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Indoor Tanning: A Bio-Behavioral Risk Factor for Skin Cancer

Carolyn J. Heckman¹ and Sharon L. Manne²

¹*Fox Chase Cancer Center*

²*University of Medicine and Dentistry of New Jersey*

Cancer Institute of New Jersey

USA

1. Introduction

Despite attempts to regulate the tanning industry, indoor tanning is a relatively common practice, particularly in the USA and other Western countries. Young women who tan to enhance their appearance are the most common patrons of tanning salons. Indoor tanning has been linked to the development of melanoma and non-melanoma skin cancers, and a disturbing increase in the incidence of melanoma among young adult women has been observed recently. This chapter will provide a review of the literature concerning some of the key facts about indoor tanning including the prevalence of indoor tanning around the world, evidence supporting the association of indoor tanning with skin cancers, the historical context of indoor tanning, psychological motivations for indoor tanning including tanning dependence, and attempts to regulate the tanning industry. The following terms will be used to describe tanning, tanning devices, and tanning establishments: indoor tanning, artificial ultraviolet (UV) tanning, tanning beds, tanning booths, sunbeds, sunlamps, tanning salons, tanning parlors, and solaria.

2. Prevalence of indoor tanning

Indoor tanning prevalence rates vary depending on the country and the population under study (See systematic review by Schneider & Kramer, 2010). Much of the research on indoor tanning has been conducted in the US. The prevalence of indoor tanning in the past year among US adults is approximately 5-16% (Choi et al., 2010; Coups, Manne, & Heckman, 2008; Heckman, Coups, & Manne, 2008; Stryker et al., 2007). Among US college students, the past year prevalence of indoor tanning is higher, with estimates ranging from 33 to 60% (Bagdasarov et al., 2008; Hillhouse, Turrisi, & Shields, 2007). Past year indoor tanning rates among US adolescents range from 3 to 26% (Cokkinides et al., 2009; Hoerster et al., 2007; Lazovich et al., 2004; Ma et al., 2007; Mayer et al., 2011). Approximately 30% of US adolescents have engaged in indoor tanning in their lifetime (Zeller et al., 2006).

Sunbed use is also common in Northern European countries, particularly in Nordic countries. A 2001 study of Swedish young adults found that 44% had ever used sunbeds

(Branstrom, Ullen, & Brandberg, 2004). One 1993 study of high school students found that about three-quarters (75%) of Norwegian girls and 65% of Norwegian boys had used a sunbed during the past year (Wichstrom, 1994). The prevalence of indoor tanning in the past year among Danish adults is approximately 30% (Koster et al., 2009). Indoor tanning rates among Danish adolescents are also high. Forty-three percent of adolescents between the ages of 15 and 18 have indoor tanned in the past year, 13% of 12 to 14 year old adolescents have indoor tanned in the past year and 2% of 8 to 11 year olds have indoor tanned in the past year (Krarup et al., 2011). Rates of skin cancer correspond with these high rates of indoor tanning: after Australia and New Zealand, Denmark has the highest incidence of melanoma skin cancer (Krarup et al., 2011). Between 2004 and 2007, 26% of the Icelandic population had used a sunbed in the last year (Hery et al., 2010). As of 2008, 50% of adolescent girls and 30% of boys reported using a sunbed in the last year (Hery et al., 2010).

Rates of sunbed use vary across Western Europe. An analysis of French data from 1994-95 found that 15% of adults reported sunbed use, with its being significantly more common in the north (13%) than in the south (10%) of France (Ezzedine et al., 2008). Two recent studies found that between 29% and 47% of German adults have ever used a sunbed (Diehl et al., 2010; Dissel et al., 2009). The prevalence of indoor tanning in the past year among German adults is 21% (Diehl et al., 2010; Schneider et al., 2009). Rates in Spain are significantly lower, with only 4% of Spanish adults reporting sunbed use in the last year (Galan et al., 2011).

Compared to European countries, sunbed use is significantly lower in the UK, Canada, and Australia. However, sunbed use varies across geographical regions within the UK. On average, ever use is about 7% among children, adolescents, and adults alike (Canadian Cancer Society, 2009; Thomson et al., 2010). Sunbed use among adolescents has been found to be more common in Northwest England (Liverpool 20%, Merseyside 43%) than in Southeast England (Southampton 6.2%; (Canadian Cancer Society, 2009; Mackay, Lowe, Edwards et al., 2007). In a recent study from Northern Ireland, 20% of adults reported ever having used a sunbed in 2008, and 1% reported indoor tanning in the past year (Boyle et al., 2010). The lifetime rate of indoor tanning is 22% among adolescents in Wales (Roberts & Foley, 2009).

With regard to Canadian sunbed use, approximately 20% of Canadian adults and 10-15% of adolescents report having ever indoor tanned (Canadian Cancer Society, 2006; Gordon & Guenther, 2009). According to recent data, 11% of Canadian adults had indoor tanned in the past 12 months (Canadian Cancer Society, 2006; Gordon & Guenther, 2009). At-home sunbeds have been common in Canada as in parts of Western Europe (Autier et al., 1994).

Sunbed use in Australia is much lower compared to most European countries or Canada, likely due to the sunny warm weather, high proportion of individuals with very UV-sensitive skin, and their long-running and successful skin cancer prevention campaigns. Nine percent of Australian adults report ever using a sunbed, and less than 1% report indoor tanning in the last year (Lawler et al., 2006). Three percent of Australian adolescents report ever having used a sunbed (Francis et al., 2010).

In summary, indoor tanning is quite common in the USA, Nordic countries, and Northern Europe. Sunbed use in the UK, Canada, and Australia is more modest. There is little data on sunbed use in southern (e.g., Italy) and eastern European countries (e.g., Poland). We are not aware of any English language literature on indoor tanning in Asian countries, perhaps because traditional Asian cultures tend to value fair skin.

3. Association between indoor tanning and skin cancer

UV radiation induces DNA damage in the skin that leads to pigmentation/tanning and can lead to carcinogenesis. Indoor tanning devices such as tanning beds and booths emit approximately 95% UVA (315-400 nm) and 5% UVB (280-315 nm), similar to the sun (Woo & Eide, 2010). UVA tends to penetrate into the dermis and cause tanning, and UVB causes burning of the epidermis (Mouret et al., 2006). More recent high-pressure tanning bulbs emit as much as 99-100% UVA radiation in order to increase the intensity and duration of tans while decreasing the likelihood of some negative effects of UVB such as skin burning and dryness (Woo & Eide, 2010). The skin cancers linked with indoor tanning are melanoma and non-melanoma skin cancers (basal cell carcinoma and squamous cell carcinoma). We will review the evidence linking indoor tanning to each.

In 2006, the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO) conducted a systematic review of 19 studies investigating the association between melanoma and indoor tanning (IARC, 2006). Individuals who had ever indoor tanned had a 1.15 relative risk of developing melanoma (IARC, 2006). In other words, individuals who had ever indoor tanned had a 15% greater chance of developing melanoma compared to individuals who had never indoor tanned. Individuals who had indoor tanned before age 35 had a relative risk of 1.75 (IARC, 2006), which translates to a 75% greater chance of developing melanoma compared to those who had not indoor tanned. There was no correlation between melanoma risk and year of publication among the articles reviewed, indicating that newer tanning devices were not safer than older ones.

Chronic UV exposure has been found to be directly related to squamous cell carcinomas (SCC), whereas intermittent exposure is more closely related to basal cell carcinoma (BCC) (Lim et al., 2011). As they did for melanoma, the IARC conducted a review of nine studies that investigated the association between SCC and BCC and indoor tanning. The review revealed that individuals who had ever used a tanning bed had a 2.25 relative risk for SCC but a 1.03 relative risk for BCC when compared to those who had never indoor tanned (IARC, 2006). However, a review by Karagas and colleagues found that the risk for both cancers increased significantly with indoor tanning (Karagas et al., 2002). The authors also found that the association with non-melanomas was inversely related to the age of indoor tanning initiation.

In 2009, the IARC reclassified UV radiation as a group 1 carcinogen or “carcinogenic to humans”, rather than the previous classification of “probably carcinogenic” (El Ghissassi et al., 2009; Mogensen & Jemec, 2010). Additional studies investigating the association of sunbeds and melanoma have been published since then. For example, in a recent study of Minnesota melanoma cases and controls, 63% of cases and 51% of controls had tanned indoors (adjusted OR 1.74) (Lazovich et al., 2010). A dose response was noted in terms of years, hours, or sessions of indoor tanning. Dose was found to be more closely associated with melanoma development than age of initiation. Among US women, Fears and colleagues (Fears et al., 2011) also found a dose response relationship with melanoma risk increasing with increasing session time and frequency of sessions. The authors estimated that 5-min indoor tanning sessions would increase melanoma risk by 19% for frequent users (10+ sessions) and by 3% for occasional users (1-9 sessions). For men, measures of sunbed use were not significantly associated with melanoma risk.

Whereas most cancers strike older individuals, melanoma has become the most common cancer among 25-29 year old women in the USA, and the second most common cancer

among 15-29 year old women (Herzog et al., 2007). With regard to studies conducted outside the USA, a study of the English population also found that 25% of melanomas among young women can be attributed to indoor tanning (Diffey, 2007). Sunbed use among Australians was found to be associated with increased risk of early-onset melanoma, with risk increasing with greater use, an earlier age at first use, or for earlier onset disease (Cust et al., 2011). Among individuals who were diagnosed with melanoma between 18 and 29 years of age, three quarters (76%) of melanomas were attributable to sunbed use (Cust et al., 2011). Melanoma risk has also been found to be significantly higher among Norwegian/Swedish individuals who indoor tanned than those who had not (Veierod et al., 2010).

In addition to skin cancers, UV radiation can cause immunosuppression, photo-aging, photodermatoses, pruritis, cataracts, and photokeratitis, among others (Lim et al., 2011). One of the main reasons for tanning promoted 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 (Gilchrest, 2007). However, like the sun under varying conditions, tanning beds differ as to the amount of vitamin D produced (Sayre, Dowdy, & Shepherd, 2010). In particular, modern high pressure tanning units that filter out most UVB result in the production of insignificant levels of vitamin D (Sayre et al., 2010) since UVA is not effective for vitamin D photosynthesis. In other words, the more vitamin D produced, the greater the risk of sunburn. Likewise, vitamin D production plateaus after a few indoor tanning sessions, whereas DNA damage does not (Lim et al., 2011). 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 (Gilchrest 2007). There has been a great deal of recent interest and controversy surrounding vitamin D deficiency and whether one should seek UV exposure to enhance vitamin D levels. Lim and colleagues refer to the latter as a “pseudo-controversy” (Lim et al., 2011). Most dermatologists and scientists agree that for most people, it is not necessary to risk skin cancer in order to protect themselves from other diseases by intentionally seeking UV radiation for its vitamin D producing properties.

Regarding indoor tanning, Weinstock and Fisher (Weinstock & Fisher, 2010) state that at this point, “The link between this form of UV exposure and both melanoma and non-melanoma skin cancers has been clarified through multiple lines of evidence from epidemiology and laboratory science reflected in recent reports by multiple prestigious bodies.” A dose response relationship has been found in many studies, indicating that the greater the UV exposure, the greater the risk for melanoma.

4. Attitudes toward tanning throughout history

4.1 Pre-industrial revolution

Not only has the understanding of UV and skin cancer changed over time, but the societal meaning of skin color also has varied across history and geography. Depending on these factors, both darker and lighter skin colors have been associated with social status.

Many ancient cultures including the Aztecs, Inca, Egyptians, Romans, and Greeks worshipped the sun and valued sun exposure (Randle, 1997). However, for much of human history, pale skin has been highly preferred, being associated with positive personal qualities including purity, cleanliness, and flawlessness. For example, pale skin was valued by ancient Asian cultures, the Bible, renaissance art, classical literature by Homer, Dante,

and Goethe, European court poets, and fairy tales such as “Snow White” (Holubar, 1998; Holubar & Schmidt, 1998).

In Europe and the USA prior to the 1900s, pale skin was associated with a higher social stature. The upper classes protected themselves from the sun using clothing, gloves, wide-brimmed hats, parasols, and heavy drapes, and bleached their skin to achieve a pale appearance (Albert & Ostheimer, 2002; Segrave, 2005). Only the lower and working classes were forced to work outside and therefore had darker appearing skin. In the early 1900s, the sun was viewed as unhealthy, being associated with tropical diseases (Carter, 2007).

4.2 Post-industrialization

Since industrialization and urbanization of the Western workforce, tanned skin has been perceived increasingly as attractive and fashionable among naturally light-skinned individuals. This attitude has been attributed to the fact that initially the lower classes worked in factories and lived in polluted, crowded, unsanitary slum areas where tuberculosis and rickets were common (Carter, 2007; Randle, 1997; Stradling, 1999). Pale skin was viewed as unhealthy and even associated with mental illness and alcoholism (Carter, 2007; Randle, 1997; Stradling, 1999). Only the upper classes had the time and money to take beach vacations and engage in outdoor hobbies; fashions such as bathing suits mirrored these trends.

In the late 1800s, the health benefits of UV were realized with the treatment of tuberculosis by the bactericidal properties of sun exposure or heliotherapy in sanatoria (Albert & Ostheimer, 2002). In 1903, Danish physician Niels Finsen won the Nobel Prize for curing cutaneous tuberculosis by developing the first artificial sunlamp (Randle, 1997). Around this time, it was discovered that childhood rickets could be prevented and treated with artificial phototherapy or heliotherapy (Albert & Ostheimer, 2003; Holick, 2008). During World War I, heliotherapy was used throughout Europe to treat infected wounds (Lim, Honigsman, & Hawk, 2007). Preventive medicine and public health professionals promoted sunlight for adults and sunbaths and even sunburns for babies and children (Albert & Ostheimer, 2003; Randle, 1997; Segrave, 2005).

The aesthetic benefits of the tan were popularized in 1929 when the fashion designer Coco Chanel was pictured with a tan in *Vogue* magazine after returning from a vacation in the French Riviera (Chapman, Marks, & King, 1992). The popularity of sunlamps peaked in the 1930s and 40s with the help of ads in *Vogue*, ads by General Electric, use in office buildings such as the US House Office Building, and prescription by physicians (Chapman et al., 1992; Martin et al., 2009; Segrave, 2005).

4.3 Modern America

Several economic and social trends in the mid twentieth century led to greater value being placed on a tanned appearance. In the 1950s and 60s, middle-class Americans were able to afford more travel including beach vacations, during which sun exposure is the norm (Lencek & Bosker, 1999; Pendergast & Pendergast, 2000; Randle, 1997). In the 1960s, beach party movies became popular in Hollywood (Lencek & Bosker, 1999), and technical advances were seen with the development of first-generation tanning beds and booths (Diffey, 1995; Spencer & Amonette, 1995). Together, these trends were associated with both outdoor and indoor tanning becoming more appealing to a greater portion of the American population. Through the 1970s, most sun care products were tan enhancers with minimal sunscreens, further increasing the level of skin cancer risk conferred by tanning.

The first tanning salon, Tantrific, opened in Arkansas in 1978 (Segrave, 2005). By 1980, there were 1,000 tanning salons in the USA and many individual tanning units in health- and fitness-related establishments (Segrave, 2005). In the early to mid 1980s, many of the 18,000 tanning salons began to increase the UVA and decrease the UVB levels emitted from their beds in order to market a “safer” tan with a lower likelihood of burning (Kwon et al., 2002; Segrave, 2005).

4.4 Current America

In two studies during the 1980s and 90s, clear evidence for the link between indoor tanning and melanoma was not found (Osterlind et al., 1988; Swerdlow & Weinstock, 1998). The tanning industry purchased advertising space in conspicuous venues such as *The New York Times* presenting these findings. The advertisement contained a message that indoor tanning was not proven to cause melanoma and that there were health benefits such as vitamin D production which would be missed if people avoided exposure.

Despite the current widespread knowledge regarding skin cancer etiology, media representations of tanning have continued to be primarily positive. For example, an analysis of articles in eight American magazines targeting girls and women from 1997 to 2006 found that the amount of coverage of negative consequences of indoor tanning was less than 50% of the amount of coverage of tanning benefits (Cho et al., 2010).

Indoor tanning is now a \$5 billion per year industry in the US with more than 40,000 indoor tanning establishments (Looking Fit, 2009-2010). Thirty million Americans indoor tan each year, and one million tan indoors each day (Fisher & James, 2010). In a recent report, Hoerster and colleagues found more indoor tanning facilities in each of 116 large US cities than the number of Starbucks coffee shops and McDonald’s restaurants in those cities (Hoerster et al., 2009). US and international regulation of indoor tanning has begun to increase. Future research will be able to provide insight into the effects of these recent and upcoming changes.

5. Psychosocial issues in indoor tanning and tanning dependence

5.1 Correlates of and motives for indoor tanning

Indoor tanners are more likely than non-tanners to be Caucasian, female, adolescents and young adults, and live in northerly climates (e.g., Heckman, Coups et al., 2008). Indoor tanners are also more likely to sunbathe, not wear protective clothing, use sunless tanners, and have low to moderate skin sensitivity to the sun (e.g., Heckman et al., 2008). Other correlates of indoor tanning include knowing other people who tan indoors, and greater use of alcohol, cigarettes, and other substances (Mosher & Danoff-Burg, 2010b).

The fact that many individuals indoor tan despite awareness of the link between UV radiation exposure and skin cancer suggests that there are important psychosocial motivations to tan that sometimes outweigh an individual’s concern for his or her health. Appearance enhancement is the most commonly-cited reason given for intentional indoor tanning (Amir et al., 2000; Beasley & Kittel, 1997; Boldeman et al., 1997; Brandberg et al., 1998; Cafri, Thompson, & Jacobsen, 2006; Cafri et al., 2006; Rhainds, De Guire, & Claveau, 1999; Sjöberg et al., 2004; Young & Walker, 1998). For example, one study involving qualitative interviews with college male and female indoor tanners found that they were often told they look “good”, “sexy”, “beautiful”, “young”, “healthy” because of their tanned

appearance and that these reactions were important to their self-image (Vannini & McCright, 2004). Additionally, tanning and body dysmorphic disorder are common co-occurrences, and many individuals with body dysmorphic disorder focus on perceived skin imperfections such as paleness (Phillips et al., 2006; Phillips et al., 2000).

Direct emotional effects such as relaxation, enhanced mood, stress relief, and improved energy comprise the second most often-cited category of motivations for indoor tanning (Beasley & Kittel, 1997; Boldeman et al., 1997; Feldman et al., 2004; Kourosh, Harrington, & Adinoff, 2010; Mawn & Fleischer, 1993; Zeller et al., 2006). For example, Danoff-Burg and Mosher (Danoff-Burg & Mosher, 2006) found that stress-relief and social alternatives to indoor tanning were significantly negatively related to indoor tanning behavior among young adults, whereas appearance-related alternatives were not. In terms of mood, Hillhouse and Turrisi (Hillhouse, Stapleton, & Turrisi, 2005) found a subset of frequent tanners who have seasonal affective disorder (SAD). These individuals may be using tanning, particularly during the winter, for self-medication purposes. However, the artificial light that is effective for SAD treatment must penetrate the eyes and does not contain UV, whereas individuals often close their eyes or wear goggles when indoor tanning.

Indoor tanning behavior is heavily influenced by the normative behavior of others. Several studies have found associations between adolescents' and young adults' indoor tanning and perceived indoor tanning behavior of their friends and peers (Bagdasarov et al., 2008; Hoerster et al., 2007; Lazovich et al., 2004). Likewise, studies have found associations between parental and adolescent indoor tanning, particularly among girls and their mothers (Cokkinides et al., 2009; Cokkinides et al., 2002; Hoerster et al., 2007; Stryker et al., 2004). For example, a recent study found that adolescent women who had initiated indoor tanning accompanied by their mothers were more likely to become frequent, habitual indoor tanners by young adulthood (Baker, Hillhouse, & Liu, 2010). Additionally, Cafri and colleagues (Cafri et al., 2009) found associations between indoor tanning behavior and perceptions of peer, family, significant other, and celebrity attitudes towards tanning.

Indoor tanning behavior is also influenced by beliefs about its effects on the skin in terms of skin cancer and other skin damage such as photo-aging. Some studies have found higher perceived skin damage susceptibility to be associated with greater indoor tanning behavior (Cafri, Thompson, Roehrig et al., 2006; Coups et al., 2008; Greene & Brinn, 2003; Heckman, Coups et al., 2008), some have found higher perceived threat of or susceptibility to skin harm to be associated with lower indoor tanning intentions (Cafri, Thompson, & Jacobsen, 2006; Cafri, Thompson, Roehrig et al., 2006; Greene & Brinn, 2003), and at least one has found no association (Hillhouse, Stair, & Adler, 1996). Differences in measurement may account for such varied results.

Several studies by Hillhouse and colleagues have found that together, combinations of variables from the aforementioned domains can account for high proportions of variance in indoor tanning attitudes, intentions, and behaviors (Cafri et al., 2009).

5.2 Tanning dependence

An additional reason for frequent tanning is tanning dependence or addiction, colloquially referred to as "tanorexia" (Heckman, 2011). A number of studies have provided evidence for the phenomenon of tanning dependence, with plausible biologic underpinnings that are

primarily related to the opioid system. Tanning dependent individuals may tan frequently and put themselves at even great risk of skin cancer than other tanners.

While tanning dependence is not an official disorder according to the American Psychiatric Association's Diagnostic and Statistical Manual-IV (DSM-IV), tanning dependence has been defined based on traditional substance dependence criteria and measures. Several approaches to measuring tanning dependence have been taken. Warthan and colleagues (Warthan, Uchida, & Wagner, 2005) modified the substance dependence criteria from the 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 behavior despite negative consequences, key criteria for the diagnosis of substance dependence. More recently, Hillhouse and colleagues (Hillhouse et al., 2010) developed the 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 TAPAS is an improvement over the modified DSM-IV and CAGE scales because its psychometric properties have been assessed and been found to be adequate, and it was developed empirically with the population of interest rather than simply being modified from existing alcohol and substance use measures (Heckman, 2011).

There is accumulating evidence supporting the phenomenon of tanning dependence (Heckman, 2011). Behavioral studies of adolescents and young adults have found addictive tendencies among indoor tanners including higher rates of other substance use (Mosher & Danoff-Burg, 2010a) and anticipated difficulty quitting indoor tanning (Lazovich et al., 2004). The prevalence of tanning dependence varies by population and measurement strategy. Among tanning salon patrons in the US, tanning dependence rates range from 33-41% (Harrington et al., 2010). Among beachgoers, rates range from 26-53% (Warthan et al., 2005). Rates are 22-45% among undergraduate indoor tanners (Heckman, Egleston et al., 2008; Mosher & Danoff-Burg, 2010a, 2010b; Poorsattar & Hornung, 2007). Among general college student samples in the USA, rates range from 12-27% (Heckman, Egleston et al., 2008; Mosher & Danoff-Burg, 2010a, 2010b; Poorsattar & Hornung, 2007).

5.2.1 Proposed mechanism of tanning dependence

The putative mechanism of tanning dependence involves UV exposure causing the up-regulation of the tumor suppressor gene p53 in skin cells, which leads to the release of beta-endorphin, a natural opioid analgesic involved in the brain's pleasure center (Cui et al., 2007). Beta-endorphin released into the blood during tanning may reach the brain in sufficient concentration to induce feelings of relaxation. However, we do not yet know how well beta-endorphin levels in the skin correlate with beta-endorphin levels in the blood or brain. Some individuals may find the feelings of relaxation, euphoria, and/or analgesic effects of beta-endorphin particularly rewarding and be more likely to tan repeatedly in order to continue to achieve these feelings (Heckman, 2011). If an individual tans frequently, his/her body may compensate for the effects of tanning, thus producing symptoms of tolerance and withdrawal, which may make discontinuing tanning aversive (Heckman, 2011).

There is biological evidence for this proposed mechanism involving beta-endorphin production during UV exposure. Expression of beta-endorphin in the epidermis of mice and human skin cells has been found to be induced by UV exposure (Wintzen et al., 2001). Human keratinocyte skin cell cultures produce proopiomelanocortin (POMC), β -lipotropic hormone, and beta-endorphin, with significant increases subsequent to UV exposure (Wintzen & Gilchrest, 1996). POMC plays a role in the regulation of skin pigmentation, stress, sleep, and energy homeostasis. One study found that keratinocytes express a μ -opiate receptor and down-regulate it in the presence of beta-endorphin or the opioid antagonist naloxone (Bigliardi et al., 1998). 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 reported, other studies have failed to confirm these findings. 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 beta-endorphin levels after UV exposure (Kaur et al., 2006).

There is also clinical evidence for tanning dependence. In a small single-blinded study, frequent tanners almost always chose to tan in a UV-light-emitting rather than a non-UV bed, reporting relaxation and lowered tension as reasons for their choice (Feldman et al., 2004). In a follow-up study, opioid blockade by the opioid antagonist naltrexone was shown to reduce this preference for the UV bed among indoor tanners and, at higher doses, induce withdrawal-like symptoms such as nausea, fatigue, and poor concentration (Kaur et al., 2006). Finally, in a small study of patients with fibromyalgia, participants reported a greater short-term decrease in pain after exposure to UV compared to non-UV exposure (Taylor et al., 2009).

Recently Lim and colleagues stated that "the addictive nature of indoor tanning is well-established" (Lim et al., 2011). However, our knowledge of tanning dependence is still in its infancy, and there is great potential for development in the field that could be modeled after traditional substance use research. This research could include 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 (Harrington et al., 2011).

In addition to tanning dependence, alternative conceptualizations could classify frequent tanning as a disorder of body image, anxiety, mood, or impulse control (e.g., pathological gambling disorder) given its association with these problems (Heckman, 2011). Serotonin may represent another potential physiologic mechanism underlying tanning dependence, but it has not been well-established in the literature (Heckman, 2011). However, it is unclear whether the association between tanning/tanning dependence and related psychiatric problems is correlative or causative.

5.3 Psychosocial interventions to reduce indoor tanning

Most of the interventions that have been successful in changing indoor tanning behavior have focused on appearance issues as at least one component of the intervention (Dodd & Forshaw, 2010). One intervention that has been found to be successful is the "Appearance Booklet" by Hillhouse and colleagues. This booklet focuses on normative influences such as recent fashion trends toward natural skin tones, and also includes material about the

history of tanning, UV radiation and its contribution to skin cancer and photo-aging, harm-reduction strategies to reduce or stop indoor tanning including use of sunless tanners, and appearance-enhancing alternatives to tanning including exercise, apparel, and sunless tanning products (Hillhouse & Turrisi, 2002). A randomized controlled trial of college female indoor tanners showed the intervention to reduce indoor tanning by half at two-month follow up (Hillhouse & Turrisi, 2002). A second study with a larger sample and using more objective outcome measures by the same group found that the intervention reduced indoor tanning relative to no treatment controls by over 35% at nine-month follow up (Hillhouse et al., 2008). Additional analyses found that the intervention was most effective for high frequency or low-knowledge tanners (Abar et al., 2010; Stapleton et al., 2010).

A second successful intervention focusing on appearance issues is showing participants UV-filtered photos illustrating current damage to facial skin in combination with information about UV exposure, focusing on appearance consequences. Two randomized controlled studies of college students found significant reductions in indoor tanning behavior at four-week follow up (Gibbons et al., 2005).

Another intervention to reduce indoor tanning used 30-minutes of a combination of motivational interviewing (MI) counseling, cognitive behavioral training, and written personalized feedback provided by undergraduate peers. Female undergraduate indoor tanners were randomized into an MI plus feedback, mailed feedback, or a no treatment control group. Participants in the MI group reported significantly fewer indoor tanning episodes at the three-month follow-up than both of the other groups (Turrisi et al., 2008).

Finally, two studies focusing on skin cancer risk and mortality demonstrated some success. Green and Brinn (Greene & Brinn, 2003) found that participants in both a statistical information about skin cancer condition and a personal narrative skin cancer case study condition reduced their indoor tanning at six months. Another study using the Mortality Salience approach also demonstrated reduced interest in indoor tanning (Routledge, Arndt, & Goldenberg, 2004). In this study mortality salience was increased by having participants answer questions intended to increase thoughts about death. Participants in the mortality salience condition reported less interest in indoor tanning compared to controls.

The literature on interventions to reduce indoor tanning is growing, and more rigorous research including more longitudinal trials is needed. Interventions for frequent tanners and tanning dependent individuals will likely need to be more intensive and focus on additional emotional and addiction issues beyond appearance and skin cancer risk.

6. Policies and regulations

Another similarity between tanning and other addictions is that policy level interventions have been particularly effective in reducing tobacco use and limiting youth access to tobacco products, and therefore, may be useful strategies for effective reduction of indoor tanning. The two industries use four primary marketing strategies: “mitigating health concerns, appealing to a sense of social acceptance, emphasizing psychotropic effects, and targeting specific population segments” (Greenman & Jones, 2010). UV definitively increases skin cancer risk; however, there are other issues related to indoor tanning that may contribute to even greater levels of risk: many children and adolescents tan, leading to high levels of lifetime UV exposure; very fair-skinned individuals at high risk for burning are often permitted to tan; salon proprietors

sometimes do not know what type or how much UV is emitted from their devices; many tanning devices are not monitored; and/or UV-related regulations are not enforced.

6.1 US state regulations

All US states except Louisiana require parental consent for medical UV treatments for minors (Dellavalle, Parker et al., 2003; Dellavalle, Schilling et al., 2003; National Conference of State Legislatures, 2010). Currently, at least 32 US states regulate cosmetic tanning by children, nine states ban access to children under age 14, and two states ban access to children under 16 or 16.5 (Elwood & Gallagher, 2010). In states in which cosmetic indoor tanning is permitted for minors, several require parental consent. States with regulations related to cosmetic indoor tanning among minors have maintained adolescent indoor tanning levels, while states without these regulations have experienced increases over time.

One reason for the limited success of efforts to reduce indoor tanning may be that tanning regulations are not enforced. In 2007, less than 50% of the cities in each state gave citations for indoor tanning facility violations, 32% did not perform inspections and 32% did not perform yearly inspections (Mayer et al., 2008). Even in the states that have clear regulations for tanning bed sanitation, these regulations are rarely enforced. The New York State Department of Health 2008 regulations state that all salons are required to provide “adequate antimicrobial treatment by a disinfectant determined to be capable of destroying pathogenic organisms on treated surfaces” (Russak & Rigel, 2010). However, in a recent study of tanning salons in Manhattan, microbes that have been associated with serious skin infections were found in all ten salons (Russak & Rigel, 2010). Other studies have found human papillomavirus, the virus responsible for warts as well as cervical and other cancers (Russak & Rigel, 2010).

In 2004, the American Association of Dermatology (AAD), the American Society of Photobiology, and the FDA agreed the highest priority with regard to indoor tanning was restricting access of minors from indoor tanning facilities (Lim et al., 2004). In a study investigating the barriers to banning indoor tanning among minors, Obayan and colleagues (Obayan et al., 2010) conducted in-depth surveys with anti-tanning advocates in 10 states and legislators in 5 states (a 60% response rate). Advocates reported that the major barriers to legislation were strong lobbying from the tanning industry, proceedings after the bill was filed, and obtaining support from other organizations. For legislators, the biggest barrier was raising awareness of the health effects of indoor tanning among their colleagues (Obayan et al., 2010).

6.2 US federal regulations

The US Food and Drug Administration (USFDA) is responsible for insuring the safety and efficacy of medical devices, cosmetics, and products that emit radiation. Cosmetic tanning units are not considered medical devices; thus, the FDA is limited to regulating their emissions. However, the FDA does not regulate the relative proportion of UVA versus UVB that is emitted (Hornung et al., 2003). Thus, the proportions vary from bed to bed and salon to salon, and patrons may be burned when switching to a new tanning bed or salon. There are FDA-mandated requirements for tanning device specifications, posting of warning labels, and provision of appropriate eye protection (US Department of Health and Human Services-Food and Drug Administration, 1985; US Department of Health and Human Services, 1986). However, most of the FDA’s regulation of tanning beds is based on tanning equipment manufacturer product reports, periodic inspections of manufacturers, and infrequent FDA inspections of tanning salons.

The FDA recommends that UV exposure should be restricted to “no more than 0.75 minimal erythemal dose (MED), three times during the first week” of exposure, gradually increasing the exposure thereafter (United States Department of Health and Human Services, 1988; United States Department of Health and Human Services, 1986). Numerous studies conducted throughout the USA have found widespread noncompliance with these FDA recommendations (Fairchild & Gemson, 1992; Hornung et al., 2003; Kwon et al., 2002; Pichon et al., 2009). Many beds have been found to emit 2-4 times the UV radiation as the summer sun at noon (Hornung et al., 2003). In a study of tanning facilities in 116 large US cities, confederates were granted permission to tan daily by a significant proportion of staff (Pichon et al., 2009). This same study found that living in a state with youth-access laws had no relationship to indoor tanning behavior among minors, suggesting that enforcement is inadequate (Mayer et al., 2011). Over a third of indoor tanning injury reports filed with the FDA and Consumer Product Safety Commission occur during episodes of non-compliance with FDA recommendations (Dowdy, Sayre, & Shepherd, 2009).

In 2007 the FDA Tanning Accountability and Notification (TAN) Act (HR 4767) was signed (US Food and Drug Administration, 2009). This amendment requires that the FDA conduct consumer testing of the warning statements on tanning devices to determine whether they provide adequate information about the risks of indoor tanning (US Food and Drug Administration, 2007). The Federal Trade Commission (FTC) regulates US advertising and prohibits false and deceptive statements. After a campaign by the AAD, the FTC charged the tanning industry with making false health and safety claims about indoor tanning (FTC, 2010). On January 26, 2010, the Indoor Tanning Association agreed to a settlement (FTC, 2010). In the future, ads that make claims about the health and safety benefits of tanning devices including vitamin D production are required to clearly and prominently make this disclosure: “**NOTICE:** You do not need to become tan for your skin to make vitamin D. Exposure to ultraviolet radiation may increase the likelihood of developing skin cancer and can cause serious eye injury” (Poole, 2010). Again, enforcement has been problematic. For example, during the spring of 2010, of all the tanning facilities in New York City, more than one-third of the tanning devices observed in half of the facilities visited did not have health risk warning signs posted, and signs were difficult to see in many others (Brouse, Basch, & Neugut, 2011). On March 23, 2010, the US President Barrack Obama signed into law the Patient Protection and Affordable Care Act, which includes a 10% federal tax on indoor tanning services (Cable News Network, 2010). This tax may be a particularly effective deterrent for adolescents, who are more affected by smaller market fluctuations than adults. Also, at a specially-convened task force meeting on March 25, 2010, an FDA panel unanimously recommended reclassifying tanning beds from class I to class II devices (US Food and Drug Administration, 2010). Class I denotes minimal potential for harm such as tongue depressors, bedpans, and elastic bandages (Lim et al., 2011). Tanning devices are currently exempt from design controls and premarket notification to demonstrate safety and efficacy. Class II devices include X-ray machines, wheelchairs, UV and laser devices for dermatologic procedures, and even tampons. The proposed reclassification of tanning beds would mean that they would require additional labeling, inspections, calibration, and monitoring (Lim et al., 2011). The panel also recommended increased restrictions on the use of tanning beds for minors. At the time of publication of this book, it remains to be seen what position the FDA will ultimately take and what effect this may have on the use of tanning beds in the USA.

6.3 Regulations outside of the US

As in the US, regulation of indoor tanning has been increasing around the world. Consistent with the WHO recommendations (World Health Organization, 2005), the following countries have now banned indoor tanning among minors: France, Scotland (Elwood & Gallagher, 2010), Austria, Finland, Germany, and Great Britain (Fisher & James, 2010). Some Canadian Provinces have prohibited indoor tanning among minors as well (Salomone et al., 2009). In 2009, a law was passed in Brazil banning all cosmetic tanning (Teich, August 2009).

While some countries have developed specific rules for sunbed installation, operation, and use, there is no standardized regulation across the European Union. Unfortunately, in the Netherlands and parts of Canada and the UK, such recommendations have been developed with the indoor tanning industry itself (Autier, 2004, 2005). Sunbed users across a number of countries report that they receive little to no instruction on avoiding sunburns or how to protect their eyes using goggles (Boldeman et al., 2003; Dissel et al., 2009; Schneider et al., 2009; Szepietowski et al., 2002).

A study of the majority of tanning salons in Ireland in 2007 obtained several interesting results (Gavin et al., 2010). The UV type in machines was unknown by staff in 71% of the salons, while 16% reported using type 4 high-dose UV devices; 36% of premises did not service sunbeds regularly, or staff were unsure of the service schedule (Gavin et al., 2010). Unsupervised sunbed use was reported in 9% of salons (Gavin et al., 2010). Eye protection was available in 98% of salons, but 35% charged for the service, and only 80% sanitized goggles between uses (Gavin et al., 2010). The 16% of the sample who were members of the Sunbed Association were more likely to keep maintenance records and operating manuals but were also more likely to provide a home sunbed service (Gavin et al., 2010).

In 2008, 78 tanning facilities throughout Norway containing municipalities with and without local salon inspections were assessed (Nilsen et al., 2011). Ninety percent of the tanning facilities were unattended by staff. Irradiances varied among solaria: UVB and UVA irradiances were 0.5-3.7 and 3-26 times, respectively, higher than those of the Oslo summer sun (Nilsen et al., 2011). Solaria in municipalities with local inspections were more compliant with regulations than solaria in other areas; however, irradiances were also significantly higher in municipalities with inspections.

Australia's voluntary indoor tanning code prohibits tanning by minors and individuals with type 1 (very fair) skin. However, one study found that 90% of salons permitted tanning by adults with type 1 skin, 75% reassured patrons about the benefits of indoor tanning, more than 50% permitted 16-year-olds to tan, and 14% offered inadequate or no eye protection (Dobbinson et al., 2008). Of 20 solaria examined in detail by an Australian radiation safety agency, only one had emissions of intensity less than UV Index 12, typical of mid-latitude summer sunlight, 15 units emitted more than UV Index 20, while three units emitted at intensities above UV Index 36 (Gies et al., 2010). UVA emissions were found to be as high as more than six times the UVA content of mid-latitude summer sunshine.

Numerous state, federal, and international regulations focus on age restrictions, parental consent requirements, UV radiation exposure amount and frequency, warning labeling on the devices, and taxation. Although the tanning industry is becoming increasingly regulated, the lack of enforcement and poor communication between the salons and their patrons regarding the recommended use of sunbeds has been documented widely.

7. Conclusion

Indoor tanning is common in the Western world and may still be gaining popularity in some countries. Indoor tanning is now known to be a definitive risk factor for skin cancers. Several studies have demonstrated a dose response relationship between indoor tanning and skin cancer. Like tobacco, indoor tanning has been marketed aggressively and appeals to adolescents and young adults, putting these populations at risk for high levels of long-term exposure to UV radiation. Appearance enhancement is the primary motivation for indoor tanning, particularly among young Caucasian women. However, there are several other compelling reasons cited for the behavior, including tanning dependence, which may also lead to high levels of lifetime UV exposures. Behavioral interventions have been little-studied and have not demonstrated strong and durable effects. Recent regulations around the world have been shown to have some effect on indoor tanning rates; however, increased regulation and stronger enforcement are needed. As new regulations are enacted, additional longitudinal and population-based research will be necessary to track indoor tanning patterns, enforcement of regulations, and skin cancer incidence around the world.

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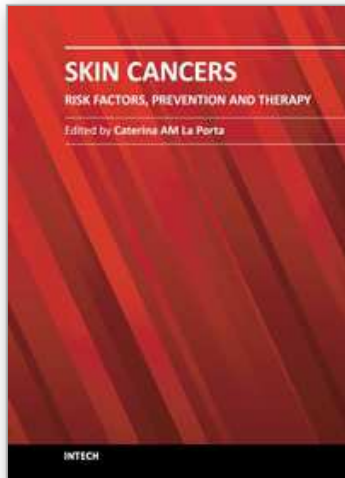
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Skin cancers are the fastest growing type of cancer in the United States and represent the most commonly diagnosed malignancy, surpassing lung, breast, colorectal and prostate cancer. In Europe, the British Isles have been the highest rates of skin cancer in children and adolescents. The overall idea of this book is to provide the reader with up to date information on the possible tools to use for prevention, diagnosis and treatment of skin cancer. Three main issues are discussed: risk factors, new diagnostic tools for prevention and strategies for prevention and treatment of skin cancer using natural compounds or nano-particle drug delivery and photodynamic therapy.

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Phone: +86-21-62489820
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