



Compliance with indoor tanning bans for minors among businesses in the USA

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Abstract

Indoor tanning is a known risk factor for skin cancer and is especially dangerous for adolescents. Some states have passed indoor tanning bans for minors, but business compliance with the bans is not well understood. Thus far, studies have assessed ban compliance in one or two states at a time. This study aimed to assess compliance with indoor tanning bans for minors and knowledge of dangers and benefits of tanning among indoor tanning businesses. Female research assistants posing as minors telephoned a convenience sample of 412 businesses in 14 states with tanning bans for minors under age 17 or 18. We evaluated differences in compliance by census region and years since ban was implemented and differences in reported dangers and benefits by compliance. Most (80.1%) businesses told the “minor” caller she could not use the tanning facilities. Businesses in the south and in states with more recent bans were less compliant. Among those ($n = 368$) that completed the full interview, 52.2% identified burning and 20.1% mentioned skin cancer as potential dangers. However, 21.7% said dangers were no worse than the sun and 10.3% denied any dangers. Stated benefits included vitamin D (27.7%), social/cosmetic (27.2%), and treats skin diseases (26.4%), with only 4.9% reporting no benefits. While most businesses followed the indoor tanning ban when a minor called, one-fifth did not. Many stated inaccurate health claims. Additional enforcement or education might increase compliance with indoor tanning bans and action is needed to prevent businesses from stating false health information.

Keywords

Indoor tanning, Melanoma, Skin cancer, Prevention, Health policy, Adolescent health

INTRODUCTION

Indoor tanning is an established risk factor for melanoma and non-melanoma skin cancer [1, 2]. Approximately 400,000 skin cancer cases are related to indoor tanning in the USA annually [3]. Data suggest there are stronger associations with skin cancer when indoor tanning starts at younger ages and with increasing frequency of use [1, 2]. While indoor tanning among US high school students slightly declined from 2009 to 2013 among all females (prevalence of 25.4 to 20.2%) and non-Hispanic black males (prevalence of 6.1 to 3.2%) [4], approximately 1.6 million minors continue to indoor tan nationwide [4, 5]. Given the

Implications

Practice: The majority of businesses offering indoor tanning appear to be compliant with indoor tanning bans which may in turn decrease indoor tanning among minors.

Policy: Policy makers who want to reduce the prevalence of an important skin cancer risk factors in adolescents should explore the possibility of a federal ban on indoor tanning for minors.

Research: Future research is needed to understand how enforcement of existing bans and education can be used to further reduce the prevalence of indoor tanning among minors.

continued popularity of indoor tanning in the USA and strong data on this as a risk factor for skin cancer, a great deal of skin cancer prevention efforts for young people have concentrated on reducing indoor tanning [6]. The current need for skin cancer prevention policies, including ones for indoor tanning, directed at youths was recently highlighted in US Surgeon General's *Call to Action to Prevent Skin Cancer* [7].

Some cities and states have made efforts to limit access to indoor tanning by enacting bans for minors [8, 9]. Limited evidence suggests that such bans are associated with decreased rates of adolescent indoor tanning [10, 11]; however, other data indicate no significant declines in use [12]. A limited number of studies have evaluated compliance with indoor tanning regulations in one or two states at a time. A study assessing industry compliance in California, the first state to pass an indoor tanning ban for minors, found that 77% of 338 indoor tanning facilities did not allow a researcher posing as a 17-year-old customer to make an appointment during a telephone call [13]. Studies of businesses in other states also reveal a lack of compliance with regulations and guidelines related to age of sale, safety, and communication of risks [14–18].

At present, there is no federal regulation addressing indoor tanning and minors. A federal ban may be the

most effective policy intervention to reduce indoor tanning in young people and is supported by numerous organizations, including the Society of Behavioral Medicine [19]. Recently, the US Food and Drug Administration (FDA) took steps to increase regulation and in December of 2015 proposed a rule for a national ban for those under age 18 and for adults to have to sign a certification acknowledging the health risks of indoor tanning [20]. At the same time, the FDA also issued a second proposed rule for manufacturers and tanning facilities to take additional measures, such as more prominent warning labels and emergency shut off buttons, to improve the safety of tanning devices [20].

Thus far, there has not been a study that assessed compliance with indoor tanning bans in all states with regulations for minors under ages 17 or 18. Since the number of states with indoor tanning laws for minors has increased, a more thorough investigation of compliance of all states with bans in one study design is warranted. This study serves to describe the level of compliance among businesses located in states with indoor tanning bans for minors enacted as of May 2015. We also assessed knowledge of dangers and benefits related to ultraviolet (UV) indoor tanning among the respondents at each business. Finally, our study also adds new data to help understand variations in compliance and health information, as we evaluated potential differences by census region and time since ban implementation and looked at compliance in relation to stating benefits and risks.

METHODS

Study population

The target population was businesses offering UV indoor tanning, with a focus on tanning salons, located in the states with indoor tanning bans for minors under 17 or 18 years as of May 2015 [8, 9]. States with bans for minors under 17 were Connecticut and New York, and those with bans for minors under 18 were California, Delaware, Hawai'i, Illinois, Louisiana, Minnesota, Nevada, Oregon, Texas, Vermont, Washington, and the District of Columbia. New Jersey was excluded, as its law was more complex with multiple bans for indoor and spray tanning based on different ages. Lists of indoor tanning businesses in each state were obtained from Yellowpages.com, using the search term "tanning salon." For each state, the number of businesses using this search term varied widely, such that for some states (e.g., Hawaii, Connecticut) with a small number of businesses, we called the entire list of businesses. For states with more than 125 businesses, we used a random number generator to select a starting number and then selected every n^{th} business up to a total of 125. A total of 1462 phone numbers were selected, and 412 businesses completed partial or complete interviews between May 2015 and December 2015. The study protocol was approved by the Yale University Human Subjects Committee (Protocol no. 1504015679).

Indoor tanning ban compliance and knowledge survey

Female research assistants, who were aware of the study design, posed as a 16- or 17-year-old minor (based on each state's law) and called the selected businesses. They followed a standardized script adapted from a study on compliance in one state [13]. The research assistant started each call with a brief introduction that included their age and then asked the individual who answered the phone (e.g., facility employee, owner) whether they could use the tanning facilities. Additional questions included how frequently she could tan, whether there were dangers from indoor tanning, whether tanning was good for her, and whether it was okay to tan even if her mother had skin cancer. Responses were noted by research assistants on paper forms that included pre-coded response options, as well as a text field for any answers outside our pre-coded options. Calls were not recorded due to the nature of the study and the Connecticut state law, where the calls were conducted, restricting the recording of telephone calls without permission. The pre-coded response options were generated prior to the start of data collection based on those reported in a similar study [13] and items arrived at by the research team. In addition, after conducting calls in the initial five states, any responses that emerged as common that were not originally part of the coding options were added to subsequent call sheets.

The content of the open-ended responses was directly coded by each research assistant as she conducted the call or immediately after each call using our pre-defined list of possible answers and open text space. The research assistants conducted a sub-set of calls ($n = 25$) together with only one person speaking to help ensure reliability in coding across interviewer given we could not record the content of any calls. If any open-ended responses did not fit into our existing codes or there was a question about which code to assign to a response, these were evaluated in a group discussion by the two research assistants and the senior author (LMF). The senior author made the final decisions when consensus could not be achieved through discussion.

Statistical analysis

Data were analyzed using SAS 9.4 software (SAS Institute Inc., Cary, NC). Descriptive statistics were calculated for the final sample ($n = 412$). If the interview was interrupted or the respondent ended a call during the additional questions about dangers and benefits, the business was included in the primary analysis of whether tanning was permitted among minors but excluded in analyses of subsequent questions ($n = 368$).

Compliance with the indoor tanning ban was assessed by the proportion of tanning businesses that told the "minor" caller that she could not use their tanning facility and complied with the state-specific

Table 1 | Final status of indoor tanning businesses ($N = 1462$)

Final status	Number	Percent
Reached and completed interview	412	28.2
Reached and no UV tanning or invalid, different business type	311	21.3
Number not working	300	20.5
Did not reach	261	17.9
Reached and only offers spray tans, bronzing, and self-tan	123	8.4
Reached and no longer offers UV tanning	46	3.1
Duplicate telephone number	9	0.6

indoor tanning regulations. In New York, where the law states that indoor tanning is permissible for a 17-year-old with permission from a guardian or health professional [8], responses stating that the minor could tan with parental permission at age 17 were also coded as compliant. For the questions about the dangers and benefits of indoor tanning, every response from the business was recorded.

States and the District of Columbia were categorized into US census regions [21]: Northeast (Connecticut, New York, Vermont), Midwest (Minnesota, Illinois), South (District of Columbia, Delaware, Louisiana, Texas), and West (California, Hawaii, Nevada, Oregon, Washington). The number of years since implementation of the law was calculated by subtracting the law's start date for every state [8, 9] from the start date of our study: May 1, 2015. We hypothesized that states in the South and West would have lower compliance due to a higher prevalence of indoor tanning and that states in which the bans had been in place longer would have higher compliance.

To test for differences in the proportion of compliant indoor tanning businesses by census region and years since implementation of the law, we used a Chi-square (χ^2) or Fisher's exact test. Similarly, we evaluated differences in reporting of the three most prevalent dangers, benefits, and responses to the skin cancer history question by compliance with the bans using the χ^2 test

or Fisher's exact test. P values less than 0.05 were considered statistically significant.

RESULTS

Respondent characteristics

Of the 1462 telephone numbers obtained from our internet search, we could not reach 561 of the businesses, as 300 (20.5%) of the phone numbers were no longer in service and 261 (17.9%) only had voicemail messages despite calls on 2 separate dates (Table 1). Among the 901 businesses that were reached, 480 were ineligible: 311 (21.3%) offered beauty services but not indoor tanning, 123 (8.4%) only offered non-UV tanning (e.g., spray tans, bronzing, and self-tanner), and 46 (3.1%) had discontinued their indoor tanning services. Nine phone numbers were duplicates (phone number listed twice online). This left 412 businesses with interviews: 368 (89.3%) with complete interviews and 44 (10.7%) with partial interviews.

Compliance with the indoor tanning ban for minors

Of the 412 respondents, 80.1% stated they would not allow the minor caller to use the indoor tanning facilities and were considered compliant with the ban over the telephone (Table 2). Fifty-one (12.4%) respondents

Table 2 | Business responses to minor requesting to use UV indoor tanning facilities over the telephone by US census region and years since indoor tanning ban implemented ($N = 412$)

Characteristics	No, may not tan ^a N (%)	Yes, may tan N (%)	Other ^b N (%)	P
Full sample	330 (80.1)	51 (12.4)	31 (7.5)	–
Census region				<0.001
Northeast (CT, NY, VT)	81 (85.3)	9 (9.5)	5 (5.3)	
Midwest (MN, IL)	72 (86.8)	3 (3.6)	8 (9.6)	
South (DC, DE, LA, TX)	64 (63.4)	29 (28.7)	8 (7.9)	
West (CA, HI, NV, OR, WA)	113 (85.0)	10 (7.5)	10 (7.5)	
Years since ban implemented				0.004
0–0.99	110 (78.0)	14 (9.9)	17 (12.1)	
1–1.99	126 (76.8)	30 (18.3)	8 (4.9)	
2 or more	94 (87.9)	7 (6.5)	6 (5.6)	

Note. Percentages may not sum to 100% due to rounding. P value for χ^2 or Fisher's exact test.

^a Includes those responses in New York stating that the minor could tan with parental permission where the law states that indoor tanning is permissible for a 17-year-old with permission from a guardian or health professional

^b Includes "depends" and "yes, with parental permission"

Table 3 | Dangers and benefits associated with indoor tanning reported by businesses ($N = 368$)

Response	N (%)
<i>I burn pretty easily in summer. Are there any dangers from tanning booths?</i>	
Overexposure/sunburn	192 (52.2)
Dangers are no worse than sunlight	80 (21.7)
Skin cancer	74 (20.1)
Need to come in person to discuss	56 (15.2)
There are dangers (no specifics mentioned)	44 (12.0)
Our booths are safer than others	42 (11.4)
Denied any dangers	38 (10.3)
Safer than sunlight	37 (10.1)
Possible to use safely	26 (7.1)
Eye damage	15 (4.1)
Other ^a	14 (3.8)
Wrinkling/ premature aging	14 (3.8)
Referred to external source on dangers	12 (3.2)
Cannot say/do not know	11 (3.0)
Contraindicated with certain medications	7 (1.9)
Skin irritation (rashes, spots)	6 (1.6)
Our booths are mostly UVA, safer than UVB	5 (1.4)
Referred to brochures in salon	5 (1.4)
Contraindicated if family history of skin cancer	1 (0.3)
<i>I have heard both pros and cons about tanning. Is tanning good for me in any way?</i>	
Vitamin D production	102 (27.7)
Social benefit (popularity/cosmetic)	100 (27.2)
Treats skin disease (acne, eczema/psoriasis)	97 (26.4)
As good for you as natural sunlight	53 (14.4)
Yes, but no specifics mentioned	44 (12.0)
Base tan prevents sunburns	33 (9.0)
Increases energy	31 (8.4)
Feels good/improves mood	31 (8.4)
Other ^b	31 (8.4)
Need to come in person to discuss benefits	22 (6.0)
Cannot say/do not know	19 (5.2)
No health benefit claimed	17 (4.6)
Referred to brochures in salon discussing benefits	16 (4.4)
Referred to external source on benefits	14 (3.8)
Improves/prevents depression	11 (3.0)
Relaxation	10 (2.7)
Pain relief	7 (1.9)
Bone health	6 (1.6)
Treats arthritis	5 (1.4)
Reduces anxiety	4 (1.1)
Increases endorphins	3 (0.8)
Cancer prevention	1 (0.3)

Note. Responses add to >100% due to multiple responses to open-ended questions.

^a Includes radiation exposure, seizures, and depends

^b Includes convenience, less risk than tanning in the sun, general good for health, healthier type of skin, and depends

replied with an outright “yes” that the minor female caller may use the facilities, and 31 (7.5%) reported other responses, including “depends” and “yes, but with permission” from an authorized health professional or guardian. Businesses located in the South had the lowest compliance, with 28.7% of businesses responding “yes” the minor could indoor tan ($p < 0.001$). The level of compliance was highest in states with bans implemented for 2 or more years, with 87.9% stating “no” to the minor’s question about indoor tanning ($p = 0.004$).

Reported dangers and benefits of indoor tanning

Table 3 describes the overall frequencies of responses by businesses to questions about the dangers and benefits associated with indoor tanning. Of the 368 respondents that completed the entire survey, all provided a response to our question on dangers. The most prevalent responses for dangers included, “overexposure/sunburn” (52.2%), “no worse than sunlight” (21.7%), and “skin cancer” (20.1%). Of these responses, we only observed a statistically significant difference by ban compliance status for overexposure/

Table 4 | Responses to *My mother had skin cancer—is it still OK for me to tan?* ($N = 368$)

Response	N (%)
Referred to external source for information	97 (26.4)
Yes, but reduce time/dose/frequency	96 (26.1)
Yes, not a problem	89 (24.2)
Cannot say/do not know	77 (20.9)
Yes, at own risk/choice	52 (14.1)
No, should not tan	26 (7.1)
Need to come in person to discuss	23 (6.3)
Yes, skin cancer is not hereditary	21 (5.7)
Consider spray tanning	20 (5.4)
Other ^a	18 (4.9)
Referred to brochures in salon	1 (0.3)

Note. Responses add to >100% due to multiple responses to open-ended questions

^a Includes depends on either skin type or certain individual characteristics and need to self-check skin to be safe

sunburn. Respondents who were compliant with the ban over the telephone were more likely to report “overexposure/sunburn” (56.7%) as a potential danger than respondents who were non-compliant with the ban (36.9% of those who said yes to minor tanning; 33.3% of those who said “other” to minor tanning) ($p = 0.003$, data not shown). Approximately 10% denied any dangers outright, but other responses were ambiguous regarding dangers, including “possible to use safely” (10.1%), “cannot say/do not know” (3.0%), and “need to come in person to discuss” (15.2%).

All 368 respondents with a full interview answered the question regarding benefits of indoor tanning. The most common reported benefits included “vitamin D production” (27.7%), “social benefits (popularity/cosmetic)” (27.2%), and “treatment of skin disease (e.g. acne, eczema, psoriasis)” (26.4%) (Table 3). Differences by ban compliance were only present for the potential of a social benefit from tanning. Businesses that were non-compliant over the telephone having told the minor she could indoor tan were more likely to mention a potential social benefit (42.0%) as compared to compliant businesses (24.7%) and those that responded “other” to our compliance question (25.9%) ($p = 0.040$, data not shown). Only 4.6% of respondents did not clearly claim a health benefit to tanning and another 5.2% said “cannot say/do not know.”

Recommendations for indoor tanning given family history of skin cancer

Respondents were also asked whether the female minor caller could still indoor tan if her mother had skin cancer (Table 4). The top three responses included “referred to an external source for information” (e.g., talk to your doctor, look on the internet) (26.4%), “yes, but reduce time/dose/frequency” (26.1%); and “yes, not a problem” (24.2%). Businesses who were categorized as non-compliant with the tanning ban and said that the minor caller was allowed to use the facilities

were more likely to say “yes, not a problem” regarding the skin cancer family history questions (44.0%) compared to compliant business (21.3%) and those that responded “other” to our compliance question (18.5%) ($p = 0.002$, data not shown).

DISCUSSION

Indoor tanning legislation and regulations serve to protect minors from exposure to a known carcinogen in order to safeguard this group from health risks, namely, skin cancer, similar to bans on cigarette sales to minors. While the majority of respondents from indoor tanning businesses did inform the female minor over the telephone that she was not allowed to use the facilities, nearly 20% told the minor that she could use the facility. This proportion of non-compliant respondents is similar to that reported in similar studies in California [13], Texas [18], and Wisconsin [17]. Earlier studies in several states reported even higher percentages of respondents who did not comply with state laws and restrictions regarding indoor tanning [14–16]. In 1993, a study in North Carolina found that 88% of 32 inspected tanning businesses did not have or use parental consent forms for minors as mandated by the state law at the time [15]. A 2006 study in Massachusetts and Minnesota, when each state had a law for parental permission, found that 81% of 200 businesses sold a tanning bed session to a minor without parental permission on at least one of two tries [16]. In a telephone study focusing on states with laws for younger minors, a 12-year-old minor caller in three states with age restrictions was told they could indoor tan by 11–77% of businesses. A similar range (17–83%) was seen in this same study for a 15-year-old minor [14].

Businesses in states that had an indoor tanning ban for minors implemented for at least 2 years had the highest level of compliance over the telephone. This was in line with our hypothesis, and a similar pattern was observed in the 2003 telephone survey in Colorado, Texas, Illinois, and Wisconsin evaluating legislation for younger minors (ages 13, 14, and 16), with higher compliance levels in states with longstanding regulations [14]. Variation in state compliance levels observed in our study may have been driven by other factors as well, such as resources available for enforcement of the law or associated penalties for breaking the law. Though assessment of these factors was beyond the scope of our study, an evaluation of the statutes in the first five states with indoor tanning bans for minors found a great deal of variability [22]. If there is very little penalty for non-compliance or there is little being done to ensure compliance in the presence of higher penalties, this may influence compliance. Consistent and strong enforcement is likely an important factor to consider for states considering bans, as well as in any federal regulations that move forward.

Although the number of minors reporting indoor tanning has slightly decreased over time [4], a substantial percentage of this population continues to engage

in high-risk indoor tanning behaviors. In 2013, the national Youth Risk Behavioral Surveillance report showed that 12.8% of minors in grades 9–12 had used an indoor tanning device one or more times during the past year [5]. While our study and others indicate the potential for public health policy in discouraging indoor tanning by minors, our findings also demonstrate that there is still room for improvement with existing policies to protect minors from the risks associated with indoor tanning, as we saw that some businesses still said that the minor caller was allowed to use the facilities. Research utilizing national data has found that indoor tanning legislation with age restrictions as opposed to parental permission or systems access (e.g., warning labels, restrictive advertising) has the greatest impact on indoor tanning rates [10]. However, some state-specific studies point to the complex nature of these regulations. In New Jersey, indoor tanning rates among high school students did not significantly decline after age restrictions [12], yet indoor tanning among minors in Utah did appear to decline after introduction of an age ban [11]. This indicates that the effect of the ban may vary between states and signals that additional research is needed to understand the ways in which ban enforcement can maximize compliance.

Results from our study suggest that false and misleading information is being given by some tanning businesses regarding the dangers and benefits of indoor tanning. Both vitamin D production and treatment of skin diseases were commonly claimed as benefits, and 10% of respondents denied any dangers associated with indoor tanning. Similar dangers and benefits were noted in a California study of indoor tanning businesses, with 29.7% of respondents reporting that dangers are no worse than sunlight, 44% citing vitamin D production, and 22.2% stating treats skin disease [13]. In a 2012 investigation by the US House of Representatives Committee on Energy and Commerce, staff members contacted 300 tanning businesses posing as 16-year-old fair skinned girls and observed that 90% of the salons reported that indoor tanning presented no risk, and 51% denied a link between indoor tanning and skin cancer [23].

We found some evidence that the dangers and benefits of indoor tanning mentioned by the respondents differed based on whether or not the business stated their indoor tanning services would be available to the minor caller. Businesses that were non-compliant with the laws were more likely to provide false information about indoor tanning as compared to businesses that were compliant. These findings might be related to the quality and amount of training for indoor tanning facility personnel. When asked about the dangers and benefits related to indoor tanning, some respondents either referred to or referenced information from external sources. Though this was rare overall (3.2% for dangers and 3.0% for benefits), most of the time, the respondent told our caller to look online. Furthermore, when our caller asked specifically about indoor

tanning with a family history of skin cancer, the external sources the respondents mentioned included doctors, but also the internet. These findings suggest that tanning businesses themselves are not the sole provider of materials and information about indoor tanning for adolescents. It is important to be mindful of the resources that inform adolescents to ensure that accurate information is readily available about indoor tanning.

Some actions have been taken to stop the spread of inaccurate health information about indoor tanning. In 2010, the Federal Trade Commission (FTC) charged the Indoor Tanning Association, an indoor tanning industry group that represents tanning facilities and manufacturers, with making false and misleading health claims and in the settlement, the Indoor Tanning Association agreed to no further deception [24]. More recently, in 2016, the FTC also filed charges against Mercola, a tanning bed manufacturer, due to misleading advertising. The settlement requires Mercola to refund consumers who had purchased their tanning beds and bans them from selling or marketing indoor tanning systems [25]. The New York Attorney General has also been a leader in this area with recent agreements regarding several large indoor tanning chains that will prohibit them from making health claims and has ongoing investigations into health claims made by indoor tanning businesses [26, 27]. While indoor tanning regulations have strengthened over the past few years, more work must be done to effectively communicate accurate information about the risks associated with indoor tanning. Despite the settlements described above, including some at national level, misleading and inaccurate health claims were made over the telephone in this study. Even individuals who indoor tan recognize the need for accurate information. A study of indoor tanners ages 18–30 found that 77.6% of female tanners wanted stronger warnings and information about the risks associated with indoor tanning [28]. Combating false health and safety claims is an area where states and other organizations can continue to take action against the indoor tanning industry, which may in turn help decrease indoor tanning among young people.

An interesting side finding was the number of listed numbers in Yellowpages.com that were not in service (e.g., went out of business), or the business reached either never offered or had discontinued UV tanning despite being listed under the search term tanning salon. Closure of some of these businesses may be due in part to the constantly changing policy landscape for indoor tanning among minors as more tanning legislation is introduced each month [9], but may also be due to the 10% tax on tanning salons that was introduced in 2010 as part of the Affordable Care Act [7]. Additionally, some businesses from our online search reported offering spray tanning rather than UV tanning, with some stating they had switched from UV tanning to non-UV tanning offerings.

To our knowledge, this is the first study to systematically assess the level of compliance of indoor tanning bans for minors across all states with indoor tanning bans for minors under age 17 or 18. Using a standardized telephone script that had been adapted from a previous study in California [13], we also examined how tanning businesses communicated dangers and benefits of indoor tanning. Our study included states with indoor tanning bans among minors that were enacted at different times across a 5-year span. With this range of time, we could assess compliance by years since the ban has been enacted. In addition, since we surveyed all states with a ban for those under 17 or 18 years or age at the time of our study, we could evaluate potential differences by region.

Certain limitations should be noted in this study to adequately interpret the data. First, while telephone versus in-person interaction may have resulted in different information, one study found that measuring legislation compliance among indoor tanning businesses was comparable using both methods [29]. However, it is still possible that an in-person interaction in the business might have resulted in differing access to the indoor tanning facilities by a minor. We also only evaluated states with bans for minors under age 17 or age 18, as we felt the standardized script would not have been as realistic for a younger minor calling businesses in states with lower age bans. Due to the nature of this deception study and Connecticut state laws regarding recording telephone conversations, we could not record the responses to our questions and had to rely on writing down and direct coding responses during the call. As our research assistants were conducting calls separately, there is the potential for differences in coding. However, we attempted to minimize variability by having joint calls with the interviewers at the start of the study and including numerous pre-coded response options based on prior research [13]. Additionally, while similar proportions of businesses were sampled from each US census region, a limited number of businesses were reached in Hawaii and the District of Columbia due to the small number of business generated in our online search.

We used the search term tanning salon as we wanted to target businesses specializing in indoor tanning who were likely to be most knowledgeable about the laws. While we likely missed some locations where tanning beds may be found, our search term did return other types of businesses, such as hair salons and gyms, which also offer indoor tanning facilities. Given the composition of our sample including mostly businesses that are solely tanning facilities, it is possible that our data represent an overestimate of compliance with indoor tanning bans. The female callers spoke to only one employee per business, and therefore, the responses of the employee have been interpreted to represent the policies and responses of the business. We did not collect any personal information about the employee who answered the phone, so we are unable to evaluate potential differences in information by

employee demographic characteristics, such as age or education. We also could not assess how long an employee had been working at the business, which could have influenced how knowledgeable they were of the laws. Another limitation to our study is that we only included states with tanning bans and did not have a comparison group of states without bans. Therefore, we are unable to assess if minors in states without bans would be allowed to tan much more readily or if stated benefits and dangers might be different in states without bans.

Overall, this research improves our understanding of one component relevant to evaluating the effectiveness of state-level policies banning minors from using indoor tanning facilities. Additional evaluation and monitoring of compliance in tandem with collecting data on indoor tanning rates is needed to understand the impact of these policy-level interventions. Most businesses in this study told the caller posing as a minor that she would not be able to use the indoor tanning facilities and so were in line with the state-specific regulations on minor tanning. This indicates that the current state-level bans are effective, to an extent. Our results suggest that a federal ban on indoor tanning for minors, which the US Food and Drug Administration is currently proposing [20], could be effective in reducing indoor tanning in minors in supervised settings. However, if a federal ban is introduced, retailer compliance and enforcement of regulations are likely to play an important role in ensuring the greatest public health impact. Furthermore, given the variation we observed by region as well as time since implementation, a federal ban for minors with strong enforcement would provide a clearer message to businesses and consumers alike regarding reducing youth access and communicating the health risks of indoor tanning.

Protecting adolescents from the dangers of indoor tanning is an important major public health challenge as signified by being one of the *Healthy People 2020* objectives [30]. Importantly, limiting indoor tanning among minors is predicted to substantially reduce melanoma incidence, treatment costs, and mortality [31]. Enacting well-crafted age restriction laws to maximize compliance through enforcement of penalties on the state level and moving towards a national ban with similar accompanying strong enforcement as proposed by many national and international health organizations [19] are essential to reduce skin cancer risk in this vulnerable population.

Compliance with ethical standards

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Conflicts of interest: The authors declare that they have no conflicts of interest.

Ethical disclosures: All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later

amendments or comparable ethical standards. Our study protocol was approved by Yale University IRB Human Subjects Committee (protocol no. 1504015679), and for this type of study, formal consent was not required. This manuscript does not contain any studies with animals performed by any of the authors.

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