Tanning facility use: Are we exceeding Food and Drug Administration limits?

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Background: The US Food and Drug Administration (FDA) recommends exposure limits for tanning bed use. Tanning patrons may not be following these recommendations and may be overexposed to damaging ultraviolet radiation (UV).

Objective: This study was conducted to assess tanning patrons' adherence to FDA-recommended exposure limits and to measure the amount of UVA and UVB radiation emitted by tanning beds.

Methods: A community-based survey was administered during routine state inspections of North Carolina tanning facilities (n = 50). At each facility, patron records were randomly selected (n = 483) for a survey of exposure records, and UVA and UVB outputs were measured for each tanning bed.

Results: The recommended limits were exceeded by 95% of patrons, and 33% of patrons began tanning at the maximum doses recommended for maintenance tanning. Average tanning bed output was 192.1 W/m^2 UVA and 0.35 W/m^2 erythemally weighted UVB.

Conclusions: Interventions for tanning bed operators and patrons are needed to increase compliance with federally recommended exposure limits. (J Am Acad Dermatol 2003;49:655-61.)

In response to increasing skin cancer incidence,[1,2] public health measures have brought attention to the dangers of solar ultraviolet radiation (UV). However, much less is known about the dangers of UV from tanning bed use. Studies have shown that tanning bed patrons can incur severe skin or corneal burns.[3,4] UV exposure also can induce acute photosensitivity reactions to medications,[5,6] such as the reported psoralen reaction resulting in the death of a tanning bed patron.[7] Chronic UV exposure can cause photoaging of skin[8,9] and cataract formation.[10,11] More importantly, studies have shown an association between sunbed use and both melanoma[12-15] and nonmelanoma skin cancers.[16,17] The potential association between tanning bed use and skin cancer is concerning given the popularity of indoor tanning.

Abbreviations used:

GEE: generalized estimating equations
FDA: Food and Drug Administration
MED: minimal erythemal dose
UV: ultraviolet radiation

The US tanning industry serves an estimated 28 million persons. It is a nearly $5 billion per year business that continues to grow.[18] There are currently 30,000 tanning facilities in the United States, including primary tanning salons and facilities such as hair salons and health clubs.[18] Modern tanning beds emit mainly UVA of wavelengths 320 to 400 nm and a small amount (<1%-9.5%) of UVB of wavelengths 290 to 320 nm.[19,20] Tanning proponents claim that tanning beds emitting predominantly UVA are a safe alternative to sun exposure, although studies have shown that UVA may be particularly effective at causing photoaging with its dermis-penetrating wavelengths,[8,9] and skin cancers have been

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reported after therapy with psoralen and ultraviolet A radiation.[21,22] The promotion of indoor tanning as a healthful way to achieve a protective tan is contradicted by results of studies demonstrating that tans from UVA-predominant beds offer little protection from sunburn,[23] equivalent to that of sun protection factor 4 sunscreen.[24]

Federal regulation of the tanning industry is primarily through the Code of Federal Regulations 1040.20 published by the US Food and Drug Administration (FDA). The Code of Federal Regulations details requirements for sunlamp manufacturers on lamp specifications, posting of warning labels, and provision of suitable eye protection.[25] The FDA does not regulate the relative amounts of UVA and UVB produced by sunlamps, although it does limit acceptable amounts of UV of wavelengths 200 to 260 nm. Guidelines for recommended tanning bed exposure doses were issued by the FDA in 1986. The guidelines called for a maximum exposure of 0.75 minimal erythemal dose (MED) 3 times during the first week of tanning followed by a gradual increase to maintenance doses of a maximum 4.0 MED delivered weekly or biweekly.[26] On the basis of these guidelines, manufacturers develop a recommended exposure schedule for each type of tanning unit, and it is a requirement that the guidelines be posted with each unit.[25] These exposure schedules represent FDA-recommended maximum exposures for first and subsequent weeks of tanning by exposure times in minutes specific to the tanning unit and patron skin type. Decreased exposure times are recommended for tanning beds with newly replaced bulbs, because these machines have higher UV output. Specifications for decreased exposure during the early lifespan of a bulb vary by manufacturer. Adherence to exposure schedules is left to the discretion of individual tanning facility operators and tanning patrons.

Existing regulations currently do not provide for national enforcement of exposure schedule adherence by tanning patrons or for monitoring the amounts of UVA and UVB emitted by tanning units. This study was conducted to examine community use of tanning facilities in an attempt to identify the extent to which users were following or exceeding FDA-recommended exposure limits and to identify the type and amount of radiation users were receiving.

METHODS

Study design

The study involved a community-based survey of tanning facilities and their patrons in North Carolina. North Carolina was chosen as the research site because it has comprehensive tanning facility regulations that require maintenance of records of tanning patrons' visits with dates and durations of tanning exposures.[27] The regulations also mandate training and certification of operators, display of warning signs, eye protection and equipment requirements, and registration and biennial inspections of each facility throughout the state by the North Carolina Division of Radiation Protection. Penalties for violation of these regulations can include monetary fines or possible closure.

A convenience sample of 62 tanning facilities were invited to participate as part of their regularly scheduled state inspections. The data were gathered by 1 state tanning bed inspector who had been trained in the study protocol. Data collection spanned a consecutive 8-month period including the winter and spring of 1999. Approximately 7 or 8 facilities were invited to participate per month as the inspector's schedule allowed time for administration of the survey during inspection visits. The inspector administered the survey in all regions visited during statewide inspection rounds to eliminate geographic sampling bias.

Each facility and its patrons were evaluated by means of a survey instrument that consisted of 12 items assessing tanning facility characteristics and 8 items assessing patron behavior. The survey items pertaining to tanning facility characteristics covered the facility type (tanning only, hair salon and tanning, health fitness center, other), the number of years in operation, the number of tanning units, the number of operators, the percentage of operators certified, the number of daily customers, and the percentage of first-time users among weekly customers. The inspector answered these items on the survey by personally interviewing the facility operator and recording the answers.

Survey evaluation of patron behaviors was accomplished by examination of 10 randomly selected patron records at each facility, although occasionally fewer than 10 records were reviewed per facility because of the inspector's time limitations. Patrons' records were used to evaluate the type of exposure schedule followed (if any), the exposure times for the first tanning visit, the history of indoor tanning in the previous year, the time period for tanning, and the frequency and length of visits. A sample list of 15 commonly used exposure schedules was compiled and provided to facilitate answering the survey section on exposure schedules. Patrons were considered to be not following an exposure schedule if records indicated that during any week of tanning they exceeded the exposure times recommended for that week of tanning by the appropriate exposure

Table I. Tanning facility characteristics

	All types	Tanning facility only	Hair and tanning facility	Health fitness center	Other
No.	50	8 (16%)	29 (58%)	4 (8%)	9 (18%)
In operation >2 y*	29 (59%)	2 (25%)	19 (67.9%)	3 (75%)	5 (55.6%)
Have ≥3 tanning units	32 (64%)	6 (75%)	18 (62.1%)	2 (50%)	6 (66.7%)
Have ≥3 tanning operators	29 (58%)	5 (62.5%)	14 (48.3%)	3 (75%)	7 (77.8%)
Have ≥50% of operators certified	50 (100%)	8 (100%)	29 (100%)	4 (100%)	9 (100%)
>30 patron visits per day*	26 (53%)	5 (62.5%)	13 (46.4%)	3 (75%)	5 (55.6%)
<25% of weekly patrons are first-time users*	48 (98%)	8 (100%)	27 (96.4%)	4 (100%)	9 (100%)

*For these data, n = 49 for all facility types (information not available at 1 site).

schedule. The inspector answered these items on the survey by accessing the written patron records and recording the appropriate information.

In addition, UVA and UVB measurements were taken from each available bed in the facility. The UV measurements were obtained with a PMA2100 UV broadband meter (Solar Light, Philadelphia, PA) with UVA and UVB detectors (also described as a Solar Light sunburning or ultraviolet intensity meter). This device allowed analysis of UVA and UVB output in each tanning bed. The PMA2100 detector measures UVB output in MED/h, defining an MED as 210J/m^2 of erythemally weighted UVB. Instrument detectors were placed in the middle of each unit on the lower bed surface so that the distance from the radiation source was the same for each unit.

Statistical analysis

Data were initially entered into 1 of 3 different computer databases in Stata (College Station, Tex): (1) tanning site data, (2) tanning bed data, and (3) patron data. These 3 databases contained an identical facility number variable between them, allowing data merge. Finally, each of the databases was converted to Microsoft Excel for further analysis. Descriptive statistics were performed in both the Stata statistical package and Excel. The discrete variables were summarized with frequencies and percentages. Continuous variables were summarized with mean, standard error, and range.

The Genmod procedure with Bonferroni correction of the SAS statistical software (Cary, NC) was used for analysis. Generalized estimating equations (GEE) were used in the analysis because this method accounted for the necessary covariance structure. With selection of different link functions, all outcome measures could be analyzed with the same GEE method. Sites (tanning facilities) were the unit of analysis. Clustering and repeated measures of beds or patrons within sites were taken into account in the analysis. Compound symmetry within site and independence between sites were assumed.

RESULTS

Of the 62 tanning facilities asked to participate, 81% consented to the study. Fifty tanning facilities were surveyed, and a total of 483 patron records were reviewed. The facilities were located throughout the state, including the greater areas around Asheville, Charlotte, Winston-Salem, Greensboro, Durham, Raleigh, Goldsboro, and Fayetteville. Fifty-eight percent of the participating facilities were a combination of hair salons and tanning salons, 16% were tanning salons only, 8% were health and fitness centers, and 18% were categorized as other (eg, grocery stores, sportswear and clothing stores). For comparison, the statewide distribution of facility types in North Carolina is 46% hair and tanning salons, 26% tanning-only salons, 8% health and fitness centers, and 20% other (personal communication, Amy Sawyer, North Carolina Division of Radiation Protection). Of the total facilities surveyed, 59% had been in business for more than 2 years, 64% had 3 or more tanning units, and 58% had 3 or more operators (Table I). Forty-nine of the 50 facilities indicated that more than 75% of their tanning bed operators were certified. Customer use was found to be more than 30 patrons per day at 53% of the facilities, and 98% of the facilities reported that less than 25% of weekly customers were first-time tanners. A range of 1 to 3 different exposure schedules were available for use at the facilities (mean, 1.3 schedules; standard error, 0.08).

In evaluation of patron data (n = 483), it was found that 95% of patrons were exceeding the recommended times and therefore did not follow the tanning bed exposure schedules outlined by the FDA (Table II). Of the 483 patrons, 33% were starting their first tanning session at or above exposure times recommended for patrons in the maintenance phase of tanning (corresponding to ≥4.0 MED). The

Table II. Tanning patron behaviors

			No.	Mean	Standard error	Range
Following exposure schedule (n = 483)						
No	460 (95%)	No. of min on first visit	483	14.25	0.27	3–30
Yes	23 (5%)					
Starting at maximum exposure time (n = 483)		Tanning period (wk)	477	6.32	0.28	0.50–52
No	326 (67%)					
Yes	157 (33%)	No. of min/wk	483	43.00	1.12	5–135
Previous tanning (n = 231)						
No	139 (60%)	No. of visits/wk	482	2.37	0.06	0.25–7
Yes	92 (40%)					

Table III. UVA and UVB measurements

	No.	Mean	Median	Range
UVA (W/m^2)	136	192.1	181.1	17.7–674.0
UVB (W/m^2), erythemally weighted	171	0.35	0.33	0.12–0.82

average session length for tanning on the first visit was 14.25 minutes (range, 3-30 minutes). The compilation of 15 common exposure schedules listed a suggested range of 2- to 15-minute sessions (average, 5.76 minutes) for the first week of tanning with gradual increases over a 4-week or longer period to a range of 8- to 30-minute maintenance sessions (average, 20.51 minutes). The average period of tanning for each patron was 6.3 weeks, and patrons spent approximately 43 minutes in the tanning bed each week (range, 5-135 minutes) during an average of 2.4 sessions per week (range, 0.25-7 sessions). Forty percent of patrons had tanning histories from the previous year and were repeat users.

The GEE method was used to compare patron behaviors against tanning facility type, years in operation, numbers of tanning units, numbers of operators, and number of daily customers. The average number of minutes of tanning per week was found to be significantly different ($P < .005$) between primary tanning facilities (34.8 minutes) and facilities categorized as other (50.33 minutes). In comparisons of primary tanning facilities with the combined group of all other facility types (hair salons, health fitness, and other), there was still a significant difference: 34.8 minutes compared with 44.76 minutes ($P = .009$). No other significant pairwise comparisons were found.

As for UV output, the beds on average emitted a mean UVA of 192.1 W/m^2 (range, 17.7-674.0 W/m^2) and UVB of 6.01 MED/h (range, 2.11-14.00 MED/h) (Table III). UVB measurements were converted from units of MED/h to W/m^2 on the basis of the definition of a MED as measured with the PMA2100 detector. The measured average UVB output of 6.01 MED/h was equivalent to 0.35 W/m^2 of erythemally weighted UVB (range, 0.12-0.82 W/m^2). The GEE method was used for comparisons of UVA and UVB measurements against tanning facility type, years in operation, number of tanning units, number of operators, and number of daily customers, but no significant ($P < .005$) pairwise comparisons were found.

DISCUSSION

It is alarmingly clear that FDA-recommended exposure schedules are not being followed in the community. In this study, 95% of patrons were exceeding the times recommended by exposure schedules. We found that the tanning facilities did have exposure schedules on site (mean, 1.3 schedules), but the patrons' records indicated that the schedules were not being followed. We also observed that as many as one third of patrons were starting their first tanning visit at or above the maximum exposure limit for maintenance tanning. This practice goes against the current recommendations for a gradual increase in exposure time with limited doses in the first week of tanning. These patrons in their initial week of tanning were more likely to have untanned skin and to be more susceptible to UV damage. These patrons also were receiving the maximum doses reserved for maintenance tanning.

Tanning bed exposure times have been described by other methods, but none involving direct analysis of patrons' records as in our study. In a 2000 study of frequency and exposure times in 60 San Diego tanning facilities, investigators posing as potential customers asked operators about the allowable frequency and duration of tanning. The investigators found that only 6.8% of tanning operators were compliant with FDA frequency recommendations,

and all operators claimed they would limit patrons' tanning to less than 30 minutes.[28] Our findings indicated that most patrons are exceeding recommended times of exposure for initial and subsequent tanning sessions. We report a much higher rate of noncompliance with FDA-recommended times than that cited by Kwon et al,[28] which may reflect the difference between claims of future enforcement by operators versus true patron use patterns. The study by Kwon et al also broadly defined compliance with exposure schedules as being a duration of less than 30 minutes. Noncompliance with recommended tanning times also was reported in a survey of 20 New York tanning bed operators. The average length of tanning the operators claimed they would allow was 43 minutes, and some operators would allow up to an hour of exposure.[29] A survey of high school students who used tanning beds showed that 57% claimed to have had tanning sessions of 30 minutes or longer.[30] Inadequate limits of length and frequency of tanning also were found in a survey of tanning facility operators in Arkansas[31] and by an undercover investigation of tanning facilities in Michigan.[32] Given the findings of this study and others and the prevalence of "unlimited tanning" offers publicized by tanning facilities, it is clear that large numbers of tanning bed patrons may be exceeding exposure limits.

These descriptions of frequent indoor tanning patterns without enforced limits are of concern in light of the popularity of tanning. A survey in New York showed that 21.5% of 1720 persons had used tanning beds, the highest rate occurring among young women.[33] One study showed that 34% of 1008 Minnesota teenagers had ever used tanning beds,[30] and another study showed that 18% of 210 Texas teens had used tanning beds within the last 6 months.[34] High use among teenagers is of concern because most cumulative UV exposure occurs before 18 years of age[35] and because in most states parental permission is not required for tanning bed use. Also troubling is that most indoor tanners have skin types I through III, and patrons with skin types I and II may be particularly at risk of poor tanning, burning, and skin cancer.[36] Finally, tanning bed overexposure has been found to cause molecular damage such as p53 dimer formation in keratinocytes taken from volunteer subjects exposed to tanning beds at doses and frequencies more intense than that recommended by the FDA.[37] The trend reported herein of a sizable portion of tanning patrons exceeding the recommended limits is clearly concerning.

Most of the salons in this study had been in operation for several years and ran several tanning beds serving more than 30 customers per day. These findings imply these use patterns may have included many patrons over an extended time range, especially because more than 40% of patrons were repeat tanners with a history of tanning in the previous year. Notably, these exposure patterns were documented from salons in which most operators were certified according to state regulations. Results of past studies have indicated that tanning bed operators as a group are poorly informed about the risks of indoor tanning. A survey of tanning operators in Michigan showed that 63% of operators did not believe that tanning beds can cause cancer.[32] Another study showed that tanning patrons in New York were told by 65% of operators that they could not get a sunburn from tanning beds, and 80% of operators told patrons they could not get skin cancer from tanning beds.[29] A study in North Carolina showed that operators were unaware of common photosensitizing drugs, and some even allowed children younger than 10 years old to tan.[38] Because operators play such an integral role in controlling tanning bed use, their collective lack of knowledge and questionable history of enforcing regulations highlight tanning beds as a potential public health danger.

UV output in standard tanning facility beds is very high given that, for example, average UVA output measured in this study was 192 W/m^2 when summer solar noon output in Washington, DC, was 48 W/m^2.[19] The average erythemally weighted UVB output of 0.35 W/m^2 also is very high because summer solar noon erythemally weighted UVB in Washington, DC, was 0.18 W/m^2.[19] Other measurements of summer solar erythemally weighted UVB from various locations in the United States have a maximum of approximately 0.25 W/m^2.[39] Our measurements of an average of 0.35 W/m^2 and a maximum of 0.82 W/m^2 erythemally weighted UVB indicate that tanning bed patrons are receiving higher doses of UVB than they would from summer sun exposure. Furthermore, a dose of 0.35 W/m^2 corresponds to a UV index of 14. Our highest measurement of 0.82 W/m^2 erythemally weighted UVB corresponds to a UV index of 33.[40] These UV indexes are alarmingly high and indicate that patrons with fair skin can burn their skin very quickly. Because, however, the PMA2100 detector does not perform spectral analysis, we could not determine the percentage these high amounts of UVB irradiance contribute to total UV emitted from tanning beds. The UVA levels we measured were comparable with those in reports of UVA ranges of 54 to 244 W/m^2[41] and 50 to 190 W/m^2[31]; however, our upper range of 674 W/m^2 was higher than has been previously reported. Our

higher range for UVA levels and the wide ranges we found in both the UVA and UVB measurements could be due to differences in specific tanning bed models and varying ages of the bulbs.

Primary tanning facilities were found to have significantly shorter patron tanning times than the other facility types in the pairwise comparisons. This finding may indicate salon owners in businesses dedicated to tanning may be more conscientious of enforcing patron adherence to exposure limits, unlike facilities where operators may be distracted with other avenues of business. It is possible that primary tanning salons may prove to be the best type of business arrangement for ensuring safe patron behavior. However, our sample size of tanning-only facilities was small (n = 8), and the proportion of tanning-only facilities in this study was lower than the statewide prevalence in North Carolina (16% vs 26%), which may limit interpretation of this finding.

A limitation of this study was that the facilities were not randomly chosen but were included as time allowed on the state inspector's rounds. This method may have resulted in selection bias that could have skewed the data. Our sample may have more hair and tanning combination facilities in place of tanning-only facilities given the prevalence statistics for different facility types in North Carolina, but the distribution of the other facility types studied was reflective of the statewide distribution. Geographical bias in facility selection was unlikely because the facilities were distributed throughout the state. Strengths of the study included consistency in data collection and objectivity of written records for determining patron behavior as opposed to information reported or recalled by patrons or operators.

It may not be possible to generalize these results to other states because North Carolina has thorough regulations for operator training and certification, and only 27 other states have regulatory programs for tanning salon operators that differ widely in size and scope.[42] We predict that the results may be similar or even worse in states with little or no state regulations, because certified North Carolina operators may be more knowledgeable about tanning bed risks and may be more likely to enforce exposure schedule adherence. However, adherence to exposure schedules is not part of the North Carolina state regulations. Even with a thorough state regulation program, North Carolina operator compliance with tanning bed regulations is poor.[43] To obtain more generalizable data, future studies conducted with objective measures of exposure time could explore exposure schedule compliance in states with varying degrees of regulation.

In summary, we report that tanning patrons are uniformly not following the schedules for tanning recommended by the FDA. These findings indicate a need for future educational interventions to increase the knowledge of both tanning patrons and facility operators for compliance with recommended exposure guidelines. There is also a need to further establish enforcement of these safety recommendations, such as with policy changes to make exposure schedule adherence mandatory in combination with inspections of tanning facilities to ensure compliance. The FDA is considering updating and including exposure schedules into the Code of Federal Regulations 1040.20 so that exposure schedule adherence would be an enforceable regulation as opposed to a guideline.[44] This change would be well advised given the poor adherence rates reported herein. In the future, tracking patrons' cumulative exposures may be helpful for determining total amounts of tanning bed exposures that patrons are receiving nationwide and in considering establishment of cumulative exposure limits. A combination of educational interventions with updated and mandatory enforced regulations is likely the best approach to ensuring better protection of tanning bed patrons from overexposure.

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