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The benefits and risks of ultraviolet (UV) tanning and its alternatives: the role of prudent sun exposure

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Synopsis

Sunlight and indoor ultraviolet (UV) induced tanning is a common behavior, especially among adolescents, young adults, and individuals with lighter skin. Excessive sun exposure is associated with several health risks including the acceleration of skin aging and the promotion of skin cancers, such as basal cell carcinoma, squamous cell carcinoma, and malignant melanoma. However, several health benefits of UV exposure include vitamin D production and improved mood. Herein, we analyze these health risks and benefits. We further discuss pertinent issues surrounding indoor tanning, the role of sunless tanning products, and prudent sun exposure.

Keywords

Tanning; ultraviolet; health; benefits; risks; sun

Deliberate tanning is a common practice since 37–49% of women and 17–29% engage in deliberate tanning in both Europe and the United States [1–3]. Tanning is most common among lighter skinned individuals. In one study 70% of light skin types (Fitzpatrick [4] skin types I and II), 19% of skin types III and IV, and 0% with dark skin (Fitzpatrick skin types V or VI) deliberately attempted to darken their skin [3]. Many health benefits and risks have been attributed to UV exposure and tanning. We discuss these claims in light of the growing indoor UV and non-UV tanning industries.

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Conflicts of interest: None

Health Benefits

Several health benefit claims such as improved appearance, enhanced mood, and increased vitamin D levels have been attributed to tanning. Furthermore, the Indoor Tanning Association claims that "catching some rays may lengthen your life" [5].

Exposure to sunlight has been linked to improved energy and elevated mood. The belief that people look better with a tan may partially explain this phenomenon. A report on the tanning attitudes of young adults found that 81% of individuals in 2007 felt that a tan improved appearance, whereas only 58% of individuals in 1968 held the same belief [6]. Individuals with seasonal affective disorder report improved mood status when exposed to sunlight [7] and to frequently tan [8]. Although early studies had suggested that mood elevation was linked to increased endorphin levels [9], subsequent studies have not found such correlation [10–12].

The Indoor Tanning Association claims that a base tan can act as "the body's natural protection against sunburn" [5]. UV induced tans offer a sun protection factor (SPF) of 3–4 [13,14], but additional changes besides hyperpigmentation, such as epidermal hyperplasia, likely play a role in UV induced photoprotection. While an SPF of 3–4 does protect from sunburn, only approximately 65% of the erythema induced by UV radiation is blocked [15]. Therefore a base tan does not provide adequate protection and appropriate clothing, the proper use of sunscreens, and prudent sun exposure remain essential for sunburn prevention.

Vitamin D production

Sunlight contains UVB, which induces the skin to synthesize previtamin D3. Healthy individuals have seasonal variations in their vitamin D levels [16,17], and may become vitamin D deficient during winter [17]. Lower vitamin D levels have been associated with increased risk for several types of cancer, heart disease, and bone disease [18–23]. Vitamin D deficiency may also play a role in autoimmune disease [24].

The Indoor Tanning Association highlights "new research on how sunshine decreases infection" [5] including a West African case-control study where more tuberculosis (TB) patients than controls had low levels of Vitamin D, [hypovitaminosis defined as 25(OH)D3≤75 nmol/L] (46% vs. 39%, RR=1.18, 95% CI: 1.01–1.38) [25]. However, even lower levels of Vitamin D [Vitamin D deficiency defined as 25(OH)D3≤50 nmol/L] was less common among tuberculosis patients than controls (8.5% vs. 13.2%, RR=0.65, 95% CI:0.43, 0.98). The causal relation of these associations is unknown.

The current recommendation for daily intake of Vitamin D is 400–600 IU, but the required daily intake should likely be increased to 800–2000 IU [26,27] to maintain blood levels of 25-hydroxyvitamin D greater than 75 nmol/L. Although UV tanning leads to the endogenous synthesis of previtamin D3, several studies in human skin have shown that total previtamin D3 production in the skin plateaus with exposure time [28]. Further increases in UV exposure will not increase the total amount of previtamin D3. A moderate amount of sun exposure to the hands, face, and arms every other day produces enough cutaneous previtamin D3 to meet daily requirements in light skinned persons, even if the daily requirements are increased to 1000 IU [29,30]. Calculations demonstrate that individuals with lighter skin (types I–III) need 5–20 minutes of sun exposure depending on season. These recommendations also apply at higher latitudes where sun induced vitamin D synthesis is less efficient [30]. Moderate sun exposure is as efficient as prolonged sun exposure for previtamin D production. However, sunlight exposure as the only source of vitamin D may be impractical in cold weather and for those with darker skin types [30]. Therefore, moderate sunlight exposure should be considered in combination with a diet fortified with vitamin D for optimal vitamin D status.

In one study, UV tanners had twice the 25-hydroxyvitamin D levels as non-tanners [31], even after controlling for variations in ethnicity between the two groups [32]. However, the decreased vitamin D status of the non-tanners may be a reflection of inadequate daily recommendations, since the current RDA for vitamin D may be insufficient [26,27]. Future studies will be necessary to determine whether increased daily recommendations and intake of vitamin D would diminish the discrepancy between tanners and non-tanners.

Health Risks

While UV radiation promotes skin malignancies like basal cell carcinoma, squamous cell carcinoma, and melanoma, the most serious of these cancers, the association for each type of skin cancer differs [33]. Intermittent sun exposure and sunburns were positively associated with melanoma [34,35], while, chronic sun exposure was not [35]. A weak association and dose-response relationship exists between sunbed use and melanoma [36], including a doubling of the risk to develop melanoma in individuals that started using tanning beds before the age of 35 [36]. These studies may be limited by recall bias, since individuals that develop melanoma are more likely to recall a history of increased sun exposure and sunburns [34,35]. Melanoma has also been strongly associated with immigration from low to high UV radiation geographic locations during childhood [37]. This ecological study did not depend on personal recall of sun exposure and is therefore less susceptible to recall bias, but the role of childhood sunburns was not specifically addressed.

Squamous cell carcinoma (SCC) and basal cell carcinoma (BCC) demonstrate varying relationships with ultraviolet exposure from sunlight or UV tanning beds. A detailed review of case-control studies showed that cumulative sun exposure was associated with both BCCs and SCCs, whereas intermittent sun exposure was associated with only BCCs [38]. A history of sunburn increased the risk for developing both BCCs and SCCs. Childhood sunburns were associated with SCCs, whereas sunburns at any age were associated with BCCs [38]. Indoor tanning was associated with SCC but not BCCs [36].

Frequent exposure to sunlight also accelerates skin aging. Much of this aging process has been attributed to UV exposure [39] and subsequent free radical generation [40], with infrared radiation (IR) playing an important role. IR likely promotes photoaging by inducing the breakdown of collagen and increasing the presence of reactive oxygen species [41,42]. Physical sun-blocking agents, like titanium dioxide, block infrared radiation [41], but most chemical based sunblocks were developed for UV, not infrared, photoprotection.

Role of indoor tanning

Indoor tanning is widespread in the United States: 8–20% of adults [43] and 7–35% of teens [44] have engaged in indoor tanning, and up to 48% of 18–19 year old Caucasian females [45]. Indoor tanning increases the risk of skin cancer [36,46,47], augments the risk for sunburn, and accelerates photoaging [39]. Interestingly, indoor tanning practices are greatly influenced by parental acceptance and peer participation [48,49]. Indoor tanners also spend more time outdoors [43] increasing their UV exposure and further elevating their risks for sunburns and skin cancers. Young Caucasian women are cosmetically and socially motivated to tan [50]. Of note, dark skinned and elderly populations who are at the highest risk for vitamin D deficiency [51] and would benefit the most from sun exposure, are the least likely to actually engage in indoor or outdoor tanning. Many teens tan indoors [44,48], and many indoor tanning advertisements specifically target this population [52,53]. Since tanning may be addictive [54,55], and because it promotes premature skin aging and skin cancer [36], many states have enacted laws to limit teen access to indoor tanning [56]. Although these laws reduce indoor tanning among teens [53], they are poorly enforced [57,58].

Sunless tanning

An alternative to UV tanning is sunless tanning. Currently marketed sunless tanning agents include spray-on tans and sunless tanning lotions. These products contain dihydroxyacetone (DHA), which reacts with the amino groups in the stratum corneum to stain the skin brown. Although DHA protects against UVA [59] and UVB [60] is transient and inadequate. Therefore, other protective measures like clothing and sunscreen use are necessary for sunburn protection. People using sunless tanning products were more likely to sunburn in the past year [61]. However the temporal relationship between and the beliefs regarding sunburn and sunless tanner use deserves further study (i.e. how often sunless tanning is a protective response due to past sunburn vs. how often sunburn is due to a false sense of photoprotection ascribed to a sunless tan). DHA may temporarily increase the formation of UV radiation induced reactive oxygen species for the first 24 hours after application [62], leading to acceleration of sun induced damage. Therefore, minimization of sun and UV exposure following application of DHA is advised during the first 24 hours after application.

People who solely rely on sunless tanning products exhibit better sun protection habits than those who tan indoors, those who utilize both indoor and sunless tanning products, and those who refrain from tanning [63]. Sunscreen and protective clothing use is increased among exclusively sunless tanners. This contradicts earlier findings that associated sunless tanning with sunburn [61]. However, the earlier study did not examine the temporal relationship between sunburn and sunless tanning. The study also did not differentiate between exclusive sunless tanners and those who utilized both sunless tanning and indoor tanning, which can confound whether the increased sunburns were due to sunless tanning or indoor tanning habits. A prospective study of exclusive sunless tanners would lead to better understanding of how sunless tanning and sunburns are associated.

DHA based sunless tanning agents have a number of drawbacks. The effect is temporary, the resulting skin color can look unnatural, and there is an increased risk for sun-induced damage within 24 hours of application [62]. The development of a new class of agents that enhance melanin production in the skin may address these concerns. Although no products are currently on the market, several possibilities are under research. Topical agents that activate the p53 cascade [64], the β2 adrenergic receptor and cAMP-dependant pathways [65,66], the melanocortin 1 receptor [66], and the topical application of T-oligos [67] may hold the key to successful sunless tanning. A topical method to induce melanogenesis has many exciting possibilities and will require more research. Such products may induce a more natural looking tan and make sunless tanning more desirable. These exciting new agents may activate the body’s natural tanning physiology, while avoiding the drawbacks of UV damage.

Summary/Conclusion

Sun exposure is beneficial in moderation, but can be harmful in excess. Sun exposure guidance should be tailored to the individual patient. Individual factors such as skin type, past history of skin cancers, and concurrent medical conditions should influence counseling practices. Tanning is primarily achieved through the overexposure of skin to UV radiation and is most prevalent among lighter skinned populations. In these populations, UV tanning may not offer any benefit over moderate sun exposure to offset elevated skin cancer and photoaging risk. Sun exposure should not be used as an alternative but as an adjunct to a diet fortified with vitamin D. Sunless tanning products may serve as a sensible, safer alternative for those who desire tanned skin. The use of sunscreens, preferably with broad coverage against UVA, UVB, and infrared radiation, are essential for tanners who have prolonged UV and sunlight exposure. However, tanners should be educated that while sunscreens prevent sunburn and reduce the

risk of squamous cell carcinoma [68], they do not seem to reduce the risk for the development of basal cell carcinoma [68] or melanoma [69]. Therefore, prudent sun exposure is paramount.

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