

Research reveals that indoor tanning is driving an increase in skin cancer

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(Medical Xpress)—Basal cell carcinoma is the most common form of cancer. While unlikely to metastasize and therefore associated with low mortality, it can be disfiguring and costly to treat. Typically, it has been seen on the heads of elderly outdoor enthusiasts: think dockworkers, golfers or Sun Belt retirees with blotchy, scabbed facial skin.

Imagine, then, dermatologists' bewilderment a couple of decades ago when they began to see this nonmelanoma form of [skin cancer](#) in more and more young women, many still in their teens.

Several years ago, Yale dermatologist Dr. David J. Leffell, informed Susan T. Mayne, the C.-E.A. Winslow Professor of Epidemiology and a cancer [epidemiologist](#) at the Yale School of Public Health (YSPH), about this development. Curious, she examined Yale's dermatopathology archives. (Due to the sheer volume of these types of cancers, they are not reportable to state registries.)

The Yale data showed that between 1990 and 2004 the number of patients under 40 with BCC had jumped. Between the first and last years, cases in men in that age group had risen by 40 percent. In women, the case number had nearly doubled. Moreover, the trends echoed other findings, like a Minnesota study that charted a similar rise in BCC in women under age 40 between 1976 and 2003.

"The fact that we saw it in females and not so much in males led us to say, 'This looks really interesting,'" Mayne recalls.

Any number of factors might account for such an increase—holes in the ozone layer, a rise in sunbathing, more-revealing fashions. But the Yale dermatologists had been questioning their patients. A great many, it turned out, were frequent users of indoor tanning.

A strong link

In a case-control study published in 2012 in the *Journal of the American Academy of Dermatology*, Mayne, postdoctoral researcher Leah M. Ferrucci, and colleagues from the Yale Cancer Center and the Yale School of Medicine investigated the relationship between skin cancer and indoor tanning. They interviewed 376 non-Hispanic, Caucasian BCC patients under the age of 40 about their history of tanning indoors and compared their answers to those of a control group with benign, non-UV-related skin conditions. Unlike previous studies, which were smaller or focused on older people, a large proportion of their subjects had engaged

in indoor tanning.

The researchers discovered that a history of ever having tanned indoors carried a 69 percent higher risk of early-onset [basal cell carcinoma](#) (BCC) than the risk for people who had never tanned indoors.

While correlation doesn't necessarily mean causation, this study suggested several important reasons to suspect a causal relationship. One particularly telling finding was a dose-response relationship between indoor tanning sessions and cancer incidence. Patients who used tanning beds more often were at a higher risk of BCC. (Additionally, the association between indoor tanning and BCC in the study group was stronger in women, the group in which indoor tanning was more common.)

When considered alongside other evidence, a dose-response relationship between two factors strongly suggests that the "dosing agent" has caused the "response," rather than their being merely associated. Another supportive factor for causality was specificity: in the study subjects, a disproportionate number of BCC lesions occurred on the torso and limbs, sites of the body that receive heavy ultraviolet (UV) exposure during indoor tanning sessions but that are less likely to be exposed to regular outdoor sunlight.

And then there is biological plausibility that the exposure is related to the disease. Basic science research has long shown UV light to be a skin carcinogen. In 2006, the International Agency for Research on Cancer (IARC) evaluated the epidemiological data on indoor tanning and skin cancer and found what it called "convincing evidence" in favor of a causal link for melanoma and the second type of nonmelanoma skin cancer, squamous cell carcinoma. (At the time of that review there were few studies of BCC and indoor tanning.) Three years later, in 2009, IARC classified tanning devices that emit UV light as Group 1

carcinogens, in the same category as tobacco smoke, asbestos and X-rays. Then, in 2012, an updated review of the epidemiology studies on BCC and indoor tanning published in BMJ concluded that indoor tanning was associated with an increased risk of BCC. Many health and medical organizations, including the American Cancer Society, the American Academy of Dermatology and the U.S. Food and Drug Administration, have recommended that people avoid indoor tanning altogether.

"We have the biochemistry. We've got a plausible mechanism. It's a known carcinogen," says Mayne of UV light. "We're just looking at it in a new exposure setting. This is about as compelling evidence for causation as you can get in the setting of epidemiologic research."

So is there any safe way to tan indoors?

"As far as we can tell, based upon the data, there wouldn't be," says Ferrucci. "We see an increase in both nonmelanoma skin cancers and melanoma with a history of indoor tanning. That one event seems to be predictive of risk."

Growing popularity

Tanning beds started arriving in the United States in the late 1970s. Since the 1980s, indoor tanning has become increasingly popular and is now estimated to be a \$5 billion business that serves about 30 million people in the United States each year, most of whom are young, Caucasian women.

As indoor tanning has grown more common, so too has skin cancer. Between 1998 and 2008, the incidence of melanoma rose 2.1 percent per year in Caucasian men and 2.4 percent per year in Caucasian women. Increases in men were seen only in those over 55, while increases were seen in women of all ages. Nonmelanoma skin cancers (NMSCs),

including BCC and squamous cell carcinoma, are also on the rise. One study found a 77 percent rise in NMSC treatments for Medicare beneficiaries between 1992 and 2006.

Unfortunately, many indoor tanners feel pressured to engage in the activity. For some young people, the norms of their sport or activity demand bronzed skin. These include beauty pageant contestants, dancers, synchronized swimmers, wrestlers, gymnasts and bodybuilders. "If they're not tan, they're viewed as not competitive," says Mayne. "These people shouldn't have to feel that they have to engage in these carcinogenic behaviors just to be competitive at what they love to do."

Simply being a teenager can also suffice to get a person in the door. Lauren Hurd, 26, knows this firsthand. A blond, blue-eyed former lifeguard, she began tanning with friends at age 17 to prepare for her prom. "I was hesitant at first and knew it probably wasn't a healthy choice, but it was a social activity and we all know at that age how heavily this can impact a decision," she recalls. On arriving at college in upstate New York, she discovered that tanning was equally popular among her new friends, and when a spa-like salon opened up across from campus, she joined them in purchasing its \$20 unlimited monthly packages. Soon Hurd was going in for 20-minute sessions several times a week; she found tanning a reprieve from the daily pressures of college.

"Just like when you're addicted to anything else you know is bad for you, you try to rationalize. You say to yourself, 'It won't happen to me. Even if I do get skin cancer, it will be way down the road.'" For Hurd, that road took only about five years. She was diagnosed at age 22 with early-stage malignant melanoma on her leg.

Mayne says she was shocked to learn of the sheer popularity of indoor tanning among the young people in her study. "Amongst our females who had these early-onset skin cancers, 81 percent of them had used a

tanning bed," she says. "That's a mind-boggling number." In her study, more than 50 percent of indoor tanners had started this practice before the age of 17. According to national data from the 2011 Youth Risk Behavior Surveillance System, 21 percent of high school girls report having engaged in indoor tanning in the past 12 months; this figure rises to 29 percent among non-Hispanic, Caucasian high school girls.

The pressure may be internal as well. Evidence is mounting that indoor tanning may be addictive. Many frequent tanners claim they are hooked, and the problem may be compounded by the youthfulness of the indoor tanning set—evidence from other behaviors such as drinking indicates that beginning such behaviors at early ages raises the likelihood of addiction. The phenomenon, says co-author Brenda Cartmel, research scientist and lecturer in the Department of Chronic Disease Epidemiology, may relate to endorphins, which are produced in the skin in response to UV exposure. One blinded study found that people could tell with near-perfect accuracy whether their tanning bed had a UV filter. Participants reported feeling more relaxed and less tense after UV exposure than they did after non-UV exposure.

Dangerous though it may be, indoor tanning as a risk factor is readily modifiable—unlike, say, a genetic predisposition. That makes it a tempting target for public health initiatives aimed at preventing skin cancer. Mayne and Ferrucci calculated that 43 percent of early-onset BCCs in women could be avoided if the women never tanned indoors, while an October study in *BMJ* suggested that indoor tanning could account for about 170,000 skin cancers each year in the United States alone.

Many states have enacted age-related restrictions on indoor tanning, most of which require parental permission for minors. Two states—California and Vermont—ban indoor tanning outright for people under 18, while New York bans it for those under 17. Supporters of such

laws point out that children are barred from legally purchasing another known carcinogen, tobacco. In addition, says Mayne, the laws can ease peer pressure.

"If you talk to skin cancer survivors, they will tell you, 'I started tanning because everybody was tanning,'" says Mayne. "If we're able to restrict it, that eliminates them having to make those difficult decisions. And then when they're 18, hopefully they're in a little bit better position to be able to make informed choices."

In February 2012, Connecticut considered a bill that would have made it the fourth state to ban tanning for most teens. Ferrucci and Hurd were among those testifying in its favor, but the bill died in committee. A similar measure is being considered by the legislature in early 2013. Current Connecticut law allows adolescents 16 and over to tan without parental permission.

In any case, such laws don't go far enough, says Ferrucci. In 2009, months after tanning devices landed on the Group 1 carcinogen list, Brazil outlawed cosmetic artificial tanning. "That would be potentially the ideal," she says.

Industry opposition

Such proposals meet with strong opposition from the tanning industry. The Indoor Tanning Association (ITA), which represents tanning businesses and sunlamp manufacturers, supports parental consent laws for minors. But it has objected to other regulatory efforts. An ITA representative opposed to the Connecticut bills argued that barring minors from indoor tanning will lead them to tan outdoors or at home "in an unsupervised and reckless manner." (Hurd recalls being told by indoor tanning staff that the activity was "safer than tanning outside.")

"We agree that overuse and sun burning are risk factors," says the ITA's executive director, John Overstreet. "But the message that's out there is a way over-the-top message. It is aimed at destroying this industry."

Indoor tanning, he added, is "the same thing as the sun. You have the same risks, and you have the same benefits."

However, many people who tan indoors report getting burned during their sessions. Among the BCC cases in Connecticut, 28 percent reported being burned from indoor tanning and 16 percent reported four or more burns. Another study of melanoma in Minnesota found a similar figure, with 22 percent reporting a burn from indoor tanning. And the relationship between indoor tanning and increased risk of both cancers holds true even in people who did not experience burns during indoor tanning.

In particular, the industry's marketing message emphasizes the fact that tanning triggers vitamin D production. Could discouraging UV exposure in an effort to prevent skin cancer lead to a rise in vitamin D deficiency and its associated problems? One group of Norwegian researchers calculated that if people in their country were to receive more sun exposure, there might be 300 more melanoma deaths per year, but 3,000 fewer annual cancer deaths overall from the associated increase in vitamin D levels (though the latter number was based on only one paper). They also pointed out that such exposure could offer protection against noncancerous diseases, such as multiple sclerosis and diabetes, to which vitamin D deficiency has been linked.

"This message, this constant drumbeat, scaring people about tanning and ultraviolet light exposure—there's a good chance there's a bigger underlying health problem being created," says Overstreet. "Most people are vitamin D deficient because they hear this message. You have people scared to death of being in the sun."

But when a panel of the National Academy of Sciences convened to review vitamin D intake recommendations (the results were published in 2010), it found that there are only inadequate and inconsistent data about a relationship between vitamin D intake and cancer risk. Moreover, says Mayne, who was a member of the panel, statements about epidemic vitamin D deficiency are unfounded: In fact, only 3 percent of adults in the United States are at risk of deficiency, with another 18 percent at risk of inadequacy. "The populations in the United States that tend to have low vitamin D status are people with deeply pigmented skin," she says. "Those aren't the people who are in the tanning booths."

Adds Cartmel, "If you are deficient, you can just take a supplement, which is much safer."

As for the industry's warnings about outdoor tanning, Mayne counters that while outdoor sun exposure is an important factor for skin cancer risk, most people's lives don't allow time for regular outdoor tanning—but people can easily tan indoors several times a week. In addition, exposure to outdoor UV is inherently limited in many northern climates.

Still, could indoor tanning advocates have a point? Is it safe or healthy to get vitamin D from any amount of UV radiation?

"When we look at what people actually take in from food versus what their blood status is, it is very clear that people in the United States are getting a significant amount of vitamin D from UV," says Mayne. "I don't think anybody's trying to tell people that we have to shield every single ray of UV. I think that's unreasonable. But I think indoor tanning is a completely different ballpark, because it is an unnatural, intense exposure that has now been associated with rising rates of these cancers."

The sun emits radiation in many wavelengths, but what reaches the earth is mostly UVA and a small amount of UVB. UVA darkens the skin immediately, while UVB causes sunburn and delayed tanning. Tanning lamps emit mostly UVA, too. Overstreet says the vast majority of sunlamps have the same spectral output as the noonday equatorial sun, while the industry website SmartTan.com estimates that most sunlamps are two to four times stronger than summer sun.

But there is evidence that they are much more intense than that. One 2002 Swiss study of tanning bed lamps found that they emit 10 to 15 times more UVA than what reaches the Earth's surface at midday at intermediate latitudes (which receive about 70 percent of the solar energy that the equator does), a finding in accord with what individuals experience when they tan indoors. "If you're on a beach in California for 10 minutes, [most people are] not going to develop a tan," says Mayne. "But you go into a tanning bed, and within 10 minutes of exposure, you're getting tan."

Moreover, sunlamp manufacturers are tweaking the technology, offering options like UVB-rich high-speed lamps and "high-pressure/high intensity" tanning. "People tell us that the duration of the sessions is shorter now than it used to be in the past, so obviously the bulbs are more intense than they were," Mayne says.

In short, Mayne sees indoor tanning as a new human experiment. "We don't have that equivalent of UV exposure in the outdoor environment."

Future directions

Mayne and Ferrucci are not finished examining indoor tanning. With Cartmel and other colleagues, they are investigating the genetics of both skin cancer susceptibility and tanning addiction. They also want to better understand how people's indoor tanning behaviors change after a skin

cancer diagnosis, as their other findings indicate that some 14 percent of BCC patients continue to engage in indoor tanning after their diagnosis. "We're just trying to work out why these people are going back and still participating in a risky behavior, when they are actually at quite high risk of getting another skin cancer," says Cartmel.

They are also studying the natural history of subsequent skin cancers in people who have already been diagnosed once at a young age. Though mostly nonfatal, these cancers cost the country a great deal in the aggregate. "As people are starting to get them younger, they have a whole lifetime to keep getting these cancers," she says.

Ferrucci recently received a five-year grant from the American Cancer Society to study [indoor tanning](#) prevention and cessation. She is developing an online intervention to discourage women in their twenties from using tanning beds, as well as conducting focus groups with young adolescent girls to pinpoint why they might start this behavior in the first place. "One of the things that's motivated me in doing this research is that this is a behavior that individuals can change," Ferrucci notes.

Indeed, for Mayne, Ferrucci and Cartmel, one thing is clear: If thousands of skin cancers can be prevented by simply avoiding UV light, then public health professionals have a clear responsibility to try to make that happen.

Hurd regrets her former tanning habit and now advocates for stricter regulation. Though her melanoma was excised, she must undergo frequent cancer surveillance for the rest of her life. "I think this is a public health issue comparable to that of the Big Tobacco industry of our generation," she says. A ban for minors "would have made an enormous difference for me had it been in place when I was 17."

Mayne has heard such regrets over and over again. "Half of the people in

our study started using tanning beds before the age of 17, and then, in their twenties and thirties, many are regretting that choice," says Mayne. "They often say, 'I wish somebody had told me. I wish somebody had worked toward this when I was a kid.' It's a completely preventable exposure."

Provided by Yale University

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