



HHS Public Access

Author manuscript

Am J Public Health. Author manuscript; available in PMC 2019 July 01.

Published in final edited form as:

Am J Public Health. 2018 July ; 108(7): 951–956. doi:10.2105/AJPH.2018.304414.

State Indoor Tanning Laws and Prevalence of Indoor Tanning Among US High School Students, 2009–2015

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Abstract

Objectives—To examine the association between state indoor tanning laws and indoor tanning behavior using nationally representative samples of US high school students younger than 18 years.

Methods—We combined data from the 2009, 2011, 2013, and 2015 national Youth Risk Behavior Surveys ($n = 41\,313$) to analyze the association between 2 types of state indoor tanning laws (age restriction and parental permission) and the prevalence of indoor tanning during the 12 months before the survey, adjusting for age, race/ethnicity, and survey year, and stratified by gender.

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Note. The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

CONTRIBUTORS

J. Qin drafted the article. J. Qin, S. Everett Jones, Z. Berkowitz, and G. P. Guy Jr designed the study and analyzed the data. S. Everett Jones, Z. Berkowitz, and G. P. Guy Jr conceptualized the study. All authors interpreted the data and revised the article.

HUMAN PARTICIPANT PROTECTION

This study did not require institutional review board review because we used secondary, de-identified data. The Centers for Disease Control and Prevention’s institutional review board approved the protocol for the national Youth Risk Behavior Survey.

Results—Age restriction laws were associated with a 47% ($P < .001$) lower indoor tanning prevalence among female high school students. Parental permission laws were not found to be associated with indoor tanning prevalence among either female or male high school students.

Conclusions—Age restriction laws could contribute to less indoor tanning, particularly among female high school students. Such reductions may reduce the health and economic burden of skin cancer.

Each year in the United States, more than 70 000 people are diagnosed with melanoma, and about 4.3 million adults are treated for nonmelanoma skin cancers.^{1,2} Indoor tanning is an artificial and avoidable source of exposure to intense levels of ultraviolet radiation that increases the risk of both melanoma and nonmelanoma skin cancers.³ Those who begin tanning at young ages tend to be at greatest risk, as these users often tan frequently and receive high doses of cumulative ultraviolet radiation.⁴ Researchers have estimated that indoor tanning before age 35 years increases melanoma risk by approximately 59% to 75%,^{5,6} and use before age 25 years increases nonmelanoma skin cancer risk by about 40% to 102%.⁷ More than half (52.5%) of current adult tanners began tanning before age 21 years, with about 1 in 3 initiating indoor tanning before age 18 years.⁸ Non-Hispanic White women age 16 to 25 years are the most common users of indoor tanning devices.⁹

Policies, legislation, and regulations can be effective public health actions to reduce cancer risk and potentially have a large population impact on health outcomes.¹⁰ Laws regarding minors' access to indoor tanning are made at the state and local levels. In the early 2000s, few states had laws addressing indoor tanning among minors. However, many states have since passed new indoor tanning laws or strengthened their existing laws to protect minors. Such laws include age restrictions and parental permission laws. Age restriction laws are laws that prohibit minors younger than a certain age from using an indoor tanning device. Parental permission laws are laws that prohibit minors younger than a certain age from using an indoor tanning device without parental consent or accompaniment. A state may have 1 or both types of laws. For example, a state may have an age restriction law for all minors younger than 18 years; another state may have an age restriction law for minors younger than 14 years and a parental permission law for minors aged 14 to 17 years.

In January 2012, California became the first state to prohibit all minors younger than 18 years from using commercial indoor tanning devices.^{11,12} As of June 2017, 17 states and the District of Columbia prohibit indoor tanning among minors younger than 18 years, although 2 of these states allow minors to tan indoors with a doctor's prescription.¹¹ Eleven states have lower age restrictions in place (i.e., prohibited for individuals younger than 14–17 years), and 25 states require minors under a specified age to have a parent's consent or be accompanied by a parent to the tanning facility without any age restrictions. Nine of these states have both age restriction and parental permission laws in place.

Evidence to support the effectiveness of youth tanning laws is limited. A previous analysis using national data demonstrated that indoor tanning laws, particularly those with age restrictions, were associated with a lower prevalence of indoor tanning among female high school students.¹³ However, that earlier study was not designed to assess the effect of age restrictions and parental permission laws separately. Since that initial analysis, many more

states have enacted age restrictions and parental permission laws, allowing separate examinations of the associations of age restrictions and parental permission laws with indoor tanning behavior. Additionally, indoor tanning prevalence among US high school students decreased from 15.6% in 2009 to 7.3% in 2015, although use remains common among certain groups (e.g., non-Hispanic White high school girls).¹⁴

We examined the association between state indoor tanning age restrictions and parental permission laws and adolescent tanning behavior in nationally representative samples of high school students. We hypothesized that state indoor tanning laws (particularly age restrictions) would be associated with lower indoor tanning prevalence.

METHODS

The Centers for Disease Control and Prevention's national Youth Risk Behavior Survey (YRBS) is a cross-sectional survey that has been conducted each odd-numbered year since 1991. Each survey year, the national YRBS uses a 3-stage, cluster sample design to obtain a nationally representative sample of US students in grades 9 through 12 attending public and private schools. Student participation in the YRBS is anonymous and voluntary, and the YRBS is conducted in accordance with parental permission procedures in each locality. YRBS questionnaires are self-administered, and students record their responses on a computer-scannable questionnaire booklet or answer sheet. Further details on the national YRBS methodology have been reported elsewhere.¹⁵

We analyzed combined data from the 2009, 2011, 2013, and 2015 national YRBS. The overall response rates were 71% for both 2009 (n = 16 410) and 2011 (n = 15 425), 68% for 2013 (n = 13 538), and 60% for 2015 (n = 15 624). Twenty-four states in 2009, 26 states in 2011 and 2013, and 25 states in 2015 contributed students to the national sample. Over 4 survey years, data was collected from 37 states.

Indoor Tanning

In each survey year from 2009 through 2015, students were asked, "During the past 12 months, how many times did you use an indoor tanning device such as a sunlamp, sunbed, or tanning booth? (Do not count getting a spray-on tan.)" Responses included "0 times," "1 or 2 times," "3 to 9 times," "10 to 19 times," "20 to 39 times," and "40 or more times." We defined indoor tanning as having used an indoor tanning device 1 or more times during the past 12 months.

State Indoor Tanning Laws

We compiled details about each state's indoor tanning laws by using information from the National Conference of State Legislatures,¹¹ published reports,¹⁶⁻¹⁸ and states' legislative Web sites. Because the national YRBS is conducted from February to May, we included laws in effect before the beginning of each survey year in our analyses. For example, we linked state indoor tanning laws in effect as of January 1, 2015, to YRBS 2015 data. States have varying age limits for age restrictions and parental permission, and many states changed their age limits during the study period to be more restrictive. Our analytic sample

included only students younger than 18 years ($n = 41\,313$) because no age restrictions or parental permission laws apply to those aged 18 years or older.

For each student record, we determined whether the student was affected by an age restriction or parental permission law on the basis of the student's age, survey year, and state of school attendance. We developed an indoor tanning law variable by categorizing each student into 1 of 3 groups:

1. The student was not affected by any state indoor tanning laws, either because the state did not have a law or the student was older than the age limit set by the law; or
2. The student was affected by an age restriction law (restricted by law from indoor tanning); or
3. The student was not affected by an age restriction law but was affected by a parental permission law (requiring parental consent or accompaniment when indoor tanning).

Statistical Analysis

To account for the complex sampling design of the surveys and weighting of student records, we conducted all analyses with SAS-callable SUDAAN statistical software version 11.0 (Research Triangle Institute, Research Triangle Park, NC). We applied weights to adjust for school and student nonresponse and oversampling of Black and Hispanic students. We used national YRBS design variables and sampling weights to provide nationally representative estimates. We estimated the weighted prevalence of indoor tanning behavior and its 95% confidence intervals (CIs). We used multivariable logistic regression models to examine the association between state indoor tanning laws and indoor tanning behavior among high school students.

We estimated adjusted prevalence ratios (APRs) comparing prevalence of indoor tanning among students affected by age restriction or parental permission laws to prevalence of indoor tanning among students not affected by laws, adjusting for student age, race/ethnicity, and survey year. We used the Taylor series linearization method for variance estimation. We conducted statistical testing for differences using the adjusted Wald F-test at the $\alpha < 0.05$ level. We stratified all analyses by gender because of different indoor tanning behaviors among female versus male students.¹³ We conducted a sensitivity analysis by including the age and law interaction in the regression models. We have not presented the result of sensitivity analysis because the interaction effect was not statistically significant.

RESULTS

The percentage of female students not affected by either type of state indoor tanning law decreased from 36.6% in 2009 to 10.3% in 2015, and the percentage of female students affected by age restriction laws increased from 2.9% in 2009 to 57.3% in 2015 (Figure 1). Indoor tanning prevalence was 24.7% among female students not affected by either type of indoor tanning law, 19.7% among female students affected by parental permission laws, and

7.1% among female students affected by age restriction laws (Table 1; Figure 1), and this decreasing trend was statistically significant (test of trend $P < .001$). Indoor tanning prevalence among female students decreased from 24.1% in 2009 to 9.5% in 2015 (Table 1). Indoor tanning prevalence among female White students was more than 3 times higher than the prevalence among other racial/ethnic groups. Female students aged 16 or 17 years were about twice as likely to use indoor tanning devices compared with female students aged 15 years and younger.

In the multivariable logistic regression model, adjusting for student age, race/ethnicity, and survey year, indoor tanning prevalence was 47% lower among female high school students affected by age restriction laws than by female students not affected by any indoor tanning laws (APR = 0.53; 95% CI = 0.40, 0.71; $P < .001$; Table 2). Parental permission laws were not found to be associated with indoor tanning prevalence among female high school students (APR = 0.94; 95% CI = 0.80, 1.11; $P = .49$; Table 2). Adjusted prevalence of indoor tanning was higher among non-Hispanic White high school girls than among other racial/ethnic groups, and higher among older female students than among those younger than 14 years (Table 2).

Indoor tanning prevalence among male students ranged from 3.3% among those affected by age restriction laws to 5.0% among those affected by parental permission laws and 5.5% among those not affected by either type of state law (Table 1). Indoor tanning prevalence among male students decreased from 5.7% in 2009 to 3.3% in 2015. In the multivariable logistic regression model adjusting for student age, race/ethnicity, and survey year, we found that neither type of law was associated with indoor tanning prevalence among male high school students (Table 2).

DISCUSSION

During 2009 to 2015, the prevalence of indoor tanning decreased significantly among US high school students younger than 18 years. Age restriction laws were associated with 47% lower indoor tanning prevalence among female high school students when we adjusted for student age, race/ethnicity, and survey year. Our findings suggest that state age restriction laws may be effective in reducing indoor tanning among female high school students for whom the prevalence of indoor tanning is the highest. We did not find parental permission laws to be associated with indoor tanning prevalence among either female or male high school students.

Other studies examining parental permission laws found poor compliance among tanning facilities and little impact on tanning rates among adolescents.^{19–21} A study conducted in Minnesota and Massachusetts, which required parental permission for indoor tanning for persons younger than 16 and 18 years of age, respectively, found that only 19% of salons complied with parental permission laws.²⁰ Other reasons for the limited effectiveness of parental permission laws may be related to the modeling of maternal tanning behavior and permissive parental attitudes toward indoor tanning^{8,19} and possible forging of a parent's signature.²¹ Maternal tanning behavior and maternal permissiveness toward indoor tanning have been shown to be strong predictors of daughters' indoor tanning.²²

Compared with parental permission laws, an age restriction is a more direct and forceful way to limit youth access to indoor tanning and has been shown to have better compliance. For example, the nation's first statewide indoor tanning ban for minors younger than 18 years in California has led most of the state's facilities (77%) to deny access to underage adolescents, demonstrating that age restrictions can meaningfully affect access in ways that parental consent laws failed to achieve.²³ Similarly, an analysis of data collected in 2015 from a random sample of 412 businesses in 14 states with age restriction laws indicated that 3 of 4 businesses were in compliance with the age restriction when a minor went to tan.²⁴

In 2015, the US Food and Drug Administration proposed a rule to restrict indoor tanning in commercial facilities to individuals younger than 18 years nationwide.²⁵ Our findings provide further evidence that such legislation at the state level has the potential to reduce indoor tanning among girls. Because the initiation of indoor tanning has been shown to be at its highest during adolescence,²⁶ age restrictions may reduce overall rates of indoor tanning in the population, which could ultimately reduce skin cancer incidence, mortality, and associated costs.^{27,28} For example, a modeling study evaluating the potential impact of a federal law restricting indoor tanning among minors found that such a law could avert as many as 61 839 melanoma cases, prevent 6735 melanoma deaths, and save \$342.9 million in treatment costs (discounted to present value) over the lifetime of youths aged 14 years and younger in the United States.²⁷

Students not affected by state indoor tanning laws also showed a decrease in indoor tanning prevalence, suggesting there may be other reasons in addition to indoor tanning laws that contributed to the observed reduction. Other public health efforts during the same period may have contributed to the decrease. In 2009, the World Health Organization declared indoor tanning devices as carcinogenic to humans²⁹; in 2010, a nationwide 10% excise tax on indoor tanning was implemented; in 2014, the *Surgeon General's Call to Action to Prevent Skin Cancer* included strategic goals to reduce harms from indoor tanning,³ and the US Food and Drug Administration recommended against minors' indoor tanning.³⁰

Another reason may be a spillover effect of the state indoor tanning laws. Peer influence, as well as parental factors, play important roles in adolescent indoor tanning initiation and behavior.^{22,31} Lastly, media coverage of indoor tanning and skin cancer research, as well as policy, legislative, and regulative changes likely increased public awareness³² and possibly initiated a shift in social norms regarding indoor tanning. Although we were unable to adjust for these factors directly, we included survey year as a covariate in the multivariable analysis to help account for the effect of these factors.

Similar to an earlier study,¹³ we did not find an association between indoor tanning laws and indoor tanning among male high school students. Although the reasons are unknown, this finding may be related to differences between male and female indoor tanners. A recent study³³ among adult indoor tanners showed women are more likely to indoor tan in tanning salons, whereas men are more likely to engage in indoor tanning in private residences, which are not subject to indoor tanning laws. In addition, the motivation for indoor tanning may differ by gender and affect the impact of the laws. For example, a study found that indoor tanning was associated with symptoms of anxiety and obsessive-compulsive disorder among

male college students, whereas indoor tanning was unrelated to these symptoms among female college students.³⁴ Furthermore, the statistical power to detect an association between tanning laws and indoor tanning among male students may be limited because of the low prevalence of indoor tanning among this population.

Limitations

This study has several limitations. First, 37 states contributed to the national YRBS across 4 survey years; thus we could not analyze data from all states. Despite this limitation, we are able to provide nationally representative prevalence estimates through the use of the multistage probability sampling design and weighting. More state-level data on the prevalence of indoor tanning could enhance our understanding of the effects indoor tanning laws have on youths' tanning behaviors. Second, it may take time for the laws to change behaviors. Our analysis did not account for the time between the effective date of the law and the survey date, which varied by state and may have affected law implementation and public awareness. Third, we were unable to examine state indoor tanning law enforcement and compliance, which also varied greatly among states.

Fourth, students may underreport their indoor tanning behaviors because of social desirability bias, especially those in states with indoor tanning laws. In addition, the survey did not ask students whether they were aware of the indoor tanning laws in their state. Fifth, we were unable to estimate indoor tanning prevalence separately for noncommercial locations (e.g., private residences, gyms), as this information is not included in the YRBS. Finally, these data apply only to youths attending schools and may not represent all youths in this age group. However, the percentage of youths aged 13 to 17 years in the United States not enrolled in school is less than 5%.³⁵

Public Health Implications

Our findings demonstrate that indoor tanning policies may be effective for curbing youth access to indoor tanning and may prevent skin cancer at the population level. Using data from large nationally representative samples of US high school students across 7 years, we have demonstrated that indoor tanning age restriction laws are associated with a lower prevalence of indoor tanning among female high school students, for whom indoor tanning prevalence is the highest.

The nation's Healthy People 2020 goal aims to reduce indoor tanning prevalence to 14% in adolescents in grades 9 through 12 by 2020. The concerted efforts of researchers, policymakers, and public health advocates to protect youths from the harms of indoor tanning have showed significant progress in the past decade, achieving the Healthy People 2020 goal several years ahead of time. Nevertheless, about 1 in 10 female students overall and 1 in 14 female students who should not have access (under age restriction laws) still engaged in indoor tanning in 2015. As the legislative landscape related to indoor tanning continues to evolve, national surveillance data can be used to monitor changes in tanning behavior over time. Additional research could explore barriers to compliance and enforcement, the influence that indoor tanning laws have on social norms, and strategies for maximizing public health benefits of such legislation.

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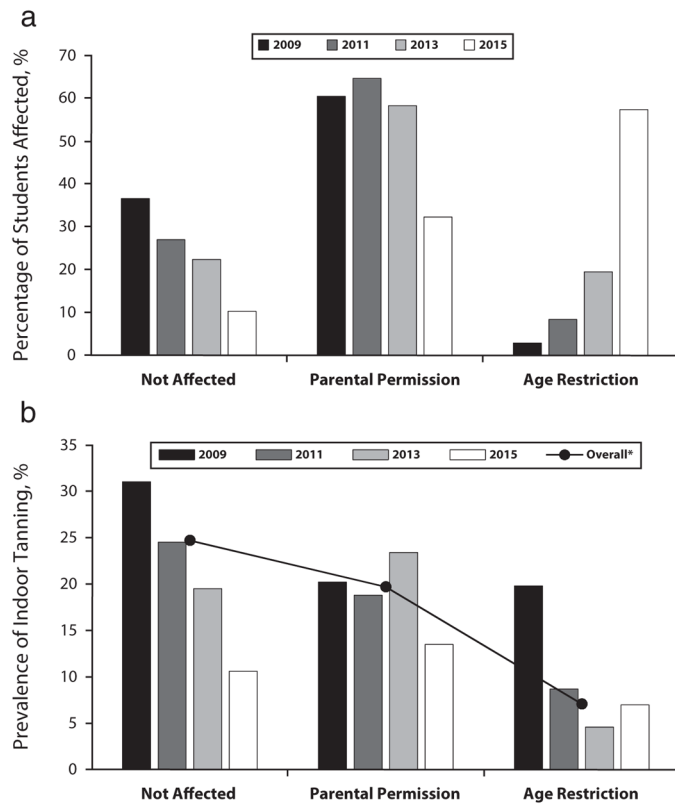


FIGURE 1. Female High School Students Younger Than 18 Years Across Survey Years by (a) Percentage Affected by Indoor Tanning Laws and (b) Prevalence of Indoor Tanning: National Youth Risk Behavioral Surveys, United States, 2009–2015

*Test of trend $P < .001$ for the overall prevalence of indoor tanning by law status.

TABLE 1
Prevalence (Weighted) of Indoor Tanning Among High School Students Younger Than 18 Years by State Indoor Tanning Laws: National Youth Risk Behavioral Surveys, United States, 2009–2015

Variable	Sample No.	All (n = 41 313), % (95% CI)	Not Affected by Law (n = 9 926), % (95% CI)	Parental Permission Law (n = 22 153), % (95% CI)	Age Restriction Law (n = 9 234), % (95% CI)
Females					
Overall	21 005	18.2 (16.5, 20.1)	24.7 (21.0, 28.8)	19.7 (17.2, 22.4)	7.1 (5.3, 9.6)
Year					
2009	6 268	24.1 (21.3, 27.2)	31.0 (25.0, 37.7)	20.2 (17, 23.8)	19.8 (15.6, 24.8)
2011	4 805	19.5 (16.2, 23.2)	24.5 (18.0, 32.4)	18.8 (14.2, 24.4)	8.7 (5.3, 13.8)
2013	5 120	18.9 (15, 23.5)	19.5 (14.3, 26.1)	23.4 (17.8, 30.1)	4.6 (3.6, 6.0)
2015	4 812	9.5 (7.4, 12.1)	10.6 (7.5, 14.9)	13.5 (9.7, 18.5)	7.0 (4.5, 10.8)
Age, y					
14	2 691	10.2 (8.5, 12.1)	13.5 (9.1, 19.7)	11.3 (8.9, 14.2)	5.9 (3.9, 8.7)
15	5 795	13.2 (11.5, 15.1)	17.7 (13.9, 22.2)	14.5 (12.0, 17.6)	6.5 (4.8, 8.7)
16	6 220	20.1 (17.8, 22.6)	26.5 (22.7, 30.6)	22.1 (18.8, 25.8)	6.4 (4.0, 10.3)
17	6 299	25.3 (22.9, 27.8)	31.6 (26.7, 36.9)	26.1 (22.8, 29.7)	10.3 (6.3, 16.2)
Race/ethnicity					
Non-Hispanic White	9 396	26.8 (24.4, 29.3)	33.0 (28.9, 37.5)	29.1 (26.0, 32.5)	10.4 (7.4, 14.4)
Non-Hispanic Black	3 187	2.3 (1.8, 3.1)	2.7 (1.8, 4.1)	2.3 (1.6, 3.4)	1.4 (0.5, 4.1)
Hispanic	5 986	7.7 (6.6, 8.9)	13.9 (10.7, 17.9)	8.2 (6.8, 9.8)	4.3 (3.0, 6.2)
Non-Hispanic other	2 178	7.9 (6.1, 10.2)	10.8 (6.8, 16.9)	8.5 (6.2, 11.5)	3.7 (1.8, 7.2)
Males					
Overall	20 308	4.8 (4.3, 5.4)	5.5 (4.6, 6.6)	5.0 (4.2, 5.9)	3.3 (2.5, 4.2)
Year					
2009	5 928	5.7 (4.8, 6.9)	5.8 (4.2, 7.9)	6.0 (4.8, 7.4)	2.8 (1.7, 4.8)
2011	4 695	5.7 (4.4, 7.2)	6.6 (5.1, 8.5)	5.6 (4.0, 8.0)	3.2 (1.5, 6.5)
2013	5 119	4.2 (3.5, 5.1)	5.2 (4.2, 6.6)	4.1 (3.1, 5.4)	3.4 (1.8, 6.0)

Variable	Sample No.	All (n = 41 313), % (95% CI)	Not Affected by Law (n = 9 926), % (95% CI)	Parental Permission Law (n = 22 153), % (95% CI)	Age Restriction Law (n = 9 234), % (95% CI)
2015	4 566	3.3 (2.5, 4.2)	2.6 (1.1, 5.9)	3.4 (2.0, 5.9)	3.3 (2.4, 4.4)
Age, y					
14	2 266	4.0 (3.1, 5.0)	3.7 (2.4, 5.7)	4.2 (3.0, 5.9)	3.8 (2.4, 6.0)
15	5 519	4.2 (3.5, 4.9)	4.6 (3.3, 6.4)	4.6 (3.7, 5.7)	2.9 (2.0, 4.2)
16	6 199	4.8 (4.1, 5.7)	5.6 (4.2, 7.6)	4.8 (3.8, 6.0)	3.6 (2.5, 5.3)
17	6 324	5.7 (4.8, 6.8)	6.7 (5.3, 8.5)	5.9 (4.6, 7.5)	3.0 (1.6, 5.6)
Race/ethnicity					
Non-Hispanic White	9 213	4.9 (4.2, 5.7)	5.3 (4.2, 6.5)	5.4 (4.4, 6.7)	2.7 (1.9, 3.9)
Non-Hispanic Black	2 939	4.3 (3.3, 5.5)	4.7 (3.4, 6.6)	4.0 (2.8, 5.7)	4.9 (2.5, 9.4)
Hispanic	5 752	4.4 (3.7, 5.3)	7.5 (5.3, 10.5)	4.1 (3.2, 5.4)	3.5 (2.5, 4.9)
Non-Hispanic other	2 053	4.9 (3.8, 6.2)	6.0 (3.7, 9.4)	5.2 (3.7, 7.3)	2.9 (1.6, 5.4)

Note. CI = confidence interval. Indoor tanning during the past 12 months before each survey.

TABLE 2

Association Between State Indoor Tanning Laws and Indoor Tanning Among High School Students Younger Than 18 Years: National Youth Risk Behavioral Surveys, United States, 2009–2015

Variable	Females (n = 21 005), APR (95% CI)	Males (n = 20 308), APR (95% CI)
Law		
Not affected by law (Ref)	1	1
Parental permission law	0.94 (0.80, 1.11)	0.95 (0.75, 1.21)
Age restriction law	0.53 (0.40, 0.71)	0.77 (0.54, 1.10)
Age group, y		
14 (Ref)	1	1
15	1.27 (1.09, 1.48)	1.05 (0.80, 1.39)
16	1.87 (1.59, 2.19)	1.21 (0.90, 1.62)
17	2.24 (1.94, 2.60)	1.44 (1.09, 1.91)
Race/ethnicity		
Non-Hispanic White (Ref)	1	1
Non-Hispanic Black	0.08 (0.06, 0.11)	0.88 (0.66, 1.17)
Hispanic	0.33 (0.28, 0.38)	0.98 (0.78, 1.21)
Non-Hispanic other	0.32 (0.25, 0.40)	1.05 (0.82, 1.34)
Year		
2009 (Ref)	1	1
2011	0.81 (0.67, 0.97)	1.02 (0.76, 1.38)
2013	0.86 (0.71, 1.03)	0.77 (0.60, 1.00)
2015	0.54 (0.43, 0.67)	0.63 (0.43, 0.91)

Note. APR = adjusted prevalence ratio; CI = confidence interval. From a multivariable logistic regression model adjusting for student age, race/ethnicity, and survey year. Indoor tanning during the past 12 months before each survey.