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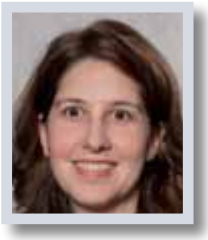


Carolyn J.
Heckman

Indoor tanning
Tanning dependence and other health risks

CAROLYN J. HECKMAN

Cancer Prevention and Control Program
Fox Chase Cancer Center
333 Cottman Ave., Philadelphia, PA 19111, USA

ABSTRACT: *Since industrialization of the Western workforce, tanned skin has been perceived increasingly as attractive and fashionable for naturally light-skinned individuals. In addition to causing tanning, photo-aging, and other health effects, ultraviolet radiation (UV) is a known carcinogen. Despite increased awareness of UV risks, tanning has become increasingly popular in several Western countries including the USA. An additional risk of UV is tanning dependence or addiction. Several studies have provided evidence for the phenomenon of tanning dependence, with plausible biologic underpinnings primarily related to the opioid system. Tanning dependent individuals may tan frequently and put themselves at even great risk for skin cancer. This review will briefly outline the risks of indoor tanning including tanning dependence.*

PREVALENCE AND CORRELATES OF INDOOR TANNING

Indoor tanning has become quite popular in recent years, particularly in the USA and several other Western countries. Prevalence rates of indoor tanning vary depending on the country and population under study. The prevalence of indoor tanning in the past year among adults was 1 percent in Queensland, Australia (1), 5-14 percent in the USA (2-3), and 21-30 percent in Europe (4-5). Among students in the USA, past year indoor tanning rates were 11-26 percent (6-7) for adolescents and 33-60 percent (8-9) for college students. Lifetime rates of indoor tanning among adolescents and college students vary from 2 percent in Brazil to 43 percent in England (10-11). Overall, indoor tanners are more likely than non-tanners to be female, adolescents or young adults, Caucasian, and to have low to moderate skin sensitivity to ultraviolet radiation (UV). Other correlates of indoor tanning include associating with other indoor tanners, as well as use of alcohol, cigarettes, and other substances. Correlates of indoor tanning may differ according to other demographic characteristics as well. For example, higher rates of indoor tanning are often associated with higher levels of education.

RISKS OF ULTRAVIOLET RADIATION

The major health risk of UV exposure is skin cancer, which is the most common cancer in the USA, with over a million new cases diagnosed yearly (12). Melanoma is the most lethal form of skin cancer, but non-melanomas can cause significant morbidity and even mortality. It is generally accepted that UV exposure is the most significant modifiable risk factor in the prevention of melanoma, and UV radiation also causes non-melanoma skin cancers. In addition to increased risk for melanoma and non-melanoma skin cancers, UV radiation causes photo-aging (the visible signs of aging such as wrinkles and age spots) and can have negative effects on the immune system. Additionally, the US National Council on Skin Cancer Prevention reported 700 emergency department visits for burns per 10,000 tanning facilities annually as of 2009 (13). Recommended practices to protect the skin from UV include limiting UV exposure, whether natural or artificial, using sunscreen and sunless tanners, as well as wearing protective apparel.

TANNING DEPENDENCE: DEFINITION AND PREVALENCE

Knowledge of the link between UV exposure and skin cancer is widespread in the USA and several other Western countries. However, there are some significant psychosocial motivations to tan that sometimes outweigh an individuals' concern for her health. Appearance enhancement is the most commonly-cited reason given for intentional indoor tanning in most studies. Indoor tanning is perceived to be an efficient and convenient way to tan, particularly in climates that are not conducive to continuous sun-tanning throughout the year. An additional reason for frequent tanning, particularly indoor tanning, may be tanning dependence or addiction, colloquially referred to as "tanorexia".

Until now, tanning dependence has been defined based on traditional substance dependence criteria and measures. To assess tanning dependence, Warthan and colleagues (14) modified the substance dependence criteria from the American Psychiatric Association's Diagnostic and Statistical Manual-IV(DSM-IV) and those of the four-item CAGE scale, traditionally used to screen for potential problems with alcohol use. The modified seven-item DSM-IV criteria include tolerance, withdrawal, and engaging in the behaviour despite negative consequences, key criteria for the diagnosis of substance dependence. Sample items are "Do you think you need to spend more and more time in the sun to maintain your perfect tan?" (tolerance), "Do you continue tanning so your tan will not fade?" (withdrawal), and "Does this (your belief that tanning can cause skin cancer) keep you from spending time in the sun or going to tanning beds?" (negative consequences). CAGE is an acronym that refers to the four yes or no items regarding trying to **C**ut down on drinking (or in this case tanning), feeling **A**nnoyed when told not to do a

behaviour, feeling **G**uilty when doing the behaviour too much, and wanting to participate in the behaviour first thing in the morning (**E**ye opener).

More recently, Hillhouse and colleagues (15) developed a multidimensional continuous Tanning Pathology Scale (TAPAS) based on empirical data from indoor tanners. The four factors of the scale are: perceiving tanning as a problem, opiate-like reactions to tanning, evidence of tolerance to tanning, and dissatisfaction with skin tone. The scale has demonstrated good reliability and validity (15). Items from this scale moderated the effects of an intervention designed to reduce indoor tanning among young women (15). This measure is an improvement over the modified DSM-IV and CAGE scales because it possesses good psychometric characteristics and was developed empirically with the population of interest rather than simply being modified from existing measures for alcohol and other substances.

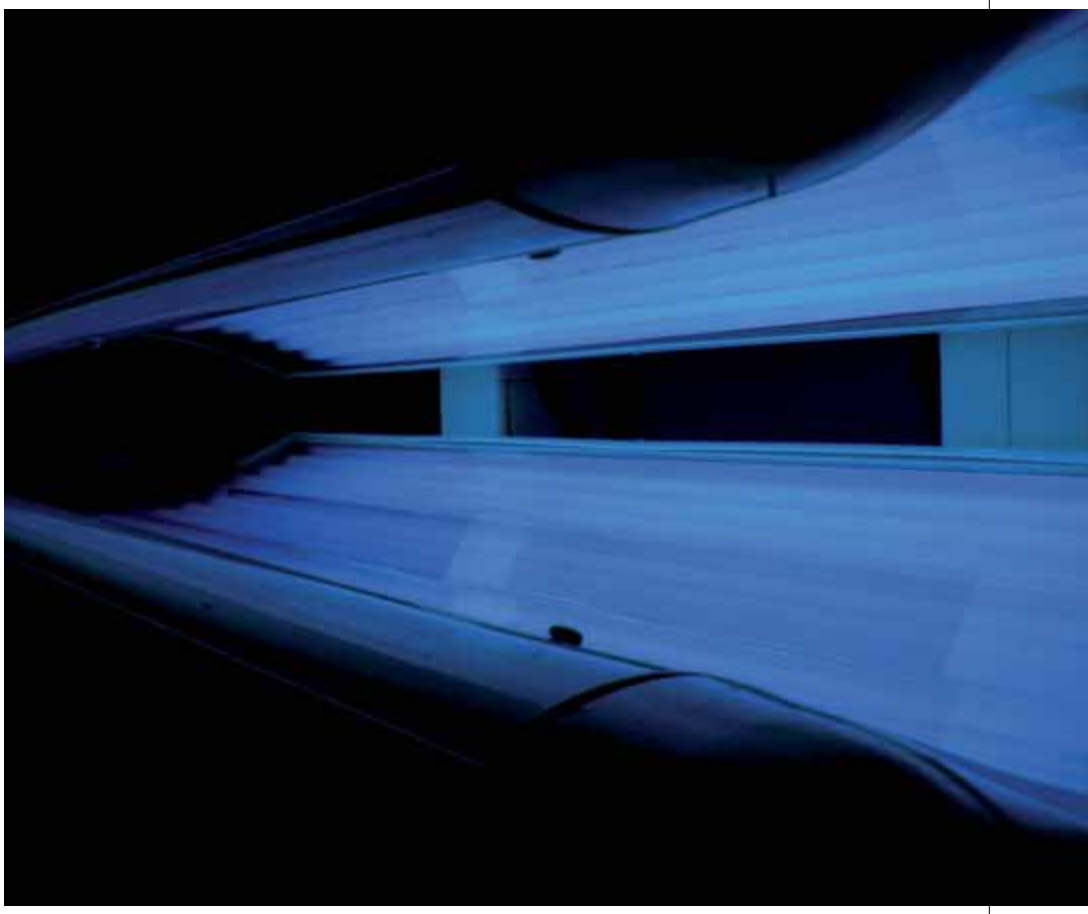
There is accumulating evidence, both observational and experimental, supporting the phenomenon of tanning dependence. Most of these data have been collected in the USA. Behavioural studies of adolescents and young adults have reported addictive tendencies among indoor tanners including higher rates of other substance use and anticipated difficulty quitting indoor tanning. The prevalence of tanning dependence varies by population and measurement strategy. Among beachgoers, tanning dependence rates range from 26 percent on the CAGE to 53 percent on the DSM-IV(14), and among tanning salon patrons, rates range from 33 percent on the CAGE to 41 percent on the DSM-IV(16). Among undergraduate indoor tanners, rates are 28-31 percent on the CAGE, 39 percent on the DSM-IV, and 22-45 percent meet criteria on both the CAGE and the DSM-IV (17-19). Among general college student samples in the USA, rates range from 12 percent on the CAGE to 27 percent meeting criteria on both the CAGE and the DSM-IV (17, 19).

TANNING DEPENDENCE: PROPOSED MECHANISM AND EVIDENCE

Methods for defining and identifying tanning dependence are being refined, and a potential biological mechanism underlying the phenomenon has been proposed. UV exposure causes the up-regulation of the tumour suppressor gene p53 in skin cells, which then leads to the release of beta-endorphin, a type of natural opioid analgesic that is involved in the brain's reward pathway. Beta-endorphin released into the blood during tanning may reach the brain in sufficient concentration to induce feelings of relaxation. Some individuals may find the feelings of relaxation, euphoria, and/or analgesic effects particularly reinforcing and be more likely to tan repeatedly in order to achieve these feelings. If one tans frequently enough, her body may compensate for the effects of tanning, thus producing symptoms of tolerance and withdrawal, making it aversive then to discontinue tanning.

There is evidence for beta-endorphin production during UV exposure. Expression of beta-endorphin in the epidermis of mice has been induced by UV exposure. Studies have also found increased beta-endorphin in human skin cells during UV exposure. Human keratinocyte skin cell cultures have been found to produce proopiomelanocortin (POMC), b-lipotropic hormone (bLPH), and b-endorphin, with significant increases after UV exposure (20). POMC plays a role in the regulation of skin pigmentation, stress, sleep, and energy homeostasis. One study found that keratinocytes express a *u*-opiate receptor and down-regulate it in the presence of beta-endorphin or the opioid antagonist naloxone (21). The evidence for UV's ability to induce increased levels of serum endorphin is somewhat conflicting, however. While both the in vitro and in vivo release of endorphins after UV exposure have been documented, other studies failed to corroborate this phenomenon. For example, a small, double-blind, placebo-controlled, randomized trial of three frequent and three non-frequent indoor tanners did not detect an increase in plasma b-endorphin levels after UV exposure (22).

There is also clinical evidence for an addictive process occurring during UV exposure. In a small single-blinded study, frequent tanners almost always chose to tan in a UV rather than a non-UV-light-emitting bed, reporting relaxation and lowered tension as reasons for their choice (23). Additionally, one participant reported amelioration of chronic lower back pain to a greater extent when tanning in the UV bed compared to the non-UV bed (24). In a follow-up study of indoor tanners, opioid blockade by the opioid antagonist naltrexone, used for the treatment of opioid dependence, was shown to reduce such preference for the UV bed and, at higher doses, induce withdrawal-like symptoms such as nausea, fatigue, and poor concentration (25). Finally, in a small study of patients with the chronic pain condition fibromyalgia, participants reported a greater short-term decrease in pain after exposure to UV compared to non-UV light exposure (26).



ALTERNATIVE CONCEPTUALIZATIONS OF FREQUENT TANNING

In addition to tanning dependence, alternative conceptualizations could categorize frequent tanning as a body image disorder, a mood disorder, or as an anxiety or compulsive disorder (e.g., pathological gambling disorder). For example, tanning and body dysmorphic disorder are common co-occurrences, with many body dysmorphic individuals focused on perceived imperfections of their skin such as paleness. In terms of mood and anxiety, tanners have reported enhanced mood, improved energy, and relaxation as reasons to indoor tan. Approximately half of college indoor tanners, and also those who score positively on a measure of tanning dependence, report tanning for relaxation purposes. The most common reasons for tanning reported in a sample of frequent indoor tanners were to look good (90 percent), to feel good (69 percent), and for relaxation (56 percent) (13). Mawn and Fleischer (27) found that positive psychological experiences such as relaxation, self-confidence, and happiness were more often reported from indoor tanning than negative physical experiences such as itching, rash, or burning.

Additionally, a higher prevalence of anxiety has been reported by college students who were tanning-dependent based on DSM-IV and CAGE questionnaires (28). Likewise, Hillhouse and Turrisi (29) have found that a subset of "hardcore" frequent tanners have seasonal affective disorder (SAD). It has been suggested that these individuals may be using tanning, particularly during the winter, for self-medication purposes as some individuals do with other substances. However, light therapy for SAD does not include UV and appears to works via exposure to the retinal ganglion cells of the eyes, whereas indoor tanners tend to close their eyes or wear goggles while tanning. Serotonin's established role in the pleasure pathways of the brain may represent another potential physiologic mechanism underlying tanning dependence, but it has not been well-established in the literature. The neurotransmitter serotonin is also converted by the pineal gland in the brain to melatonin, which is important to sleep regulation and circadian rhythms and likely to mood, anxiety, and fatigue. However, it is unclear whether the association between tanning/tanning dependence and related psychiatric problems is correlative or causative.

Finally, tanners have reported increased vitamin D level as a reason to indoor tan. One of the main reasons offered in defense of tanning by the tanning industry is the health benefit of vitamin D (e.g., bone health, colon cancer prevention), which is produced by the skin after UV exposure. No published studies have examined vitamin D levels in frequent tanners or tanning dependent individuals. Additionally, vitamin D is readily available as an oral supplement, and the high prevalence of vitamin D deficiency and claimed health benefits of high vitamin D levels are not well-established (30).

CONCLUSION AND FUTURE DIRECTIONS

Indoor tanning is all-too common given its known association with skin cancer. Like tobacco, indoor tanning has been marketed and appeals to adolescents and young adults, putting them at risk for high levels of long-term exposure to UV. Appearance enhancement is the primary motivation for indoor tanning, but there are several other reasons cited for the behaviour. One of the more problematic risks of frequent indoor tanning is tanning dependence, which is also common among adolescents and young adults. Evidence exists supporting beta-endorphin's role in tanning dependence including data from rodents, human cell lines, and clinical experiments with indoor tanners. Our knowledge of tanning dependence is still in its infancy, and there is great potential for future research and development in the field that could be modelled after traditional substance use research, such as cue response, brain imaging, and interventional investigations. For example, a recent single photon emission tomography (SPECT) imaging study showed increased striatal activation and decreased tanning desire when tanning dependent indoor tanners were exposed to a UV tanning canopy compared to a sham (non-UV) canopy (13). Such innovative studies could help determine what type of pharmacologic or behavioural interventions might be most useful for decreasing tanning behaviour and ultimately reducing skin cancer risk.

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