 1999). We performed statistical testing with the chi-square statistic in the unadjusted analyses and Wald F statistics in the adjusted analyses. Differences between subcategories within individual variables were assessed with general linear contrasts. P values < 0.05 were considered statistically significant. To generalize the study results, the data were weighted to match the U.S. Current Population Survey proportions for gender, age, household income, race/ethnicity, household size, education level, census region, metro

status, and whether or not the respondent had internet access prior to joining the panel. Analyses were performed with SAS-callable SUDAAN (RTI International, Research Triangle Park, NC).

3. Results

Appendix Table 1 provides the unweighted and weighted demographic data from the 2015 *SummerStyles* survey as well as estimates from the 2014 Census. The majority of adults were female (51.8%), non-Hispanic white (65.6%), had a household income of $60,000 or more (51.7%), lived in a metropolitan area (84.4%), and had internet access (77.9%).

As shown in Table 2, 19.7% of adults agreed with the statement, “If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D.” Agreement with this statement was significantly ($P < 0.05$) associated with race/ethnicity and education in both the unadjusted and adjusted analyses (Table 2). In the adjusted analysis, non-Hispanic blacks were more likely than non-Hispanic whites to agree with the statement (25.6% versus 17.7%; $P = 0.01$). Adults with a bachelor’s degree or higher were more likely to agree (22.4%) than high-school graduates (17.5%; $P = 0.01$) or those with some college (16.9%; $P = 0.004$). None of the skin cancer risk-related behaviors we examined were associated with this belief (Table 3).

Less than half (43.1%) of adults agreed with the statement, “I can get enough vitamin D from the foods I eat and the vitamins I take” (Table 2). Agreement with this statement was significantly associated with age and marital status. Adults aged 45–59 years (45.1%) and those aged 60 years and older (47.7%) were more likely to agree than adults aged 18–29 years (38.0%; $P = 0.02$ and $P = 0.002$, respectively). Adults who never married (49.7%) and those who were widowed, divorced, or separated (46.3%) were more likely to agree than those who were married or living with a partner (39.5%; $P < 0.001$ and $P = 0.01$, respectively). Sun protection was the only skin cancer risk-related behavior associated with the belief. Those who agreed with the statement were significantly more likely to try to protect their skin from the sun when spending time outdoors (71.3%) compared with those who were neutral or disagreed with the statement (56.5%; $P < 0.001$; Table 3).

The belief that “indoor tanning is an effective way to get vitamin D” was the least prevalent belief, with only 5.1% of adults agreeing with the statement. None of the demographic characteristics were significantly associated with this belief. However, agreement with this statement was positively associated with outdoor tanning ($P < 0.001$; Table 3) and indoor tanning ($P < 0.001$; Table 4). Of those who agreed with the statement, 45.1% were outdoor tanners (Table 3), and 13.8% were indoor tanners (Table 4). Of those who disagreed or were neutral, 28.5% were outdoor tanners (Table 3) and 1.9% were indoor tanners (Table 4).

Each of the vitamin D beliefs was associated with different demographic characteristics and different skin cancer risk-related behaviors. Beliefs about vitamin D were not associated with skin cancer risk-related behaviors, with the exception of the positive relationship between the belief about getting enough vitamin D from dietary sources and use of sun protection and the positive relationship between believing indoor tanning is an effective way

to get vitamin D and intentional tanning behaviors (outdoor and indoor tanning). Sunburn was not significantly associated with any of the vitamin D beliefs.

4. Discussion

Our findings suggest that most adults do not believe regular use of sun protection will put them at risk of not getting enough vitamin D. However, less than half believe they can get enough vitamin D from the foods they eat and vitamins they take. These findings are similar to findings in Australia, where studies have suggested that most Australian adults do not believe regular sun protection puts them in danger of not getting enough vitamin D (Janda et al., 2007; Vu et al., 2010; Youl et al., 2009) but a high proportion of adults lack accurate knowledge about dietary sources of vitamin D (Vu et al., 2010). Although our results do not indicate an association between the belief that sun protection can put one at risk of not getting enough vitamin D and any of the measured skin cancer risk-related behaviors, Australian studies have found associations between this belief and low sunscreen use (Vu et al., 2010) as well as increased tanning behaviors (Janda et al., 2007; Youl et al., 2009).

Data from the 2003–2006 National Health and Nutrition Examination Survey (NHANES) indicate that the prevalence of low serum vitamin D concentration (<40 nmol/L) in the US population aged one year and older was 17.2% (confidence interval: 14.7%, 20.0%) (Centers for Disease Control and Prevention, 2012). Non-Hispanic blacks, the racial/ethnic group most likely to agree that sun protection will put them at risk of not getting enough vitamin D, are also the racial/ethnic group at greatest risk of having low serum vitamin D levels (Centers for Disease Control and Prevention, 2012). Additional analyses of NHANES data from 2003 to 2006 indicate that white individuals who frequently protect themselves from the sun by seeking shade or wearing long sleeves may be at risk for vitamin D deficiency (Linos et al., 2012). This information paired with our current study findings suggests a need to empower adults to obtain the vitamin D they need for optimal health through dietary sources, particularly given the skin cancer prevention benefits of using sun protection. Our findings suggest that those who believe that they can get enough vitamin D from the foods they eat and the vitamins they take are significantly more likely to protect their skin from the sun, perhaps indicating a potential benefit of pairing messages about how to obtain adequate vitamin D with messages about the importance of using sun protection.

In the current study, older adults were more likely than younger adults to believe that they could get enough vitamin D from the foods they eat and vitamins they take. This finding is interesting because NHANES data indicate that older adults are more likely than younger adults to have low vitamin D levels (Centers for Disease Control and Prevention, 2012). Research suggests that circulating levels of serum vitamin D can be lowered by the inflammatory processes involved in the occurrence and progression of disease (Autier et al., 2014; Welsh and Sattar, 2014) which may, in part, explain the link between vitamin D levels and age. In general, adults may benefit from additional resources and information to ensure that high self-efficacy regarding maintaining adequate vitamin D levels is complemented by one’s actual ability to do so.

This study is the first to report on beliefs about indoor tanning as a way to get vitamin D. Our findings suggest that very few adults agree that indoor tanning is an effective way to get vitamin D. Although this belief was uncommon, it was associated with both indoor and outdoor tanning behaviors. There is a need to ensure adults understand that indoor tanning is neither necessary nor a safe way to assure adequate vitamin D levels. While obtaining vitamin D is not likely to be the primary reason that tanners engage in these risky behaviors, this perceived benefit may be used to further encourage or justify such behaviors (Carcioppolo et al., 2014; Woo and Eide, 2010).

Our findings are aligned with the five goals of *The Surgeon General's Call to Action to Prevention Skin Cancer* (*CTA*), thus informing future public health research and practice (US Department of Health and Human Services, 2014). Goal 1 of the *CTA* is to increase opportunities for sun protection in outdoor settings. Examples include shade and other supports for sun protection, making sun-safety the easy, and often default, choice, regardless of knowledge or beliefs related to the somewhat complex relationship between sun-safety and vitamin D. Goal 2 is to provide individuals with the information they need to make informed, healthy choices about sun exposure. The findings from this study point to future opportunities to inform and educate the public specifically regarding strategies for minimizing skin cancer risk while maximizing overall health, including maintaining optimal vitamin D status. Given the diversity of skin types within the US population, such efforts will likely require a tailored approach. Goals 3 and 4 are to promote policies that advance the national goal of preventing skin cancer and to reduce harms from indoor tanning, respectively. Consistent with national data, the findings from this study indicate that indoor tanning device use is relatively uncommon among adults. However, among those who do indoor tan, vitamin D beliefs may influence (and/or be influenced by) this behavior. Future efforts to reduce harms from indoor tanning will likely benefit from components that address misconceptions about vitamin D production as a potential benefit of indoor tanning. Goal 5 of the *CTA* is to strengthen research, surveillance, monitoring, and evaluation related to skin cancer prevention. The findings from this study suggest that additional research on the link between beliefs about vitamin D and skin cancer risk-related behaviors is warranted. Future research could include further refining measures of vitamin D beliefs, including the development of a composite measure of such beliefs. Additionally, a focused examination of vitamin D beliefs among intentional tanners may be of value. The evaluation of the effects of including messages about vitamin D in skin cancer prevention interventions is also warranted.

4.1. Limitations

This study has several limitations. One, the data are based on self-reported information and subject to bias, including social desirability and recall bias. Two, the study had a response rate of 67% and the potential for nonresponse bias. However, we weighted the survey data to the US population which may have mitigated this effect. Three, we did not have information on the amount of time the participants typically spend outdoors or whether they have ever been provided with information about their own vitamin D status from a health care provider, both of which may influence skin cancer risk-related behaviors and beliefs about vitamin D. Four, the cross-sectional nature of this study precludes any conclusions regarding

causation. Fifth, the data for the study were collected during the summer months, and we do not have enough information to know if and how the seasonal timing of data collection might have influenced the results.

5. Conclusion

The findings from this study expand the current knowledge base on beliefs about vitamin D among US adults and can inform and shape the development of future public health messages about using sun protection, avoiding intentional tanning behaviors (indoor and outdoor tanning), and getting enough vitamin D for optimal health. Some beliefs about vitamin D were associated with certain skin cancer risk-related behaviors. These findings suggest that interventions promoting sun protection and the avoidance of overexposure to UV radiation may benefit from the inclusion of information about ways to obtain adequate vitamin D while minimizing skin cancer risk. Additionally, some of the groups that tend to be at low risk for overexposure to UV radiation may be at increased risk for inadequate vitamin D levels for various reasons (e.g., certain racial/ethnic groups, older adults, those with certain medical conditions, those living in certain geographic latitudes). These individuals may benefit from targeted messages to ensure they are empowered and supported to meet their unique vitamin D needs. Tying study findings to the five strategic goals of The Surgeon General's Call to Action to Prevention Skin Cancer is a helpful approach to inform future public health research and practice.

Acknowledgments

This work was funded by the Centers for Disease Control and Prevention. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. No other financial disclosures were reported by the authors of this paper.

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Appendix A

Table A.1

Select demographic variables from the 2015 *SummerStyles* survey (unweighted and weighted) and the 2014 Census estimates.

	Current Population Survey 2014[a] %	**Unweighted 2015 *SummerStyles* data %**	**Weighted 2015 *SummerStyles* data %**
Gender			
Women	51.8	53.7	51.8

	Current Population Survey 2014[a] %	Unweighted 2015 *SummerStyles* data %	Weighted 2015 *SummerStyles* data %
Men	48.2	46.3	48.2
Age			
18–24	12.7	7.2	12.5
25–34	17.5	12.9	17.6
35–44	16.8	15.5	16.5
45–54	18.4	22.3	18.0
55–64	16.3	21.3	16.7
65+	18.3	20.8	18.7
Region			
Northeast	18.1	17.6	18.2
Midwest	21.4	25.5	21.4
South	37.1	35.1	37.0
West	23.4	21.8	23.4
Household income			
<$25,000	18.5	17.9	17.9
$25,000–$39,000	14.1	17.1	13.8
$40,000–$59,000	16.4	17.7	16.6
≥$60,000	51.0.	47.3	51.7
Race/ethnicity			
Non-Hispanic white	66.0	74.7	65.6
Non-Hispanic black	11.6	9.7	11.6
Non-Hispanic other	7.5	4.8	7.7
Hispanic	15.0	10.8	15.1
Education			
Less than high school	12.6	7.1	12.2
High school	29.6	29.9	29.7
Some college	28.9	30.5	28.8
Bachelor’s degree or higher	28.9	32.6	29.3
Metropolitan statistical area status			
Non-metro	15.8	16.2	15.6
Metro	84.2	83.8	84.4
Household internet access			
No	21.4	17.5	22.1
Yes	78.6	82.5	77.9
Household size			
1	14.2	18.7	14.3
2	34.1	35.1	34.3
3	19.2	18.4	19.4
4	17.4	15.8	17.0
≥5	15.1	12.0	15.0

[a]Data are taken from the Current Population Survey, which interviews a sample of the population annually. The sample consists of 74,762 households and 145,049 persons. Weights are then provided to project the data to the U.S. total 122,445,330 million households and 235,898,708 million adults.

Table 1

Items on the 2015 *SummerStyles* survey asking about vitamin D beliefs and skin cancer risk-related behaviors.

Question		Response options
Q1	If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D.[a]	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither agree nor disagree 4 = Somewhat agree 5 = Strongly agree
Q2	I can get enough vitamin D from the foods I eat and vitamins I take.[b]	
Q3	Indoor tanning is an effective way to get vitamin D.[c]	
Q4	I try to protect my skin from the sun when spending time outdoors.[d]	
Q5	During the past 12 months, how many times have you had a sunburn? By “sunburn” we mean even a small part of your skin turns red or hurts for 12 hours or more. Also include burns from sunlamps and other indoor tanning devices. Just give your best guess.[e]	Open-ended; limited to a range of response options from 0 to 365.
Q6	When spending time outdoors, how often do you try to get some sun for the purpose of developing a tan?[d]	1 = Never 2 = Rarely 3 = Sometimes 4 = Usually 5 = Always
Q7	During the past 12 months, have you used an indoor tanning device such as a sunlamp, sunbed, or tanning booth?[e]	1 = Yes 0 = No

[a] Adapted from Janda M, KimlinM, Whiteman D, Aitken J, Neale R. Sun protection and low levels of vitamin D: are people concerned? Cancer Causes and Control 2007;18:1015–1019.

[b] Adapted from Kim BH, Glanz K, Nehl EJ. Vitamin D beliefs and associations with sunburns, sun exposure, and sun protection. Int J Environ Res Public Health 2012;9:2386–2395.

[c] Adapted from Stapleton, J. L. (2014). Unpublished data.

[d] New item developed by authors.

[e] Adapted from the 2015 National Health Interview Survey. http://www.cdc.gov/nchs/nhis.htm.

Prev Med. Author manuscript; available in PMC 2018 June 01.

Table 2

Unadjusted and adjusted percentage of US adults who agree with each of the following two statements about vitamin D by demographic characteristics, *SummerStyles* 2015 online survey data.

	If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D. (n = 4118)[a]				**I can get enough vitamin D from the foods I eat and the vitamins I take. (n = 4116)[a]**			
	Unadjusted		**Adjusted**		**Unadjusted**		**Adjusted**	
	% (95% CI)[b]	***P*-value[c]**	**% (95% CI)[b]**	***P*-value[d]**	**% (95% CI)[b]**	***P*-value[c]**	**% (95% CI)[b]**	***P*-value[d]**
Overall	19.6 (18.2, 21.0)		19.7 (18.3, 21.1)		42.9 (41.1, 44.6)		43.1 (41.3, 44.9)	
Gender		0.17		0.12		0.16		0.23
Women	20.5 (18.6, 22.6)		20.8 (18.8, 22.9)		44.1 (41.7, 46.5)		44.1 (41.7, 46.6)	
Men	18.5 (16.5, 20.7)		18.5 (16.5, 20.6)		41.5 (39.0, 44.1)		41.9 (39.4, 44.5)	
Age (years)		0.44		0.11		**0.01**		**0.004**
18–29	17.4 (14.1, 21.2)		16.5 (13.3, 20.3)		40.7 (36.2, 45.3)		38.0 (33.4, 42.9)	
30–44	19.2 (16.4, 22.4)		18.6 (15.8, 21.8)		39.2 (35.6, 42.9)		40.3 (36.6, 44.1)	
45–59	20.6 (18.2, 23.3)		21.0 (18.6, 23.8)		44.2 (41.2, 47.3)		45.1 (42.0, 48.3)	
60–94	20.6 (18.2, 23.3)		22.0 (19.2, 25.0)		46.7 (43.6, 49.7)		47.7 (44.4, 51.0)	
Race/ethnicity		**0.01**		**0.01**		**0.02**		0.28
Non-Hispanic white	17.9 (16.4, 19.5)		17.7 (16.1, 19.4)		44.6 (42.6, 46.6)		44.3 (42.1, 46.4)	
Non-Hispanic black	23.9 (19.4, 29.1)		25.6 (20.5, 31.4)		44.0 (38.5, 49.6)		43.7 (37.8, 50.0)	
Non-Hispanic other	27.1 (20.5, 34.9)		26.1 (19.6, 33.8)		39.0 (31.4, 47.2)		40.2 (32.4, 48.4)	
Hispanic	19.6 (15.8, 24.0)		20.7 (16.6, 25.5)		36.5 (31.6, 41.7)		38.8 (33.6, 44.2)	
Skin sensitivity to the sun		0.58		0.32		0.44		0.73
Get a severe sunburn with blisters	24.3 (18.0, 31.9)		25.0 (18.6, 32.8)		45.8 (37.8, 54.1)		45.3 (37.6, 53.2)	
Have a moderate sunburn with peeling	18.8 (16.1, 21.9)		19.7 (16.8, 23.0)		44.8 (41.1, 48.6)		44.4 (40.7, 48.3)	
Burn mildly with some or no tanning	19.5 (17.1, 22.1)		20.3 (17.8, 23.1)		43.7 (40.7, 46.7)		43.3 (40.2, 46.5)	
Turn darker without sunburn/ nothing would happen to my skin	19.7 (17.4, 22.1)		18.6 (16.4, 21.0)		41.4 (38.6, 44.3)		41.9 (39.0, 44.9)	
Annual household income		0.68		0.71		0.19		0.07
<$25 K	19.7 (16.4, 23.4)		19.5 (16.1, 23.4)		40.7 (36.6, 45.0)		39.3 (35.1, 43.7)	

	If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D. (n = 4118)[a]				I can get enough vitamin D from the foods I eat and the vitamins I take. (n = 4116)[a]			
	Unadjusted		Adjusted		Unadjusted		Adjusted	
	% (95% CI)[b]	*P*-value[c]	% (95% CI)[b]	*P*-value[d]	% (95% CI)[b]	*P*-value[c]	% (95% CI)[b]	*P*-value[d]
$25 K–<40 K	18.1 (15.0, 21.7)		17.8 (14.7, 21.4)		41.0 (36.8, 45.4)		40.9 (36.7, 45.3)	
$40 K–<60 K	18.6 (15.5, 22.0)		19.2 (16.1, 22.8)		40.8 (36.7, 45.0)		41.0 (36.9, 45.2)	
$60 K+	20.3 (18.2, 22.4)		20.3 (18.2, 22.7)		44.7 (42.2, 47.3)		45.6 (42.9, 48.4)	
Education		**0.001**		**0.002**		0.70		0.78
Less than high school	23.8 (18.6, 29.8)		24.7 (19.2, 31.1)		41.9 (35.7, 48.4)		43.5 (37.1, 50.1)	
High school	17.1 (14.8, 19.6)		17.5 (15.2, 20.2)		42.2 (39.1, 45.4)		42.6 (39.3, 45.9)	
Some college	16.9 (14.7, 19.5)		16.9 (14.7, 19.5)		42.3 (39.1, 45.5)		42.1 (39.0, 45.3)	
Bachelor’s degree or higher	22.9 (20.4, 25.7)		22.4 (19.8, 25.2)		44.5 (41.4, 47.6)		44.4 (41.2, 47.6)	
Marital status		0.93		0.46		**0.02**		<**0.001**
Married or living with partner	19.4 (17.7, 21.2)		19.2 (17.4, 21.2)		40.9 (38.7, 43.1)		39.5 (37.2, 41.9)	
Widowed, divorced, or separated	19.3 (16.0, 23.1)		18.3 (14.9, 22.2)		47.5 (43.0, 51.9)		46.3 (41.5, 51.1)	
Never married	20.1 (17.0, 23.5)		21.5 (18.1, 25.3)		45.0 (41.2, 49.0)		49.7 (45.5, 54.0)	
Region		0.31		0.31		0.15		0.27
Northeast	21.8 (18.4, 25.6)		22.2 (18.8, 26.2)		41.1 (37.0, 45.3)		40.4 (36.3, 44.6)	
Midwest	17.7 (15.1, 20.7)		18.5 (15.8, 21.6)		44.8 (41.3, 48.3)		43.9 (40.4, 47.5)	
South	19.0 (16.8, 21.4)		18.7 (16.5, 21.1)		44.5 (41.5, 47.5)		44.9 (41.9, 48.0)	
West	20.5 (17.5, 23.8)		20.3 (17.3, 23.7)		39.9 (36.2, 43.7)		41.5 (37.8, 45.3)	

[a] n= sample size.

[b] CI = confidence interval; percentages and 95% CIs are weighted to the study population.

[c] *P* value was calculated with the Wald chi-square statistic. Boldface indicates statistical significance ($P < 0.05$).

[d] *P* value was calculated with the Wald F statistic (for multivariable analysis).

Table 3

Adjusted percentages[a] of adults who experienced sunburn in the past 12 months, try to protect their skin from the sun, and engage in outdoor tanning, by beliefs about vitamin D, *SummerStyles* 2015 online survey data.

	Sunburn (n = 4042)[b,c]		Sun protection (n = 4065)[c,d]		Outdoor tanning (n = 4066)[c,e]	
	% (95% CI)[f]	*P* value[g]	% (95% CI)[f]	*P* value[g]	% (95% CI)[f]	*P* value[g]
Overall	37.0 (35.3, 38.8)		62.8 (61.1, 64.6)		29.3 (27.7, 31.0)	
If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D		0.76		0.20		0.91
Agree	36.5 (32.7, 40.5)		65.1 (61.1, 68.9)		29.5 (26.0, 33.3)	
Disagree or neutral	37.1 (35.3, 39.1)		62.3 (60.3, 64.2)		29.3 (27.5, 31.1)	
I can get enough vitamin D from the foods I eat and the vitamins I take		0.97		<**0.001**		0.08
Agree	37.0 (34.5, 39.5)		71.3 (68.8, 73.7)		27.7 (25.4, 30.1)	
Disagree or neutral	37.0 (34.8, 39.3)		56.5 (54.2, 58.8)		30.5 (28.4, 32.7)	
Indoor tanning is an effective way to get vitamin D		0.70		0.61		<**0.001**
Agree	35.6 (28.6, 43.3)		64.7 (57.2, 71.6)		45.1 (37.2, 53.3)	
Disagree or neutral	37.1 (35.3, 38.9)		62.7 (60.9, 64.5)		28.5 (26.8, 30.1)	

[a] Models also included gender, age, race/ethnicity skin sensitivity to the sun, annual household income, education, marital status, and region.

[b] Experienced sunburn in the past 12 months.

[c] n = sample size.

[d] Agreed with the statement, "I try to protect my skin from the sun when spending time outdoors."

[e] Reported trying to "get some sun for the purpose of developing a tan."

[f] CI = confidence interval; percentages and 95% CIs are weighted to the study population.

[g] *P* value was calculated with the Wald F statistic. Boldface indicates statistical significance ($P < 0.05$).

Table 4

Unadjusted percentage of US adults who used an indoor tanning device in the past 12 months by beliefs about vitamin D, *SummerStyles* 2015 online survey data.

	% (95% CI)[a]	*P*-value[b]
If I regularly protect my skin from the sun, I will be at risk of not getting enough vitamin D.		0.39
Agree (n = 790)	3.1 (1.9, 5.1)	
Disagree (n = 3302)	2.4 (1.8, 3.0)	
I can get enough vitamin D from the foods I eat and the vitamins I take.		0.39
Agree (n = 1810)	2.2 (1.6, 3.1)	
Disagree (n = 2279)	2.7 (2.0, 3.7)	
Indoor tanning is an effective way to get vitamin D.		<**0.001**
Agree (n = 196)	13.8 (9.2, 20.0)	
Disagree (n = 3893)	1.9 (1.4, 2.5)	

Abbreviations: n = sample size; CI = confidence interval.

[a] CI = percentages and 95% CIs are weighted to the study population.

[b] *P* value was calculated with the Wald chi-square statistic. Boldface indicates statistical significance ($P < 0.05$).