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Adolescents' Use of Indoor Tanning: A Large-Scale Evaluation of Psychosocial, Environmental, and Policy-Level Correlates

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Objectives. We evaluated psychosocial, built-environmental, and policy-related correlates of adolescents' indoor tanning use.

Methods. We developed 5 discrete data sets in the 100 most populous US cities, based on interviews of 6125 adolescents (aged 14–17 years) and their parents, analysis of state indoor tanning laws, interviews with enforcement experts, computed density of tanning facilities, and evaluations of these 3399 facilities' practices regarding access by youths. After univariate analyses, we constructed multilevel models with generalized linear mixed models (GLMMs).

Results. In the past year, 17.1% of girls and 3.2% of boys had used indoor tanning. The GLMMs indicated that several psychosocial or demographic variables significantly predicted use, including being female, older, and White; having a larger allowance and a parent who used indoor tanning and allowed their adolescent to use it; and holding certain beliefs about indoor tanning's consequences. Living within 2 miles of a tanning facility also was a significant predictor. Residing in a state with youth-access legislation was not significantly associated with use.

Conclusions. Current laws appear ineffective in reducing indoor tanning; bans likely are needed. Parents have an important role in prevention efforts. (*Am J Public Health.* 2011;101:930–938. doi:10.2105/AJPH.2010.300079)

In 2010, melanoma was estimated to be responsible for approximately 68130 new cases and approximately 8700 related deaths in the United States.[1] Evidence is mounting that exposure to ultraviolet radiation (UVR) from tanning lamps during indoor tanning sessions is a risk factor for both melanoma[2,3] and squamous cell cancer.[2] Moreover, indoor tanning use before the age of 35 years increases melanoma risk by 75%.[2] Therefore, the high rate of indoor tanning use by US adolescent girls, which is significantly higher than the rate among adolescent boys,[4–7] is particularly alarming, with rates as high as 40% among older adolescent girls.[4] This finding may explain the recent rise in melanoma incidence among young US women.[8] In July 2009, the International Agency for Research on Cancer, which is part of the World Health Organization, elevated tanning beds to its highest risk category: carcinogenic to humans.[9] In March 2010, the US Food and Drug Administration (FDA) convened an advisory panel to more comprehensively address indoor tanning risks and relevant classifications and policies.[10]

As ecological models suggest, indoor tanning by adolescents is likely influenced by a combination of psychosocial and individual factors, environmental factors, and policy-related factors.[11] To date, research on correlates of adolescents' indoor tanning has focused on the psychosocial level.[12,13] Although those data have been useful for designing interventions,[14,15] they may represent only part of the picture. For example, many US states have passed indoor tanning legislation related to access by youths,[16–20] but at the time the current study was conducted, no studies had evaluated whether presence or absence of legislation was associated with indoor tanning use. Likewise, although evidence existed that (1) availability of commercial indoor tanning is high,[21,22] (2) tanning facilities may be more prevalent in neighborhoods with higher numbers of young adults and high schools,[23] and (3) tanning facilities are not complying with youth-access laws,[24–30] relationships between these data and actual indoor tanning use had not been assessed.

CITY100 (Correlates of Indoor Tanning in Youth) is a multicomponent project consisting of 5 data sets; its goal is to evaluate the correlates of adolescents' indoor tanning use, guided by the 3 levels of an ecological model of health behavior mentioned previously. Using cross-sectional data from the 100 most populous US cities, we simultaneously evaluated the relationships between recent indoor tanning use and demographic and psychosocial variables (e.g., age, sex, parents' use of tanning), built-environment variables (i.e., city-level density of tanning facilities per population and proximity to tanning facilities of individual adolescents), and policy-related variables (i.e., presence and stringency of legislation, enforcement of legislation at the local level, and practices by facilities related to youth access). This article provides the main results of the entire CITY100 project, which links all 5 data sets to predict indoor tanning.

METHODS

CITY100 consists of:

1. a telephone survey conducted in January through December of 2005 of adolescent–parent pairs to measure indoor tanning facility use by adolescents in the past 12 months, as well as potential demographic and psychosocial correlates of this use;
2. a systematic calculation of the number and density (per population) of indoor tanning facilities in each included city in March 2006;
3. identification of the presence of indoor tanning laws in each included state in early

2006 using law databases and quantification of their stringency;
4. a telephone interview in April through May of 2007 of key informants to quantify local-level enforcement of existing laws, with emphasis on inspection frequency (the majority were directors, managers, or supervisors in state-level health, environmental health, or radiological health agencies); and
5. telephone contacts by data collectors (posing as prospective 15-year-old clients) of indoor tanning facilities in each included city in June through September of 2006 to assess practices related to access by adolescents.

All 5 components were conducted in the 100 most populous US cities based on Census 2000 statistics.[31] These cities represented 34 states plus Washington, DC. Study procedures were approved by San Diego State University's institutional review board.

Detailed data collection procedures for each data set, along with descriptive data, have been described previously[12,20,21,30,32] and, along with survey items, are also available at http://www.indoortanningreportcard.com. We briefly describe the methodology for each data set.

Indoor Tanning Behaviors and Psychosocial Correlates

To obtain estimates of indoor tanning behavior, as well as to obtain data on potential demographic and psychosocial correlates, we conducted a survey of adolescent–parent pairs in each of the 100 cities, with approximately 60 pairs per city.[12] Eligible households were within each city's formal city boundaries and consisted of an adolescent aged between 14 and 17 years and a parent or guardian; each had to be able to complete the interview in English. This survey was adapted from the survey developed by Forster and her colleagues.[33,34]

Lists of targeted age samples, including telephone numbers and street addresses, for each of the 100 cities were purchased from a professional survey sampling firm, to more efficiently reach households with 14- to 17-year-old adolescents. The telephone interviews were conducted by trained interviewers employed by a professional research firm, with extensive monitoring and other quality control procedures conducted throughout the data collection period. Our preference was to interview the adolescent's mother or female guardian, once oral consent from the parent, parental consent for the adolescent, and assent from the adolescent were obtained. Parents were interviewed first, and the parent and adolescent interviews lasted approximately 5 minutes and 15 minutes, respectively. Ten attempts were made to reach each household. Our cooperation rate was 74.9%, with 6125 of the 8176 eligible households agreeing to participate.

The main outcome of the study was whether the adolescent had used indoor tanning in the past year. This survey item asked the adolescent: "In the past 12 months, did you go to a tanning salon or other business and use the tanning lamps?" The adolescents also were asked about their age, sex, race/ethnicity, skin sensitivity when exposed to sunlight (i.e., skin type), allowance, attitudes about having a tan and tanning, perceptions about being allowed by their parents to tan, and whether they had friends who had tanned. Parents were asked similar demographic questions, about their perceived risk of indoor tanning, and about their own indoor tanning use.

Before this study, a pilot test was conducted with 32 female college students to assess test–retest reliability of most adolescent survey items, with a 1-week interval between surveys. For an item asking if respondent had used indoor tanning during the past 12 months (but not specifying at a business establishment), reliability was excellent ($\kappa=1.0$).[12] Reliability estimates for the other variables are presented in Tables 1 and 2.

Built-Environmental Correlates

The potential correlates of adolescent tanning related to the built environment were (1) the city's density of indoor tanning facilities, computed from the number of facilities per 100 000 population, and (2) the proximity of each adolescent respondent's residence to tanning facilities. As described in greater detail in Hoerster et al.,[21] our inclusion criteria for facilities were (1) must offer UVR indoor tanning and (2) must be open to the public and not require a membership. We identified businesses with indoor tanning services in each city and its buffer zones by using ReferenceUSA and SuperPages.com with "tanning salons" as the key words. Once lists of tanning facilities for a city plus buffer were generated, we eliminated duplicates, phoned any facilities in question to verify eligibility, and eliminated gyms and athletic clubs (because they typically require membership).

For each of the 100 cities, we created geographic boundaries for the city with geographic information systems.[35] We also created 1-, 2-, and 3-mile buffer zones around the boundary of each city, because residents living in the city likely travel beyond the formal boundaries. Indoor tanning businesses that met our inclusion criteria were entered into a database file and geocoded to city-specific maps. Tanning facility density was then computed by dividing the number of indoor tanning facilities in the city plus 3-mile buffer by the city's total population and then multiplying the result by 100 000. Population size was obtained from the 2000 US Census.[31] When a tanning facility was within the 3-mile boundary for multiple cities, we included it in the facility count for all affected cities. We additionally geocoded the home address of each participating adolescent (obtained through the telephone survey), and computed the number of indoor tanning facilities within 1, 2, and 3 miles of each adolescent's home.

For 30 cities, 2 research assistants independently counted the number of facilities using the protocol described earlier. Exact agreement was found for 22 (73.3%) of the 30 cities; for the other 8 cities, raters differed by just 1 facility.[21]

Policy-Related Correlates

State law presence and stringency. As described previously,[20] we determined the presence or absence of any state law related to indoor tanning as of early 2006 by using Westlaw and Lexis-Nexis, and we analyzed the contents of the existing laws with criteria developed by our research team. We also noted whether the laws included restrictions of access to indoor tanning by youths; these restrictions typically involved parental consent or accompaniment requirements or bans of specific age groups. We computed a total stringency score for each law as a whole, with a possible range of 0 to 100. The scoring procedure was found to have a respectable level of interrater reliability; the overall scale had an intraclass correlation of 0.95.[20] For the current analyses, as potential

TABLE 1—Descriptive Data and Univariable Analyses of Predictors of Adolescent Indoor Tanning in the Past 12 Months in the 100 Most Populous US Cities, Categorical Variables: CITY100, 2005–2007

Variable[a]	No. (% of Sample)	κ[b]	% Tanned Past 12 Mo	OR (95% CI)	*P*
Psychosocial and individual level[c]					
Adolescent age, y					
14 (Ref)	1486 (24.3)	NA	5.5	1.00	<.001
15	1688 (27.6)		8.1	1.50 (1.20, 2.10)	
16	1603 (26.3)		12.4	2.50 (1.90, 3.30)	
17	1330 (21.8)		16.5	3.60 (2.70, 4.70)	
Adolescent sex					
Girls (Ref)	3153 (51.6)	NA	17.1	1.00	
Boys	2962 (48.4)		3.2	0.16 (0.13, 0.20)	<.001
Adolescent race					
Non-Hispanic White (Ref)	4135 (69.0)	0.90	12.6	1.00	<.001
Non-Hispanic Black	447 (7.5)		0.9	0.06 (0.02, 0.17)	
Hispanic White	273 (4.6)		6.6	0.56 (0.34, 0.92)	
Other[d]	1137 (18.9)		7.0	0.58 (0.45, 0.75)	
Parent education					
< College degree (Ref)	2786 (46.2)	NA	11.9	1.00	
≥ College degree	3241 (53.8)		9.1	0.74 (0.63, 0.88)	<.001
Household annual income					
< $40 000 (Ref)	851 (15.1)	NA	7.5	1.00	<.001
$40 000–$60 000	1040 (18.5)		8.8	1.13 (0.81, 1.59)	
> $60 000	3744 (66.4)		11.7	1.60 (1.21, 2.11)	
Adolescent weekly allowance					
$0–$10 (Ref)	2017 (33.8)	NA	4.9	1.00	<.001
$11–$25	1954 (32.8)		9.3	2.10 (1.60, 2.70)	
> $25	1987 (33.4)		17.3	4.20 (3.30, 5.30)	
Adolescent sun sensitivity					
Always burns, never tans	661 (10.9)	0.73	6.1	0.54 (0.38, 0.77)	
Usually burns, hard to tan	1122 (18.6)		11.7	1.10 (0.88, 1.39)	
Sometimes burns, then tans	1975 (32.8)		11.3	1.07 (0.88, 1.30)	
Rarely burns, easily tans (Ref)	2263 (37.6)		10.5	1.00	.002
Parent ever indoor tanned					
No (Ref)	4658 (77.0)	NA	7.4	1.00	
Yes	1391 (23.0)		20.6	3.10 (2.60, 3.70)	<.001
Parent: indoor tanning can cause skin cancer					
Agree	5012 (82.8)	NA	10.9	1.30 (1.01, 1.63)	.043
Disagree or don't know (Ref)	1041 (17.2)		8.2	1.00	
Parent: people with a tan look more attractive					
Agree	3896 (66.2)	NA	12.6	2.10 (1.70, 2.50)	<.001
Disagree (Ref)	1987 (33.8)		6.4	1.00	
Parent: concerned if adolescent tanned occasionally					
Not a lot (Ref)	2559 (42.8)	NA	16.4	1.00	
A lot	3417 (57.2)		6.0	0.33 (0.27, 0.39)	<.001
Adolescent: parents allow me to tan					
Strongly or somewhat disagree (Ref)	3559 (59.4)	0.94	3.0	1.00	
Strongly or somewhat agree	2434 (40.6)		21.6	8.90 (7.20, 11.10)	<.001
Adolescent: most friends like to be tanned					
Strongly or somewhat disagree (Ref)	1355 (22.2)	0.87	2.2	1.00	
Strongly or somewhat agree	4745 (77.8)		12.8	6.40 (4.40, 9.30)	<.001

Continued

TABLE 1—*Continued*

Adolescent: my chances of skin cancer are small					
Strongly or somewhat disagree (Ref)	2820 (46.8)	0.93	10.7	1.00	
Strongly or somewhat agree	3202 (53.2)		10.2	0.94 (0.79, 1.11)	.44
Adolescent: people who tan have already damaged their skin					
Disagree or don't know (Ref)	2782 (45.4)	0.96	8.7	1.00	
Agree	3342 (54.6)		11.8	1.40 (1.20, 1.70)	<.001
Adolescent: indoor tanning using lamps is safer than sunlight					
Disagree or don't know (Ref)	4689 (76.6)	0.91	10.4	1.00	
Agree	1433 (23.4)		10.4	1.05 (0.86, 1.27)	.65
Adolescent: indoor tanning can cause skin cancer					
Disagree or don't know (Ref)	963 (15.7)	0.65	4.8	1.00	
Agree	5161 (84.3)		11.4	2.50 (1.80, 3.40)	<.001
Adolescent: skin cancer is easy to treat					
Disagree or don't know (Ref)	5690 (92.9)	–[e]	10.4	1.00	
Agree	434 (7.1)		10.1	0.98 (0.71, 1.40)	.90
Adolescent: getting an indoor tan first protects from burning in the sun					
Disagree or don't know (Ref)	4050 (66.1)	0.75	7.8	1.00	
Agree	2074 (33.9)		15.5	2.20 (1.80, 2.50)	<.001
Adolescent: people with tan look more attractive					
Strongly or somewhat disagree (Ref)	1650 (27.4)	0.92	4.8	1.00	
Strongly or somewhat agree	4367 (72.6)		12.6	2.90 (2.20, 3.60)	<.001
Adolescent: having tan makes people look healthier					
Strongly or somewhat disagree (Ref)	2988 (49.7)	0.95	8.9	1.00	
Strongly or somewhat agree	3031 (50.3)		11.9	1.40 (1.20, 1.60)	<.001
Adolescent happy with appearance					
Rarely or sometimes (Ref)	1461 (23.9)	0.91	12.2	1.00	
Often or most of time	4645 (76.1)		9.8	0.78 (0.65, 0.94)	.008
Adolescent ever noticed ads for indoor tanning					
No (Ref)	1203 (19.7)	–[e]	6.3	1.00	
Yes	4899 (80.3)		11.4	1.70 (1.30, 2.20)	<.001
Adolescent knows anyone personally who has had skin cancer					
No (Ref)	3638 (59.7)	0.94	9.3	1.00	
Yes	2455 (40.3)		12.1	1.30 (1.10, 1.60)	.001
Built-environmental level					
Proximity: adolescent lives within 2 mi of a tanning facility[f]					
No	1437 (23.6)	NA	7.1	1.00	
Yes	4659 (76.4)		11.3	1.52 (1.21, 1.91)	<.001
Policy level[g]					
State law addressing minors' use					
No	2277 (37.2)	NA	12.3	1.00	
Yes	3844 (62.8)		9.2	0.72 (0.57, 0.93)	.01
Annual inspection					
No	3659 (74.0)	NA	9.2	1.00	
Yes	1285 (26.0)		11.3	1.30 (0.84, 1.50)	.42

Notes. CI = confidence interval; CITY100 = Correlates of Indoor Tanning in Youth study; NA = data not available; OR = odds ratio.
[a]Variables organized by levels of influence addressed by an ecological model of behavior.[11]
[b]Test–retest reliability from pilot study with 32 female college students.
[c]Variables in this category were analyzed at the individual level.
[d]American Indian, Asian, Pacific Islander, multiethnic/multiracial, and other–unspecified.
[e]κ could not be computed because of lack of variability; there was 100% agreement.
[f]This variable was analyzed at the individual level.
[g]Variables in this category were analyzed at the city level.

TABLE 2—Descriptive Data and Univariable Analyses of Predictors of Adolescent Indoor Tanning in the Past 12 Months in the 100 Most Populous US Cities, Continuous Variables: CITY100, 2005–2007

Variable[a]	Mean (SD) for Sample	ICC[b]	Mean (SD) by Tanning Outcome: Yes	Mean (SD) by Tanning Outcome: No	OR (95% CI)	*P*
Psychosocial and individual level[c]						
% of adolescent's friends who have ever tanned indoors with tanning lamps (20% unit increase)	27.4 (29.9)	0.97	64.1 (28.9)	23.0 (26.8)	2.40 (2.20, 2.50)	<.001
How often adolescent protects skin in summer (1 = never to 5 = all the time)	3.0 (1.2)	0.96	2.9 (1.3)	3.03 (1.2)	0.91 (0.85, 0.98)	.007
Built-environmental level[d]						
City's tanning facility density (no. of salons per 100 000 people)	11.0 (5.4)	NA	12.1 (5.1)	10.9 (5.4)	1.05 (1.03, 1.07)	<.001
Log physical size of city + 3 mi buffer[e]	6.7 (0.7)	NA	6.8 (0.7)	6.7 (0.7)	1.21 (1.01, 1.46)	.042
Policy level[d]						
Overall law stringency score	42.4 (26.9)	NA	39.5 (28.7)	42.5 (26.6)	1.00 (0.99, 1.00)	.082
% of tanning facilities in city requiring parental signature (10% unit increase)	86.2 (12.5)	NA	85.8 (13.1)	86.3 (12.5)	0.97 (0.88, 1.07)	.53
% of tanning facilities in city complying with FDA recommended tanning frequency (10% unit increase)	10.1 (11.0)	NA	9.9 (10.7)	10.2 (11.0)	0.96 (0.86, 1.08)	.54
Mean no. of d/wk facilities would allow adolescent to tan	6.0 (0.7)	NA	6.1 (0.6)	6.0 (0.7)	1.28 (1.06, 1.55)	.013

Notes. CI = confidence interval; CITY100 = Correlates of Indoor Tanning in Youth study; FDA = Food and Drug Administration; ICC = intraclass correlation coefficient; NA = data not available; OR = odds ratio.

[a]Variables organized by levels of influence addressed by an ecological model of behavior.[10]

[b]Test–retest reliability from pilot study with 32 female college students.

[c]Variables in this category were analyzed at the individual level.

[d]Variables in this category were analyzed at the city level.

[e]Used as a covariate in multivariate analyses.

correlates of indoor tanning, we focused on whether the state of residence for each adolescent had a youth-access law and on the overall law stringency score. States without a law were given a stringency score of zero. Eighty of our sample cities were in 23 states with any indoor tanning law and 63 of these cities were in 16 states with a youth-access restriction.

Frequency of inspections at the local level in cities in states with laws. Procedures for identifying and contacting those knowledgeable about local enforcement of state indoor tanning laws have been previously published.[32] The response rate for this 28-item telephone survey was 100%. In the majority of cases, when there was more than 1 city in a state with a law, the same respondent in that state provided inspection data for all the targeted cities. The item for inspection frequency, which is the key enforcement-related variable used in the current analyses, was, "In the absence of a complaint, how often is a tanning facility inspected in this city/county?"[32]

Facility practices related to youths' access. Using the list of indoor tanning facilities that were identified in our facility count component, female data collectors, who were hired on the basis of their ability to sound like a 15-year-old girl, phoned facilities and posed as prospective clients. A total of 3399 facilities were contacted. As described previously,[30] at the beginning of the contact they described themselves as being 15 years old with fair skin and never having used indoor tanning before. They then asked the following questions, the responses to which were evaluated as potential correlates in the current analysis: "Does my mom need to sign anything so I can tan?" and "How many times can I tan the first week?" For the latter, a response of more than 3 times was considered noncompliant with the FDA recommendation.[36] For each of the cities, we aggregated data for each of these variables across tanning facilities at the city level to indicate the proportion of indoor tanning facilities in the city that required parental consent, the proportion that complied with the FDA recommendation, and the mean number of times the adolescent would be allowed to tan the first week. Interrater reliability was assessed by having the supervisors listen to a random sample of 20% of the calls on a second phone line and independently record the responses. The κ for parental consent was 0.98 and the intraclass correlation coefficient for the number of sessions allowed was 0.99.[30]

Statistical Analyses

We performed univariable and multivariable analyses by using generalized linear mixed models (GLMMs) to adjust for the effects of city clustering. Because the outcome variable, adolescent tanning salon use within the past 12 months, was dichotomous, we used a binary error and logit link in the construction of the statistical model. Although a general correspondence exists, the 3 levels of influence in the ecological conceptual model used to guide our study should not be confused with the 2 levels of analysis in our statistical model. With the exception of proximity to tanning salons of adolescent participants (a built-environment variable analyzed at the individual unit of analysis level), we analyzed psychosocial or individual level of influence variables at the individual unit of analysis level, whereas we analyzed variables at the built-environmental and policy levels of influence by using city as the unit of analysis. More specifically, potential predictors at the individual level of analysis included adolescent demographics, facility

proximity, adolescent behaviors and attitudes, parental demographics, parental knowledge and attitudes, parental gatekeeping, and peer-related behaviors. Potential predictors at the city level of analysis included tanning facility density, tanning laws, enforcement variables, and tanning facility practice and compliance variables. During the univariable stage, the selection process from among these variables included (1) assessment of multicollinearity within domains to eliminate redundant information, (2) conceptual considerations from among variables of similar construct that were highly correlated, selecting the most meaningful predictors, and (3) a screening criterion of $P<.20$.

Once a set of variables was chosen, we constructed a multilevel model using GLMMs, including variables at the individual and city level. We carried out a stepwise analysis beginning with all of the variables in the model, eliminating 1 variable at a time until all remaining variables yielded a P value less than .05. Additionally, the variables that were removed were reexamined to determine if any could be included in the model after adjusting for the set that remained. Finally, we examined specific variables (e.g., demographics) that were removed for their potential impact as confounders based on a change-in-estimate of 15%. We used the stepwise process and significance testing as a means of prioritizing the variables for model building rather than as a rigid algorithm. We performed all analyses with SAS version 9.1.3 (SAS Institute Inc, Cary, NC).

RESULTS

Around 10.4% of the adolescents had used commercial UVR indoor tanning in the past year (i.e., 635 of 6121, with missing data for 4 participants on this variable). Tables 1 and 2 present descriptive data for the sample, reliability estimates for all available variables, distributions or means for the variables by indoor tanned versus not indoor tanned in past 12 months, and univariate test results for potential correlates. Table 1 presents the categorical variables and Table 2 presents the continuous variables. Approximately 52% of the sample were girls, and the majority (69%) were non-Hispanic White. Approximately 30% had skin that was relatively sun-sensitive (Fitzpatrick type 1 or 2).[37] Use of indoor tanning in the past year was higher among girls and among the older age groups. These proportions among 14-, 15-, 16-, and 17-year-old girls were 8.5%, 13.6%, 20.9%, and 26.8%, respectively, and among boys these proportions were 2.0%, 2.1%, 3.9%, and 5.1%, respectively (data not shown). As shown, in univariate tests the majority of the other potential psychosocial or demographic variables that were measured had statistically significant associations with indoor tanning, as did both built-environment variables. Of the 6 policy-related variables, significant univariate associations with indoor tanning were found for 2: that is the number of days facility operator would allow a 15-year-old client to tan the first week (more days predicted tanning) and whether the state had a law addressing minors' access (presence of this predicted not tanning).

Table 3 presents the results of the final multivariate analysis. At the psychosocial or individual level of the ecological model, many of the variables that were significant in the univariate analyses were also significant in the multivariate model. Adolescents who were female, non-Hispanic White, and older and had a larger allowance and less sun sensitivity were significantly more likely to have indoor tanned in the past year. Adolescents who believed indoor tanning can cause skin cancer and that tans look attractive also were significantly more likely to have tanned. Parent-related factors also predicted adolescent tanning. More specifically, adolescents with a parent who used indoor tanning were 70% more likely to have used indoor tanning than were those with a parent who had not used indoor tanning. Indoor tanning was less likely among adolescents with parents who expressed more concern about their adolescent's indoor tanning behavior. Adolescents who perceived that their parents allowed them to use indoor tanning were nearly 5 times more likely to have used it relative to those who perceived that their parents would not allow this. As the adolescent's estimated number of friends who use indoor tanning increased, the odds of the adolescent using indoor tanning increased.

Of the 2 built-environment variables that were assessed, only the tanning facility proximity variable was significant in the multivariate model; adolescents living within 2 miles of at least 1 indoor tanning facility were 40% more likely to have used indoor tanning than were those without a facility within 2 miles. Although significant in the univariate test, facility density of the adolescent's city was not a significant predictor in the multivariate analysis.

None of the policy-related variables significantly predicted indoor tanning in the multivariate model. Adolescents in states with youth-access laws or in cities whose facilities, on average, reported that the adolescent would be allowed to tan fewer days the first week, were just as likely to have used indoor tanning as their counterparts. (Law stringency, facility inspection frequency, and facility-reported parental requirements were not significantly associated with indoor tanning in univariate tests and, therefore, were not included in the multivariate analysis.)

DISCUSSION

Although the prevalence of recent indoor tanning in our entire sample was approximately 10%, the prevalence for older adolescent girls was substantially higher—nearly 27%. This sex–age pattern has been found previously in national US samples.[4–7] Our multivariate test results regarding indoor tanning and parental and peer influences were consistent with our preliminary report, in which only psychosocial and demographic variables were evaluated,[12] and also were comparable to the findings of Stryker et al.[34] The adolescent's belief that indoor tanning may cause skin cancer was positively associated with indoor tanning use. Although this finding initially may seem counterintuitive, it is based on cross-sectional data, and it is possible that adolescents who use indoor tanning have had greater exposure to health-risk messages on tanning equipment and consent forms.

In addition to psychosocial and demographic variables, indoor tanning also was significantly associated with the built-environment variable of the adolescent's proximity to tanning facilities from their home. In other health areas, such as alcohol and tobacco control, availability of built-environmental resources also has been linked to healthy or unhealthy behaviors.[38–42] The relationship between city-based tanning facility density and indoor tanning, significant in the univariate test, may not have

TABLE 3—Multilevel Stepwise Analysis for Adolescent Indoor Tanning in 100 Most Populous US Cities With Predictors Selected From the Individual and City Level Using Generalized Linear Mixed Effects Models: CITY100, 2005–2007

Variables Remaining in Model[a]	Adjusted OR (95% CI)	*P*
Adolescent age, y		
14 (Ref)	1.00	.003
15	1.10 (0.74, 1.60)	
16	1.50 (1.00, 2.10)	
17	1.80 (1.20, 2.60)	
Adolescent sex		
Female (Ref)	1.00	
Male	0.42 (0.26, 0.68)	<.001
Adolescent race		
Non-Hispanic White (Ref)	1.00	.019
Non-Hispanic Black	0.20 (0.06, 0.67)	
Hispanic White	0.62 (0.33, 1.20)	
Other[b]	0.75 (0.53, 1.10)	
Adolescent weekly allowance		
$0–$10 (Ref)	1.00	<.001
$11–$25	1.40 (0.98, 1.90)	
> $25	2.10 (1.50, 3.00)	
Adolescent sun sensitivity		
Always burns, never tans	0.42 (0.26, 0.68)	
Usually burns, hard to tan	0.66 (0.48, 0.92)	
Sometimes burns, then tans	0.92 (0.70, 1.20)	
Rarely burns, easily tans (Ref)	1.00	.001
Parent ever indoor tanned		
No (Ref)	1.00	
Yes	1.70 (1.30, 2.20)	<.001
Parent: people with a tan look more attractive		
Agree	1.50 (1.10, 2.00)	.005
Disagree (Ref)	1.00	
Parent: concerned if adolescent tanned occasionally		
Not a lot (Ref)	1.00	
A lot	0.58 (0.45, 0.74)	<.001
Adolescent: parents allow me to tan		
Strongly or somewhat disagree (Ref)	1.00	
Strongly or somewhat agree	4.80 (3.60, 6.30)	<.001
% of adolescent's friends who have ever tanned indoors with tanning lamps (20% unit increase)	1.80 (1.60, 1.90)	<.001
Adolescent: indoor tanning can cause skin cancer		
Disagree or don't know (Ref)	1.00	
Agree	1.60 (1.00, 2.40)	.043
Adolescent: getting an indoor tan first protects from burning in the sun		
Disagree or don't know (Ref)	1.00	
Agree	2.00 (1.60, 2.50)	<.001
Adolescent: people with a tan look more attractive		
Strongly or somewhat disagree (Ref)	1.00	
Strongly or somewhat agree	1.80 (1.30, 2.50)	<.001

Continued

been significant in the multivariate test because of multicollinearity, with a strong correlation between the proximity and density variables (data not shown). Proximity to individual adolescents' homes was likely a more sensitive and precise measure of tanning salon availability.

At the policy level, we recently reported that tanning facility personnel in states with (vs without) indoor tanning youth-access laws were significantly more likely to tell our study confederates that they would need parental consent.[30] However, this finding does not appear to translate into reduced indoor tanning by adolescents; the current multivariate analyses found no significant difference in indoor tanning behavior among adolescents in states with adolescent indoor tanning access laws versus states without such laws (e.g., parental consent or accompaniment). A recent report also found a lack of association between these variables, and concluded that "the presence of state legislation restricting minors' access to indoor tanning has limited effectiveness, perhaps because most state policies permit use with parental consent."[43(p190)] We agree with this interpretation.

Limitations of our study include reliance on adolescents' self-reported indoor tanning behavior, a cross-sectional study design, using a telephone (vs in-person) data collection strategy by young women posing as 15-year-old girls to obtain facility practice data, and omitting smaller cities and rural areas from our sampling sites. An important methodological strength included careful pilot testing,[28] sampling, and quality control procedures for each data set, which yielded respectable levels of reliability. Moreover, to our knowledge this study represents the most comprehensive attempt to examine potential correlates of indoor tanning by adolescents, simultaneously examining demographics, psychosocial variables, tanning facility availability, and policy-related factors such as legislation and practices by tanning facility operators.

As noted before, a key finding was the lack of a significant association between whether a state had an indoor tanning youth-access law and whether adolescents in that state were using indoor tanning. Our data, as well as those of others,[43] suggest that the current laws, most of which involve parental consent requirements,

TABLE 3—*Continued*

Proximity: does adolescent live within 2 mi of a tanning facility		
No (Ref)	1.00	
Yes	1.40 (1.00, 1.90)	.028

Notes. CI = confidence interval; CITY100 = Correlates of Indoor Tanning in Youth study; OR = odds ratio.
[a]Variables at the adolescent level of analysis that were removed from earlier versions of this model, in order of elimination, were: has adolescent ever noticed ads for indoor tanning, is adolescent happy with appearance, does adolescent know anyone personally who has had skin cancer, does adolescent think having a tan makes people look healthier, does adolescent think most of his or her friends like to be tanned, household income, does adolescent think people who tan have already damaged their skin, how often adolescent protects skin in summer, parent education, and does parent agree that indoor tanning can cause skin cancer ($P = .96$). Variables at the city level of analysis that were removed from earlier versions of this model, in order of elimination, were: log physical size of city, mean number of days per week facilities would allow a adolescent to tan, does adolescent live in a city with a state law addressing minors' use of indoor tanning, and city's tanning facility density ($P = .92$–$.32$).
[b]American Indian, Asian, Pacific Islander, multiethnic/multiracial, and other-unspecified.

are not working. Possible reasons for this ineffectiveness are:

1. parents may be providing their consent;
2. adolescents may be falsifying their parents' signatures;
3. adolescents may be visiting the (less compliant) facilities that have a history of not requiring parental consent;
4. parents and adolescents may be unaware of the laws; or
5. the age limit in some of the states requiring parental consent may be too low.

The high rate of indoor tanning by older adolescent girls suggests that better laws are needed, preferably in the form of bans for those younger than 18 years as recommended by the World Health Organization.[44] Such laws already have been passed in several European countries,[45] several states in Australia,[45] and Howard County, Maryland.[46] Results of statistical modeling have suggested that effective regulation of the indoor tanning industry in Australia, including banning minors' use, could substantially reduce skin cancer incidence and associated costs.[47]

Additionally, in the meantime and in conjunction with stronger laws, our data show that parents who influence their adolescents' indoor tanning behavior both by modeling this behavior themselves and by granting their permission for their adolescents to tan could play an important role in lowering their adolescents' melanoma risk. More specifically, they could discontinue their own use of indoor tanning, withhold their consent for their child to tan, place restrictions on their child's use of his or her allowance, or lobby for the passage of effective indoor tanning laws in their state and nationally. ■

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This article was accepted November 19, 2010.

Contributors

J.A. Mayer obtained funding and contributed to origination, design, analysis, interpretation, study supervision, and writing. S.I. Woodruff contributed to origination, design, analysis, interpretation, study supervision, and writing. D.J. Slymen contributed to origination, design, analysis, interpretation, and writing. J.F. Sallis, J.R. Weeks, and G.E. Belch contributed to origination, design, interpretation, and writing. J.L. Forster, M.A. Weinstock, and T. Gilmer contributed to origination, design, and interpretation. E.J. Clapp contributed to origination, design, data acquisition, and study supervision. K.D. Hoerster and L.C. Pichon contributed to analysis, interpretation, study supervision, data acquisition, and writing.

Acknowledgments

This study was supported by the National Institutes of Health/National Cancer Institute (grants R01 CA093532, R01 CA093532S1, and K05 CA100051).

We thank Ami Hurd and Minal Patel for their contributions to the pilot research that informed this study, Laura Solomon and Brian Saelens for helping with the law scoring validation, and Donald Bishop and Lorri Freitas for their feedback on the enforcement evaluation instrument. We are grateful to our 5 tanning facility compliance confederates—Laurel Butcher, Ashley Bickmore, Muriel Eclavea, Erin Greene, and Jennifer Nicol. We thank Debra Rubio for assisting with administrative tasks and article preparation and Rebecca Garrow for assisting in evaluating tanning facility density. Survey Sampling Inc and Luth Research provided high-quality services related to our adolescent–parent survey.

Human Participant Protection

The institutional review board of San Diego State University approved all study procedures.

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