The indoor UV tanning industry: A review of skin cancer risk, health benefit claims, and regulation

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Background: Nearly 30 million people tan indoors in the United States annually, including 2.3 million adolescents. Despite increased evidence on the dangers of artificial UV radiation, the popularity of indoor tanning is growing.

Objectives: We aim to assess the following 3 entities: (1) the association of indoor tanning with skin cancer; (2) statements regarding the health benefits of indoor tanning, especially regarding the production of vitamin D; and (3) current regulation of the tanning industry in the United States.

Methods: We conducted a narrative review of the literature.

Results: Indoor tanning poses great risks. Studies support the role of artificial UV radiation in cutaneous carcinogenesis. Despite claims by the tanning industry, artificial tanning is not a safe or necessary way to increase systemic vitamin D levels. The National Institutes of Health and the World Health Organization have acknowledged the risks of indoor tanning. Nonetheless, regulations limiting tanning in the United States are surprisingly sparse.

Limitations: Systematic review of the literature was not performed.

Conclusions: Health care providers must increase efforts to warn and educate the public and government about the dangers of UV radiation. (J Am Acad Dermatol 2005;53:1038-44.)

TANNING OVERVIEW

Indoor tanning is popular

The indoor tanning industry is large and sophisticated in the United States and Northern Europe. It has a $5 billion estimated annual revenue, which has increased from $1 billion in 1992.[1,2] A total of 50,000 facilities are used by 28 million US citizens annually.[3] The popularity of indoor tanning is growing, despite public health warnings. Large revenues enable skilled lobbyists to work for advantageous regulations from federal and state governments.[4] For many years, these efforts were successful and the medical profession's attempts to warn the public about the dangers of UV exposure fell behind. Although recent gains in regulations have been made, further progress is imperative.

The evolution of indoor tanning

Three recent *Journal of the American Academy of Dermatology* articles have provided a comprehensive overview of the history of tanning beginning with the parasols of upper-class 19th century women, onto the emergence of sunbathing at the end of the 19th century, and through the advent of phototherapy for medical purposes in the late 1800s. The popularity of artificial tanning ultimately led to the growth of the indoor tanning industry in the 1970s.[5-7]

The move toward greater UVB

Before the mid-1970s, sunlamps used at home emitted a broad spectrum of radiation from UVC to infrared. In the late 1970s to the early 1980s, it was suggested that a UVA-induced tan was safer than one caused by UVB and UV lamps were then produced with minimal or no UVB radiation.[8-11] Two modern US sunlamps evaluated by the Food and Drug Administration (FDA) emit 99.9% and 95.7% UVA.[9]

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However, recently lamps have been produced to emit greater amounts of UVB and, thereby, lead to a more substantial tan.[8-11] In addition, high-pressure UVA tanning beds are now produced that emit UVA doses at outputs far higher than that of the sun.[1,2]

Tanning demographics

On an average day in the United States more than 1 million people tan in tanning salons.[12] Of customers, 70% are white girls and women, aged 16 to 49 years.[13] More than 2.3 million teenagers are among the US consumer base.[1] More than 25% of US teenaged girls have used tanning booths 3 or more times in their lives.[14] One study showed that teenaged girls in a Minneapolis, Minn, suburb had a lifetime tanning bed use prevalence of 51%.[15]

Factors shown to be associated with indoor tanning in the United States include female sex, residence in the Midwest or South, rural school location, increasing age, use of tobacco and alcohol, and increased personal spending money.[14]

THE DANGERS OF SUNBEDS

Many studies document adverse effects from sunbeds

There is a vast amount of literature on the adverse results of tanning beds. The consequences range from minor to potentially fatal disorders (Table I).[13] In one study, 44% of sunbed users had increased erythema.[16] Another noted that 59% of tanning bed users had some resultant skin injury.[15] A Centers for Disease Control and Prevention report shows that there are 700 emergency department visits per year secondary to adverse reactions from sunbeds.[17] Interestingly, these adverse effects do not necessarily limit sunbed use. In Italy, 25% of sunbed users experienced salon-induced sunburns, but only 60% suspended sessions after burning.[18]

The prevacation tan

One particularly dangerous practice is the use of tanning beds as a UV radiation multiplier. This is when people go to tanning beds to prepare their skin for a sunny vacation. Not only does this lead to extra radiation during the prevacation period, but it also leads to decreased use of sun-protective precautions during vacation, as people falsely believe that their tan will protect against the harmful rays of the sun.[13,19] The prevacation tan by a sunbed, however, affords practically no photoprotection. Tanning under the sun confers only minimal photoprotection, equivalent to a sunscreen with sun protection factor 3. The tan induced by a sunbed provides even less protection than a natural suntan.[20]

Table I. The adverse effects of sunbeds

Acute sunburn
Photoinduced medication reaction
Polymorphous light eruption
Skin fragility and blistering
Sunbed lentigines
Atypical melanocytic lesions
Suppression of cutaneous DNA repair and immune functioning
Ocular disorders
Exacerbation of porphyria and of SLE, SCLE, DLE
Increased risk of skin cancer

DLE, discoid lupus erythematosus; *SCLE*, subacute cutaneous lupus erythematosus; *SLE*, systemic lupus erythematosus.

Indoor tanning and skin cancer

In recent years an association between sunbed use and a significantly elevated risk of skin cancer has crystallized. A link has been shown between indoor tanning and squamous/basal cell carcinoma. Overall use of sunbeds has been associated with an odds ratio (OR) of 2.5 (95% confidence interval [CI] 1.7-3.8) for squamous cell carcinoma and 1.5 (95% CI 1.1-2.1) for basal cell carcinoma, adjusting for sunburns, sunbathing, and sun exposure.[21]

Molecular studies have also shown the danger of tanning beds. Similar to sunlight, tanning salons cause DNA alterations and p53 protein expression in skin, demonstrating a potential for UV radiation to increase the risk of cancer.[12]

Indoor tanning is associated with melanoma

Indoor tanners are at an increased risk for melanoma. A population-based, matched, case-control study in Sweden reported a significantly elevated OR for developing melanoma after regular exposure to tanning beds, adjusted for hair color, raised nevi, skin type, and number of sunburns (OR 1.8, 95% CI 1.2-2.7). The OR was even higher in individuals younger than 36 years who regularly used indoor tanning (OR 8.1, 95% CI 1.3-49.5).[8]

This positive association between sunbeds and melanoma has been widely published.[22] In one large prospective cohort study of pigmentation factors and sun exposure in relation to melanoma risk, 106,379 women from Norway and Sweden were followed up for an average of 8 years. In all, 187 cases of melanoma were found. A statistically significant risk of melanoma was associated with specific risk factors including the use of a device that emits artificial light one or more times per month (P = .04). Overall, regular (≥1 time/mo) solarium use at any age was associated with a statistically significant, 55% increase in risk of melanoma after adjustment for sun

sensitivity and measures of sun exposure (association greatest for ages 20-29 years).[23]

The National Institutes of Health and the World Health Organization affirm the dangers of sunbeds

In the 10th report on carcinogens by the National Institutes of Health (NIH), it is stated, "Exposure to sunbeds and sunlamps is known to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in humans, which indicates a causal relationship between exposure to sunbeds and sunlamps and cancer."[9]

The World Health Organization (WHO) recognizes the dangers of sunbed use, as well, and has declared that worldwide, no person under 18 years of age should use a sunbed.[4,24]

INDUSTRY PROPAGATION AND THE VITAMIN D CONTROVERSY

The tanning industry's overall health assertions

The tanning industry strives to convince the public that indoor tanning is healthy. They emphasize that tanning produces a psychologic sense of well-being and induces vitamin D production, which lowers ones overall cancer risk.[25] They also state that a tan protects the skin from sunburn and because sunburn causes skin cancer, indoor tanning prevents skin cancer.[26-28] The Smart Tan Network, a lobby of the tanning industry, states that sunscreen is not needed every day. Sunscreen, they explain, can completely block the body's ability to produce vitamin D. The lobby states, "The $30 billion sun-care industry encourages everyone to wear sunscreen ... this may in fact cause more harm than good."[29] This statement, among others, is one example of the many marketing techniques used by the indoor tanning industry to convince the public that indoor UVR is healthy.

Medical support of industry claims

Tanning industry claims are supported by research focusing on vitamin D metabolism and deficiency. In a study funded in part by the UV Foundation, a division of the Indoor Tanning Association (ITA), it was concluded that regular use of a tanning bed resulted in higher vitamin D serum concentration.[30] The tanning industry publicizes the funding they have provided for this and other related work.[31]

The science of sun exposure and vitamin D production

Despite the importance of adequate vitamin D levels, research confirms that the amount of sunlight needed to produce sufficient vitamin D is small and does not justify the large abuse of tanning beds. A study in Cincinnati, Ohio, determined that white, clothed infants, exposing their hands and face, require 0.5 to 2.0 hours of sun exposure per week for adequate vitamin D synthesis.[32] A randomized double-blind controlled trial in Australia evaluated the serum vitamin D levels in persons using a sun protection factor 17 sunscreen daily verses persons using placebo. During the study, none of the participants developed vitamin D levels under the normal range.[33] A 6-year study of 6 patients with xeroderma pigmentosum found mean levels of 25-hydroxyvitamin D were in the low normal range and levels of 1,25-dihydoxyvitamin D, calcium, ionized calcium, and parathyroid hormone were all in the normal range despite meticulous sun avoidance.[34]

Recent attempts to increase the recommended vitamin D level

Recently several researchers contend that the currently recommended vitamin D requirements are insufficient.[35-37] Others do not believe that the health benefits of dramatically raising vitamin D requirements have been established in the literature.[38,39] Despite this controversy, literature produced by the tanning industry repeatedly cites the "severe vitamin D deficiency epidemic"[25] as support for the use of artificial tanning beds.

Sunbed UV exposure is excessive for vitamin D production

The standard UVB dose given at an average tanning session greatly exceeds the recommended 25% of 1 minimal erythema dose (MED). The MED for type II skin is reached after 12.6 minutes and for type III skin after 17.7 minutes using a standard tanning bed. Sunbed visitors average 20 minutes of UVB exposure.[40] Because 25% of 1 MED for type II and type III skin equals an exposure time of approximately 3 and 4.5 minutes, respectively, tanning salon patrons consistently receive 4.5 to 7 times the amount of UVB radiation in each session needed for vitamin D production. Further, tanning patrons are exposing a much larger skin surface area than is quoted above. Individuals with darker skin types (Fitzpatrick skin type $\geq$ IV) may need longer UVB exposure times to reach a beneficial level of circulating vitamin D,[41] but these individuals are least likely to use tanning beds.

Not only is extended tanning unnecessary for adequate vitamin D production, but it is seemingly counterproductive because at approximately 1 MED of UV radiation, vitamin D production and destruction reach equilibrium. During periods of extended UVB exposure, the amount of 7-dehydrocholesterol converted to precholecalciferol (previtamin D_3) is

offset by the simultaneous conversion of previtamin D_3 to the biologically inert molecules lumisterol and tachysterol. Cholecalciferol (vitamin D_3) is also converted to the molecules 5,6-transvitamin D_3, suprasterol I, and suprasterol II.[42] It is doubtful that the greater risk incurred by extensive tanning bed exposure offsets the benefits of increased vitamin D production.

Vitamin D supplementation is recommended in the literature

Even if the current vitamin D recommendations are too low, research does not support frequent and prolonged exposure to tanning beds as a means of correcting this problem. In an article published in 2004, Holick[43] specifically mentioned the therapeutic use of tanning beds for the correction of vitamin D deficiency in patients with severe intestinal fat-malabsorption syndrome—patients who would not benefit from oral vitamin D replacement. He notes that maintenance doses of 800 to 1000 IU of oral vitamin D can provide an adequate supply of the nutrient. When suggesting sunlight as the source of vitamin D, he advises "exposure of the hands, face, arms, and legs to sunlight to an amount of time equal to about 25% of what would develop a mild sunburn, i.e., one MED, two to three times a week is more than adequate."[41]

The American Academy of Pediatrics and vitamin D supplementation

The American Academy of Pediatrics, acknowledging the need for vitamin D despite the dangers of the sun, has stated that the solution is not to increase sun exposure, but rather, "infants younger than 6 months should be kept out of direct sunlight . . . protective clothing as well as sunscreen should be used." To maintain adequate levels, the academy recommends vitamin D supplementation 200 IU/d for these children.[44]

TANNING REGULATIONS IN THE UNITED STATES

The paradox

As described, epidemiologic studies and case reports have cited an increased risk of potentially fatal melanoma in persons frequenting tanning salons. Experimental animal studies have supported the role of tanning-type radiation sources in cutaneous carcinogenesis.[45-50] Despite this, regulation of the tanning industry in the United States is spotty, with only 24 states having regulatory laws.[51,52]

How indoor tanning is regulated

The FDA regulates manufacturers of indoor tanning equipment. Requirements are placed on lamp specifications, posting of warning labels, and provision of suitable eye protection.[53] The US Federal Trade Commission investigates deceptive and false advertising including claims that indoor tanning is safe.[54] Operators of indoor equipment are regulated at the state level, or not at all. Although the FDA does limit the amount of UVC that can be emitted by indoor tanning beds, it does not regulate the proportion of UVA and UVB emitted.[11]

In 1986, the FDA issued recommended maximum exposure doses of 0.75 MED, 3 times during the first week. UV exposure should be increased gradually to maintenance doses of 4.0 MED to be delivered at maximum, weekly or biweekly.[55] Based on these guidelines, manufacturers are to develop recommended exposure schedules for their clients.

Nonadherence to regulations

Adherence to proposed schedules is not regulated. A community-based survey of tanning facilities in regulated North Carolina showed that 95% of patrons exceeded recommended limits, with 33% beginning tanning at maximum doses recommended for maintenance tanning.[11] Studies in San Diego, Calif, and New York, NY, have also shown vast noncompliance with the minimal regulations that are in place.[3,56]

Data from the FDA Center for Devices and Radiological Health has shown that on a per-MED basis, UVA doses of 1.1 to 4.1 times that of the sun are used in regular tanning lamps and doses of 10 to 15 times that of the sun in newly available high-pressure sunlamps.[40] As previously mentioned, the average exposure time of patrons significantly exceeds their MED.[40]

The paucity of tanning regulations for minors

There is unequivocal evidence that indoor tanning is harmful to youth. In 1997, in France, tanning was prohibited for people younger than 18 years.[1] However, in 2005 in the United States only 6 states (Wisconsin, Illinois, California, North Carolina, New Hampshire, and Texas) restrict youth access to tanning beds. Other states restrict youth access for individuals younger than 18 years, except with parental consent. In all, less than half of the states have any regulations on youth indoor tanning and in some with regulations, enforcement is lacking.[51,52]

This overall lack of regulation for pediatric artificial tanning is in contrast to the medical treatment of patients younger than 18 years with UV radiation whereby guardian consent is required in all states except Louisiana.[1]

Past attempts to regulate youth access to indoor tanning facilities have failed. Bills have been defeated

in Maryland, Michigan, Wisconsin, Minnesota, and Missouri, and deferred in New York, Connecticut, Pennsylvania, and New Jersey. Suggestions for increasing pediatric regulation of tanning have been debated in the literature including a proposal to tax indoor tanning, just as the purchase of cigarettes has been taxed, and to use this money to increase enforcement of tanning regulations.[57] Educational campaigns, such as organized by Texas in 2001, have also been suggested.[2]

Government position

The government, in its approach to tanning legislation, must contend with the strong lobbying at federal and state levels by the multibillion-dollar tanning industry.[58] In 1994, the American Medical Association proposed to ban cosmetic indoor tanning given the compelling evidence of long-term risks from indoor tanning, most significantly photoaging and skin cancer. The indoor tanning industry vigorously opposed this and the FDA declined to institute a ban.[59]

In an effort to regulate the health risks of tanning, but not to ban the practice, the government has decided to try and make indoor tanning safer. On October 1, 2003, the FDA Center for Devices and Radiological Health was directed to move forward with amendment proposals by its advisory committee, the Technical Electronic Product Radiation Safety Standard Committee,[60] to develop a safer tanning protocol. This was intended to lead to the development of tanning exposure guidelines that, if followed, should provide indoor tanning with the lowest risk for long-term effects.[59]

Medical community concerns over government guidelines

These new guidelines are of concern from the medical community. Although they may lower the recommended maximum exposure to indoor UV radiation, it is unlikely anyone will abide by these laws because salons are largely unregulated. These guidelines may actually inadvertently promote tanning, as tanning salons will then be able to advertise that they follow NIH scientific guidelines for safe tanning.[59]

Tanning industry concerns over government guidelines

The ITA, as well, is cautious about the effects of these amendments, stating, "We will continue to work with the FDA to make sure our specific concerns about their concept—amendments are addressed before amendments get into writing . . .

"What we are concerned about is that several of these proposals would mandate changes that may not actually positively affect public health, but which would potentially create detrimental economic effects for the indoor tanning industry."[61]

Conclusion

Indoor tanning, with growing popularity among both pediatric and adult populations, is a dangerous practice leading to a vast array of adverse effects. Government regulation of indoor tanning is insufficient and hampered by lobbying of the indoor tanning industry. As physicians interested in preventing photoaging and skin cancer, we must increase efforts to warn and educate the public and the government about the dangers of excessive UV exposure. Increased lobbying is needed from the medical arena to implement and enforce legislation that, in compliance with WHO guidelines, bans sunbed use for all persons younger than 18 years, and that regulates the use of this carcinogen for all at risk.

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