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New Approaches to Melanoma Prevention

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Keywords

tanning attitude

Over the last several decades in the United States (US), national programs have primarily targeted white people for sun protection educational programs; however, people's attitudes about having a tan have not significantly changed. During this same period in developed countries, indoor tanning has become an increasingly common source of ultraviolet radiation (UVR) exposure. (1–3) Broad spectrum UVR has long been recognized as the highest risk category of carcinogen by the International Agency for Research on Cancer (IARC), and UVR-emitting tanning devices were elevated to this category in 2009. (4) UVR exposure is the primary environmental etiologic factor for both melanoma and non-melanoma skin cancers. (5–7) People who deliberately tan often do so with natural light via sunbathing and/or with artificial light from tanning beds.

Melanoma is the second most common cancer in individuals aged 15 to 29 years, accounting for 11% of all malignant neoplasms in this age group. (8) The incidence rate of melanoma is increasing at a disturbing rate of 2.7% per year among young non-Hispanic white women. (9) Although the causes for this trend are multifactorial, the observed rise of melanoma in women, particularly in the truncal skin, suggests deliberate exposure to UVR sources as a plausible etiology. (8, 10, 11)

Scope of Indoor Tanning

Over 30 million people in the US, of which 2.3 million are adolescents, tan indoors annually. (12) Studies show that 25 to 40% of young women have used indoor tanning in the past year, with the prevalence of use among women in their late teens and early twenties estimated at over 35%. (13–15) The median number of indoor tanning visits for women in this age group is 40–50/year. (16) Mothers often accompany their daughters during the first tanning experience, thus, giving permission for underage tanning and establishing a pattern of regular tanning that carries over into young adulthood (17). Fifty or more hours of sunbed use are associated with a 3 times greater risk of developing melanoma . (10)

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Indoor tanning beds and booths have a widespread presence beyond indoor tanning salons, with facilities now located within gyms, beauty salons, and even people's homes. Across 116 cities in the United States, the overall mean number of commercial tanning facilities per city (mean=41.8) was much higher than the overall mean number of Starbucks (mean=19) and McDonald's (mean=29.6), in these same locations. (18)

Tanning Attitudes

Part of the popularity of indoor tanning may be attributed to the fact that tanned skin is portrayed as attractive and desirable in popular culture. Appearance-enhancing factors are consistently foundto strongly motivate intentions to achieve a tan, overriding the knowledge and perception of the remote threat of developing skin cancers women may hold. (19–22) The contradiction between people knowing that UVR exposure causes skin cancer and holding the belief that having a tan makes a person look healthy and/or attractive may be explained by the strong evidence that people have at least 2 cognitive systems. (23) One system involves conscious, controlled, and focused effort in processing stimuli and produces explicit beliefs and attitudes. The other system is rapid, effortless, automatic application of implicit knowledge, beliefs, attitudes and skills stored through repeated exposures in long–term memory. The first system may "know" that UVR exposure causes skin cancer, yet the second admires and compliments the person with a "nice tan". Cognitive dissonance of this magnitude can be resolved either by conscious decision-making or by implicit attitudes. When people are engaged in thinking through decisions and have cognitive resources, motivation, knowledge and opportunity to ponder the pros and cons of different actions, then the action is often different from the impulsive action not entirely under conscious control. (24) Implicit attitudes are more likely to influence behavior when cognitive processing capacity is low due to fatigue, anxiety or cognitive overload. For example, when a teen is invited to go along with others to the pool to be with friends, the anxiety over fitting in with the peer group may stifle the nagging thought of not having sunscreen. Among teens, impulsive actions are often more common than carefully weighing the pros and cons of a behavior and making a thoughtful decision about engaging in tanning.

At-risk Population

The most likely indoor tanners were women between the ages of 20 and 30 who had skin types that would become slightly burned with a moderate tan or not burned with a good tan one week after one hour exposure to sunlight (i.e., skin types III or IV on the Fitzpatrick Skin Type Classification Scale). (16, 25) Among adult females, those who have tanned indoors were more likely to have unhealthier diets, smoke, drink alcohol, and lack correct information on the safety of indoor tanning compared to women who did not engage in indoor tanning. (3) Both adult men and women were most likely to have engaged in this activity under age 30. (16)

In younger populations of teens, which are also often predominantly composed of females, indoor tanners were more likely to engage in other risk-seeking behaviors, such as smoking, drinking and recreational drug use (25,26) and had less healthy lifestyle choices (27) compared with those who had never used tanning beds/booths. The clustering of addictive behaviors, such as smoking and drinking, with indoor tanning may reflect general risk-taking behavior rather than addiction. (28) Given the young age at initiation, high prevalence of use, and other correlated risk-taking behaviors, young women who tan indoors are an ideal group to target for health promotion messages.

Promoting Behavioral Change

Behavioral economics suggests that promoting healthy alternatives that serve a similar function as an unhealthy behavior but with no greater effort or cost can reduce unhealthy behavior. People indoor tan for two primary reasons: physical appearance and stress reduction. Thus, alternatives that address these motivations could be effective in promoting behavior change. (16, 29) Secondary reasons for indoor tanning are to prevent sunburn when engaging in outdoor activities and assure adequate vitamin D.

When counseling patients, it helps to consider the patient's perspective of the benefit of tanning. Is the patient tanning to look good for an event such as the prom or wedding? Is the patient a regular tanner who tans year round and uses tanning to improve their mood and relieve stress? The range of tanning types extends from event tanners through spontaneous mood tanners to regular tanners. (16) Physicians can open a dialog with the patient when taking a history by using open-ended questions, such as how does having a tan make you feel? The conversation allows the physician to take a patient-centered approach, and frame a harm reduction message that evolves from the patient's responses. There are a number of ready alternatives to the secondary reasons for tanning that the physician can provide. Sunburns can be prevented more effectively with use of sunscreen than with a tan, especially in those who have difficulty tanning. Patients who are concerned about vitamin D production can be encouraged to eat foods high in vitamin D (i.e., salmon, fortified orange juice) and/or advised to take oral supplements.

Event Tanning

The event tanner is primarily motivated by appearance. Such patients may be receptive to using sun protection to prevent early aging of the skin. For such tanners, a physician could suggest forgoing tanning and allocating the tanning funds to other ways of enhancing appearance such as clothing, a manicure, or a makeover with a new hairstyle and cosmetics. The physician may also suggest substituting sunless tanning for UV tanning as a harm reduction strategy. The event tanner patient may see this as a worthwhile opportunity to look good and boost self-confidence. The dermatologist who is familiar with the various types of sunless tanning can help guide the patient's choice.

Non-UVR tanning products, also known as sunless tanning products, including lotions, spray-on tans, and bronzers, are popular alternatives for achieving a tanned look without the risks of exposure to harmful UVR. Sunless tanning lotions and spray-on tans contain the FDA-approved active ingredient dihydroxyacetone (DHA) in a concentration ranging from 3–5%, which preferentially reacts with basic amino acids in the stratum corneum of the skin to form dark brown compounds that deepen the skin's color. (30) Bronzing cosmetics, in the form of powders, moisturizers, or foundations, contain water-soluble dyes to instantaneously give the skin a tanned look and are easily removed by cleansing the area of application but may also be removed by perspiration and stain clothing. (31).

The use of non-UVR tanning products as an alternative to a UVR-induced tan has been explored in only a few studies. Recently, Pagota et al. demonstrated that education about and promotion of sunless tanning products in a population of sunbathers resulted in significantly increased rates of use of these products and decreased rates of sunbathing, which persisted for one year after the intervention. (32) In another study, 73% of tanning bed users who received spray-on tan treatments at indoor tanning salons reported decreased use or intention to use indoor tanning beds. (33) There is possible benefit in promoting non-UVR tanning products as an effective and safer alternative to UVR-induced tanning for the purpose of achieving a tanned look.

Although a few studies have explored the prevalence and predictors of use of non-UVR tanning product use in the US, (13, 34–37) the role of these products as an effective substitute to indoor tanning remains largely uncharacterized among the high-risk population of indoor tanners. Preliminary evidence suggests that indoor tanners who adopt sunless tanning subsequently reduce intentional tanning. (33) The major deterrent to using spray-on tanning is the perception that the color conferred by this method of tanning is not natural. Very few participants commented on cost as a significant barrier to using spray-on tans in the open-response answer choices of the survey. A 2004 investigation of US tanning businesses offering non-UVR tanning services determined the median prices for these options ranged from $26.00 to $87.50 per session, whereas the price for a UVR tanning session was significantly less expensive at $13.50. (31)

Combining appearance-based strategies may be more effective with event tanners than a single educational intervention. An intervention consisting of the use of a sunless tanning lotion along with education on photoaging and viewing of a personal UV facial photograph resulted in greater exercise of sun protection behaviors compared to the group that underwent the same intervention without addition of the sunless tanning lotion. (37) Effective interventions are typically of low intensity and can be carried out during the physician visit. Messages targeting appearance are most effective in late-adolescent females, with techniques including self-guided booklets, a video on photoaging, 30-minute peer counseling sessions, and UV facial photography to demonstrate the extent of skin damage from UV exposure. To reduce risk for skin cancer, the US Preventive Services Task Force (USPSTF) recommends counseling persons aged 10 to 24 years with fair skin to minimize exposure to ultraviolet radiation. (38)

Spontaneous Mood Tanners

Women may tan inconsistently for short periods of perhaps one season and often do so to help them relax or to feel good about themselves. (39) For those who engage in tanning to relax, physicians may suggest other healthy alternatives that create similar immediate consequences to intentional tanning. Exercise classes such as Pilates and spinning are sources of stress relief, and yoga has proven efficacious for stress reduction. (40–43) A widely available healthy alternative, such as yoga, gives patients an opportunity to try something that may be new to them that is consistent with seeking a healthy lifestyle. While sunless tanning is not a source of stress reduction, it may be used in combination with other means of stress reduction to help tanners feel good about themselves.

Regular Tanners

Regular tanners, who tan frequently throughout the year, often discuss how tanning makes them feel relaxed with feelings of tranquility. Some may even report euphoria. Tanning might reduce stress because of a direct physiological effect of UVR (44–47) and/or because the act itself is relaxing (i.e., lying down in a warm, quiet place). Regular tanners may respond to suggestions for ways to relieve stress such as regular exercise, and ways to promote relaxation such as yoga.

The likelihood of a behavior being adopted depends on 1) the reinforcing value of that behavior relative to alternatives, 2) the cost of engaging in the behavior relative to alternatives, and 3) the relative availability of the behavior and its alternatives. (39, 48) “Behavioral substitution” occurs over time as one behavior declines and another replaces it. For example, as use of the nicotine patch increases, cigarette smoking declines. According to behavioral economics, behavioral substitution of indoor tanning could be facilitated by increasing the costs of indoor tanning and increasing the availability and desirability of alternatives. As the costs of sunbathing and indoor tanning (e.g., perceived risk for skin

cancer, skin damage, sunburns, as well as the monetary cost of a session of tanning) accumulate, the use of alternatives such as spray-on tanning that produce the same outcome with fewer costs should increase.

Legislative Actions

In July 2010, a 10% federal tax on indoor tanning became the first legislative step affecting the monetary costs of the behavior. The impact of the tax on consumer behavior has yet to be determined. Only 26% of Illinois salons reported experiencing fewer clients after implementation of the tax, and distinguishing the impact of the tax from the current economic climate as the source of decline was difficult. (49) Furthermore, 78% of tanning salon owners reported that clients did not seem to care about the tax. The effect of tobacco taxation on smoking led to the hypothesis that due to the limited income of younger clients a price increase may be a greater deterrent for younger than for older clients (50), however, this may not be the case for indoor tanning, whose use has steadily increased in the last two decades. (2) Tanning salon operators frequently reported that the salon's younger and first-time clients were less likely than its older clients to notice or care about the increased prices resulting from the tax. (49) These results may indicate that the demand for indoor tanning services is perhaps insensitive to a 10% tax level.

Prior to October 2011, Howard County, Maryland was the only jurisdiction in the US to ban indoor tanning for minors. However, California recently became the first state in the US to ban commercial indoor tanning for anyone under the age of 18; the law will go into effect in January 2012. This legislation is likely to have a dramatic impact on teen tanning, and other states may soon follow California's lead.

Tanning Dependence

Physicians should be particularly concerned for individuals who tan regularly and frequently even after receiving information about tanning's serious harmful effects; this may be indicative of pathological behavior, often termed "tanning dependence" in the literature. The dual process model indicates that dependence behaviors are influenced by both rational decisions and implicit cognitions (i.e. unconscious impacts that influence a person's behavior). Recent research indicates that individuals who are more motivated by dependence processes in their tanning behaviors have a weaker relationship between their intentions (i.e., rational decisions) and behavior (i.e., what they actually do). (51)

Initial explorations into tanning dependence (52–61) have modified existing screening instruments to estimate the prevalence of dependence. Using a modified version of a common alcohol-screening questionnaire, the CAGE (62), has reported prevalence rates ranging from 12–55%. The four items from the CAGE were modified to reflect tanning behavior (52). For example, the item "Have you ever felt that you need to cut down on your drinking, but still continue?" is adapted to, "Have you ever tried to stop tanning, but still continue?" The item, "Have people annoyed you by criticizing your drinking?" became "Do you ever get annoyed when people tell you not to tan?" and, "Have you ever felt guilty about drinking?" became "Do you ever feel guilty that you tan too much?" The last item, "Have you ever had an eye-opener - a drink first thing in the morning to steady your nerves or get rid of a hangover?" transitioned to "When you wake up in the morning, do you want to tan?" It should be noted this last item does not convey the same sense of chemical dependency in the original CAGE (i.e., to steady the nerves by using the substance).

Others have adapted items from the Diagnostic and Statistical Methods, 4th edition (DSM-IV) criteria for substance use disorders to diagnose tanning abuse and dependence using the five dependency criteria of tolerance, withdrawal, loss of control, compulsive use, and

continued use despite adverse consequences. Some items do not translate flawlessly from substance use disorders to tanning, because tanning is not generally illegal (with the exception of underage tanning in California), nor does it seem to impair performance of activities in the same way many substances do (Table 1). (63) The most recent study on tanning dependence adapted items from the Structured Clinical Interview for DSM Disorders (SCID) (63) that focus on opiate abuse and dependence to determine if participants met criteria for tanning abuse or dependence. Results indicated that the prevalence of tanning abuse was 10.8%, and the prevalence of dependence was 5.4% in a sample of college students (mean age = 21.8 years). (64) These rates are congruent with past year prevalence rates for other forms of substance abuse and dependence from national surveys (e.g., alcohol dependence = 5.9%). (65) Indoor tanning frequency in dependent tanners was more than 10X the rate of participants with no diagnosis.

From a physiologic standpoint, a small clinical study recently demonstrated that frequent users of tanning beds exhibited brain activity similar to that observed in people addicted to drugs or alcohol. (66) Regional cerebral blood flow did not increase when tanners were exposed to filtered UVR, suggesting the tanners could distinguish real UVR from the sham solely on the basis of subjective response. Moreover, the study participants had less desire to tan after exposure to UVR than when compared with the sham UVR, suggesting UVR had a rewarding effect. Further research on dependence in relation to indoor tanning is needed.

Conclusion

Skin cancer is a major public health concern, and tanning remains a modifiable risk factor. In the near future, laws and taxes are likely to be ineffective in stemming tanning. (67) Multidimensional influences, including psychosocial, individual, environmental and policy-related factors, create the milieu for the individual to engage in tanning. Parents and physicians can modify the behavior of teens and young adults using strategies based upon harm reduction. Environmental and policy-related factors similar to those used to contain the tobacco industry in the US in the 20th century need to be created. Federal regulations can restrict direct advertising and the excise tax can be increased to a prohibitive amount. Social networking may assist with affect regulation.

References

1. Robinson JK, Rigel DS, Amonette R. Trends in sun exposure knowledge, attitudes and behaviors: 1986–1996. J Am Acad Dermatol. 1997; 37:179–86. [PubMed: 9270501]
2. Robinson JK, Kim J, Rosenbaum S, Ortiz S. Indoor tanning: knowledge, attitudes, behavior, and information sources among young adults from 1988 to 2007. Arch Dermatol. 2008; 144:484–488. [PubMed: 18427042]
3. Cokkinides VE, Weinstock MA, O'Connell MC, Thun MJ. Use of indoor tanning sunlamps by US youth, ages 11–18 years, and by their parent or guardian caregivers: Prevalence and correlates. Pediatrics. 2002; 109(6):1124–30. [PubMed: 12042553]
4. International Agency for Research on Cancer Working Group on artificial ultraviolet (UV) light and skin cancer. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: A systematic review. Int J Cancer. 2007; 120(5):1116–1122. [PubMed: 17131335]
5. Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. J Photochem Photobiol B. 2001; 63(1–3):8–18. [PubMed: 11684447]
6. Madan V, Lear JT, Szeimies RM. Non-melanoma skin cancer. Lancet. 2010; 375(9715):673–685. [PubMed: 20171403]
7. Narayanan DL, Saladi RN, Fox JL. Ultraviolet radiation and skin cancer. Int J Dermatol. 2010; 49(9):978–986. [PubMed: 20883261]

8. Herzog, C.; Pappo, A.; Bondy, M.; Bleyer, A.; Kirkwood, J. [Accessed September 2011.] Malignant melanoma: cancer epidemiology in older adolescents and young adults; National Cancer Institute, SEER AYA monograph. 2007. p. 53-63.Available at: http://seer.cancer.gov/publications/aya/5_melanoma.pdf
9. Purdue MP, Freeman LB, Anderson WF, Tucker MA. Recent trends in incidence of cutaneous melanoma among U.S. Caucasian young adults. J Invest Dermatol. 2008; 128(12):2905–2908. [PubMed: 18615112]
10. Lazovich D, Vogel RI, Berwick M, Weinstock MA, Anderson KE, Warshaw EM. Indoor tanning and risk of melanoma: a case-control study in a highly exposed population. Cancer Epidemiol Biomarkers Prev. 2010; 19(6):1557–1568. [PubMed: 20507845]
11. Cust AE, Armstrong BK, Goumas C, et al. Sunbed use during adolescence and early adulthood is associated with increased risk of early-onset melanoma. Int J Cancer. 2011; 128(10):2425–2435. [PubMed: 20669232]
12. Indoor Tanning Association. [Accessed September 12, 2011.] About indoor tanning. Available at: http://www.theita.com/?page=Indoor_Tanning
13. Choi K, Lazovich D, Southwell B, Forster J, Rolnick SJ, Jackson J. Prevalence and characteristics of indoor tanning use among men and women in the United States. Arch Dermatol. 2010; 146(12): 1356–1361. [PubMed: 21173319]
14. Cokkinides V, Weinstock M, Lazovich D, Ward E, Thun M. Indoor tanning use among adolescents in the US, 1998 to 2004. Cancer. 2009; 115(1):190–198. [PubMed: 19085965]
15. Demko CA, Borawski EA, Debanne SM, Cooper KD, Stange KC. Use of indoor tanning facilities by white adolescents in the United States. Arch Pediatr Adolesc Med. 2003; 157(9):854–60. [PubMed: 12963589]
16. Hillhouse J, Turrisi R, Shields AL. Patterns of indoor tanning use: Implications for clinical interventions. Arch Dermatol. 2007; 143(12):1530–5. [PubMed: 18087003]
17. Baker MK, Hillhouse JJ, Liu X. The effect of initial indoor tanning with Mother on current tanning patterns. Arch Dermatol. 2010; 146 (12):1427–28. [PubMed: 21173329]
18. Hoerster KD, Garrow RL, Mayer JA, et al. Density of indoor tanning facilities in 116 large U.S. cities. Am J Prev Med. 2009; 36(3):243–246. [PubMed: 19215849]
19. Cafri G, Thompson JK, Jacobsen PB, Hillhouse J. Investigating the role of appearance-based factors in predicting sunbathing and tanning salon use. J Behav Med. 2009; 32(6):532–544. [PubMed: 19653089]
20. Lazovich D, Forster J, Sorensen G, et al. Characteristics associated with use or intention to use indoor tanning among adolescents. Arch Pediatr Adolesc Med. 2004; 158(9):918–924. [PubMed: 15351760]
21. Knight JM, Kirincich AN, Farmer ER, Hood AF. Awareness of the risks of tanning lamps does not influence behavior among college students. Arch Dermatol. 2002; 138(10):1311–1315. [PubMed: 12374536]
22. Hillhouse JJ, Turrisi R, Kastner M. Modeling tanning salon behavioral tendencies using appearance motivation, self-monitoring and the Theory of Planned Behavior. Health Educ Res. 2000; 15(4):405–414. [PubMed: 11066458]
23. Evans JS. Dual-processing accounts of reasoning, judgment, and social cognition. Annu Rev Psychol. 2008; 59:255–278. [PubMed: 18154502]
24. Dovidio JF, Penner LA, Albrecht TL, et al. Disparities and distrust: the implications of psychological processes for understanding racial disparities in health and health care. Soc Sci Med. 2008; 67(3):478–486. [PubMed: 18508171]
25. Schneider S, Kramer H. Who uses sunbeds? A systematic literature review of risk groups in developed countries. J Eur Acad Dermatol Venereol. 2009; 24(6):639–648. [PubMed: 20015180]
26. Coups E, Phillips L. A more systematic review of correlates of indoor tanning. J Eur Acad Dermatol Venereol. 2011; 25(5):610–616. [PubMed: 21349117]
27. O'Riordan DL, Field AE, Geller AC, et al. Frequent tanning bed use, weight concerns, and other health risk behaviors in adolescent females (United States). Cancer Causes Control. 2006; 17(5): 679–686. [PubMed: 16633915]

28. Bagdasarov Z, Banerjee S, Greene K, Campo S. Indoor tanning and problem behavior. J Am Coll Health. 2008; 56(5):555–561. [PubMed: 18400668]
29. Danoff-Burg S, Mosher CE. Predictors of tanning salon use: Behavioral alternatives for enhancing appearance, relaxing and socializing. J Health Psychol. 2006; 11(3):511–8. [PubMed: 16774902]
30. Wittgenstein E, Berry HK. Reaction of dihydroxyacetone (DHA) with human skin callus and amino compounds. J Invest Dermatol. 1961; 36:283–6. [PubMed: 13786108]
31. Fu AJM, Dusza SW, Halpern AC. Sunless tanning. J Am Acad Dermatol. 2004; 50(5):706–713. [PubMed: 15097954]
32. Pagota SL, Schneider KL, Oleski J, Bodenlos JS, Ma Y. The sunless study: a beach randomized trial of a skin cancer prevention intervention promoting sunless tanning. Arch Dermatol. 2010; 146(9):979–984. [PubMed: 20855696]
33. Sheehan DJ, Lesher JL Jr. The effect of sunless tanning on behavior in the sun: A pilot study. South Med J. 2005; 98(12):1192–5. [PubMed: 16440919]
34. Cokkinides VE, Brandi P, Weinstock MA, Ward E. Use of sunless tanning products among US adolescents aged 11 to 18 years. Arch Dermatol. 2010; 146(9):987–992. [PubMed: 20855697]
35. Brooks K, Brooks D, Dajani Z, et al. Use of artificial tanning products among young adults. J Am Acad Dermatol. 2006; 54(6):1060–1066. [PubMed: 16713463]
36. Stryker JE, Yaroch AL, Moser RP, Atienza A, Glanz K. Prevalence of sunless tanning product use and related behaviors among adults in the United States: results from a national survey. J Am Acad Dermatol. 2007; 56(3):387–390. [PubMed: 17097362]
37. Mahler HIM, Kulik JA, Harrell J, Correa A, Gibbons FX, Gerrard M. Effects of UV photographs, photoaging information, and use of sunless tanning lotion on sun protection behaviors. Arch Dermatol. 2005; 141(3):373–380. [PubMed: 15781679]
38. Lin JS, Eder M, Weinmann S. Behavioral counseling to prevent skin cancer: a systematic review for the US Preventive Services Task Force. Ann Int Med. 2011; 154:190–201. [PubMed: 21282699]
39. Pagoto SL, Hillhouse J. Not all tanners are created equal: implications of tanning subtypes for skin cancer prevention. Arch Dermatol. 2008; 11:1505–08. [PubMed: 19015427]
40. Satyapriya M, Nagendra HR, Nagarathna R, Padmalatha V. Effect of integrated yoga on stress and heart rate variability in pregnant women. Int J Gynaecol Obstet. 2009; 104(3):218–22. [PubMed: 19110245]
41. Smith C, Hancock H, Blake-Mortimer J, Eckert K. A randomized comparative trial of yoga and relaxation to reduce stress and anxiety. Complement Ther Med. 2007; 15(2):77–83. [PubMed: 17544857]
42. Granath J, Ingvarsson S, von Thiele U, Lundberg U. Stress management: A randomized study of cognitive behavioural therapy and yoga. Cogn Behav Ther. 2006; 35(1):3–10. [PubMed: 16500773]
43. Michalsen A, Grossman P, Acil A, Langhorst J, Ludtke R, Esch T, et al. Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program. Med Sci Monit. 2005; 11(12):CR555–561. [PubMed: 16319785]
44. Feldman SR, Liguori A, Kucenic M, Rapp SR, Fleischer AB Jr, Lang W, et al. Ultraviolet exposure is a reinforcing stimulus in frequent indoor tanners. J Am Acad Dermatol. 2004; 51(1): 45–51. [PubMed: 15243523]
45. Kaur M, Liguori A, Lang W, Rapp SR, Fleischer AB Jr, Feldman SR. Induction of withdrawal-like symptoms in a small randomized, controlled trial of opioid blockade in frequent tanners. J Am Acad Dermatol. 2006; 54(4):709–11. [PubMed: 16546596]
46. Levins PC, Carr DB, Fisher JE, Momtaz K, Parrish JA. Plasma beta-endorphin and beta-lipoprotein response to ultraviolet radiation. Lancet. 1983; 2(8342):166. [PubMed: 6135011]
47. Belon PE. UVA exposure and pituitary secretion. Variations of human lipotropin concentrations (beta LPH) after UVA exposure. Photochem Photobiol. 1985; 42(3):327–9. [PubMed: 4059366]
48. Jaccard J. Attitudes and behavior: implications for attitudes toward behavioral alternatives. J Exp Soc Psychol. 1981; 17:286–307.
49. Jain N, Rademaker A, Robinson JK. Implementation of the federal excise tax on indoor tanning services in Illinois. Arch Dermatol. 2012 in press.

50. Dellavalle RP, Schilling LM, Chen AK, Hester EJ. Teenagers in the UV tanning booth? Tax the tan Arch Pediatr Adolesc Med. 2003; 157(9):845–846.
51. Baker, MK.; Hillhouse, JJ.; Turrisi, R.; Shields, A.; Jain, S.; Longacre, I. A Dual Process Model of Pathological Tanning Behavior. Poster session presented at The Appalachian Student Research Forum; Johnson City, TN. 2011 Mar 24.
52. Harrington CR, Beswick TC, Leitenberger J, Minhajuddin A, Jacobe HT, Adinoff B. Addictive-like behaviours to ultraviolet light among frequent indoor tanners. Clin Exp Dermatol. 2011 Jan; 36(1):33–8. [PubMed: 20545951]
53. Heckman CJ, Egleston BL, Wilson DB, Ingersoll KS. A preliminary investigation of the predictors of tanning dependence. Am J Health Behav. 2008 Sep-Oct;32(5):451–64. [PubMed: 18241130]
54. Mosher CE, Danoff-Burg S. Indoor tanning, mental health, and substance use among college students: the significance of gender. J Health Psychol. 2010 Sep; 15(6):819–27. [PubMed: 20453052]
55. Nolan B, Feldman S. Ultraviolet tanning addiction. Dermatol Clin. 2009; 27:109–112. [PubMed: 19254653]
56. Poorsattar S, Hornung R. UV light abuse and high-risk tanning behavior among undergraduate college students. Journal Am Academy of Dermatology. 2007; 56(3):375–379.
57. Warthan MM, Uchida T, Wagner RF Jr. UV light tanning as a type of substance-related disorder. Arch Dermatol. Aug; 2005 141(8):963–966. [PubMed: 16103324]
58. Zeller S, Lazovich D, Forster J, Widome R. Do adolescent indoor tanners exhibit dependency? J AM Acad Dermatol. Apr; 2006 54(4):589–596. [PubMed: 16546579]
59. Pagoto SL, Schneider KL, Oleski J, Bodenlos JS, Merriam P, Ma Y. Design and methods for a cluster randomized trial of the Sunless Study: a skin cancer prevention intervention promoting sunless tanning among beach visitors. BMC Public Health. 2009; 9:50. [PubMed: 19196482]
60. Nolan BV, Taylor SL, Liguori A, Feldman SR. Tanning as an addictive behavior: a literature review. Photodermatol Photoimmunol Photomed. 2009; 25(1):12–19. [PubMed: 19152511]
61. van Steensel M. UV addiction: a form of opiate dependence. Arch Dermatol. 2009; 145:211. [PubMed: 19221281]
62. Mayfield D, McLeod G, Hall P. The CAGE questionnaire: validation of a new alcoholism screening instrument. Am J Psychiatry. 1974; 131:1121–3. [PubMed: 4416585]
63. First, MH.; Spitzer, RL.; Miriam, G.; Williams, JBW. Structured Clinical Interview for DSM-IV Axis I Disorders – Patient Edition (SCID-I / P). New York: Biometrics Research Department, New York State Psychiatric Institute; 2002.
64. Baker, MK.; Hillhouse, JJ.; Turrisi, R.; Shields, A.; Stapleton, J.; Jain, S.; Longacre, I. Skin Cancer Prevention in Young Women: Evaluating a Measure of Pathological Tanning. Poster session presented at the Summit on Cancer in Tennessee; Franklin, TN. 2011 Jun 16.
65. SAMHSA. [Accessed June 1, 2011.] 2001 National Househol Survey on Drug Abuse. 2010. http://www.oas.samhsa.gov/nhsda/2k1nhsda/vol2/appendixh_5.htm
66. Harrington CR, Beswick TC, Graves M, Jacobe HT, Harris TS, Kourash S, Devous SR, Adinoff B. Activation of the mesostriatal reward pathway with exposure to ultraviolet radiation (UVR) vs. sham UVR in frequent tanners: a pilot study. Addict Biol. 2011 Apr 11. [Epub ahead of print]. 10.1111/j.1369-1600.2010.00312.x
67. Mayer JA, Woodruff SI, Slymen DJ, et al. Adolescents' use of indoor tanning: a large-scale evaluation of psychosocial, environmental, and policy-level correlates. Am J Public Health. 2011; 101(5):930–938. [PubMed: 21421947]

Table 1

DSM-IV criteria for substance dependence

DSM_IV criteria	Original question	Modification for tanning
Tolerance	Need for markedly increased of amounts of substance to achieve intoxication or desired effect	Do you feel that you need to spend more and more time in the sun or tanning bed in order to maintain your tan?
Withdrawal	Withdrawal symptoms if use of substance is decreased or stopped	Do you feel unattractive or anxious to tan if you do not maintain your tan?
Loss of control	Substance often taken in larger amounts or over a longer period than intended	Do you think that you should stop tanning or decrease the time you spend tanning?
	Persistent desire or unsuccessful efforts to cut down or control substance use	Have you tried to stop tanning, but still continue?
Compulsive use	Important social, occupational, or recreational activities are given up or reduced because of substance use	Have you ever missed a social engagement, work, school or other recreational activities because you went to the beach or tanning salon instead? *
Continued use despite adverse consequences	Substance use is continued despite having a persistent or recurrent physical or psychological problems that are likely to have been caused or exacerbated by the substance	Have you ever gotten into trouble at work, with family or with friends due to tanning? *
		Do you continue to tan despite knowing that it is bad for your skin (can cause wrinkles, premature ageing, sun spots, etc.)?
		Have you ever had a skin cancer, or do you have a family history of skin cancer?

* Items with poor correlation with substance dependency responses because tanning is not illegal nor does it impair performance of activities of daily living.