Abstract
Cutaneous malignant melanoma has increased more than threefold in the last 35 years. Because damage is cumulative, exposure to ultraviolet radiation early in life elevates a risk which is increased further as individuals use artificial sources of ultraviolet radiation. The full impact and scope of damage caused by year-round indoor tanning may take years to appreciate given the long latency period for most skin cancers. Teenagers are frequent visitors to tanning parlors, with girls being more frequent and sustained users. The tanning industry disputes the World Health Organization’s and the International Agency for Research on Cancer’s classification of their product as a Class 1 physical carcinogen. Tanning parlors have sought to establish and maintain a client-base among teenagers. Consequently, the Canadian Paediatric Society is joining other prominent health organizations in support of a ban on the use of commercial tanning facilities by Canadian children and youth under the age of 18 years.

Key Words: Artificial tanning; Children; Melanoma; Skin cancer; Sun; Tanning industry; Teenagers; Ultraviolet radiation; Vitamin D

Ultraviolet radiation and cancer
Ultraviolet radiation (UVR) has a wavelength longer than x-rays but shorter than visible light and constitutes an invisible form of electromagnetic radiation [1]. UVR can be further divided into three categories with separate wavelength ranges: UVA (315 to 400 nm), UVB (280 to 315 nm) and UVC (100 to 280 nm) [1]. Both UVA and UVB contribute to darkening of the skin by stimulating the synthesis of melanin molecules in the skin. UVA is responsible for immediate pigment darkening upon exposure [1]. UVB is responsible for the further darkening of the skin in days following exposure, signalling activation of skin melanocytes [1]. Erythema and sunburn are acute reactions to an excessive amount of UVR [2]. UVA, like UVB radiation, damages DNA and induces discrete mutations. Moreover, UV radiation may be carcinogenic without causing sunburn [3]. While the precise roles of specific UV wavelengths in both melanin production and carcinogenesis are still to be fully elucidated, DNA damage appears to be the key intermediary for both. Tanning induced by UVR that is devoid of carcinogenic risk may be scientifically impossible [4].

Individuals with light skin colour, freckles, skin moles and easy-to-burn skin that tans poorly are at an increased risk of cutaneous malignant melanoma (CMM) compared to individuals without these characteristics.[5][6] Risk of developing CMM is also increased for people who have had a first-degree relative with CMM or a personal history of CMM, as well as for those having a large number of typical or atypical moles (high nevus count).[7] Red or blonde hair color may be more strongly associated with CMM risk than skin type.[8] Moreover, exposure to UVR has been shown to contribute to immunosuppression, which is increasingly recognized as an important factor in the development of skin cancer.[9][10]

CMM is not the most common type of skin cancer but accounts for most Canadian skin cancer deaths (in the
order of 75%) \cite{11}. Although substantial advances have been made in CMM therapies, metastatic disease has fewer successful treatment options \cite{17}. In Canada, the estimated incidence of CMM was 15.2 per 100,000 in 2009 \cite{11}. The Canadian incidence rates of CMM have increased more than threefold over the last 35 years \cite{11,12}.

This increase may be associated with better disease detection as well as with increased sun-seeking behaviour without adequate UVR protection, a decrease in the earth’s protective ozone layer, changing patterns of dress that favour more skin exposure, and more opportunities for leisure activities and vacations in sunny areas \cite{7,11}. However, the increased proliferation and popularity of tanning beds is also cited for the increased incidence of CMM and related mortality \cite{9,13}. The possibility that changes in diagnostic criteria may be contributing to increased incidence more than exposure to artificial UVR is lessened by the fact that the trend is specific to a certain age range and sex \cite{4}.

**Artificial tanning use and its relation to cancer**

In North American surveys, the prevalence of the use of artificial tanning has been estimated to be between 4% and 27%, while the prevalence of suntanning outdoors was reported as being between 4% and 49% \cite{15,16}. Of the one million people who use tanning salons every day in the United States \cite{17}, 70% are females between the ages of 16 and 49 \cite{18}.

Population estimates based on survey data suggest up to one-quarter of individuals between 13 and 19 years old have used tanning salons \cite{19,20}, and some studies, depending on the age and gender, report the use of facilities in the preceding year alone as ranging from 8.6% to 25.4% \cite{21-23}. The frequency of visits in any given year can range from one session to more than 10 \cite{20}. Girls are up to seven times more likely to have used artificial tanning devices than boys \cite{15,23,24}. Moreover, tanning bed use among young girls appears to change as a function of age, more than doubling at age 14 to 15 years (7% to 15%) and doubling yet again at age 17 years (to 35%) \cite{24}.

The use of tanning facilities has not been consistently correlated to knowledge of associated risks. Even having a risk factor for skin cancer does not uniformly decrease use \cite{25-27}. Nor is indoor tanning linked to socioeconomic status \cite{26,28}. However, more ‘extreme’ risk taking \cite{19,20}, poorer self-esteem \cite{29} and unhealthy lifestyle choices \cite{30-32} are associated with indoor tanning. In individuals who are physically active, UVR exposure is more often reported among solitary fitness pursuits (aerobics, gymnastics, weightlifting and condition training) than for team and contact sports \cite{26}.

Finally, whether a teenager engages in indoor tanning is closely associated with a parent also using such facilities, and this is especially true for mothers and daughters \cite{33}.

A link has been demonstrated between having ever tanned indoors and an increased risk for developing CMM \cite{34-36}. Study findings suggest the timing of exposure may also be important. Early life exposure has been associated with higher risks of CMM \cite{8,36,37}, as have the number of years of tanning and hours in tanning sessions \cite{35,38}. Individuals who begin indoor tanning before age 35 demonstrate a 75% increased risk for developing CMM \cite{34}. The full impact and scope of damage caused by current year-round indoor tanning trends may take years to appreciate because of the long latency period for most skin cancers. A meta-analysis of the evidence prompted the World Health Organization (WHO) to add tanning beds to the list of Class 1 “physical carcinogens,” alongside “chemical carcinogens” such as cigarettes and asbestos \cite{39}, two other exposures associated with a potentially long time lag before disease onset.

CMM, while the most deadly, is not the only skin cancer linked to UVR exposure. Basal cell carcinomas (BCC) and squamous cell carcinomas (SCC), classified as non-melanocytic skin cancer (NMSC), account for an estimated Canadian incidence of 227.6 per 100,000 skin cancer cases in 2009 \cite{11}. Despite their high incidence, most of these lesions can be successfully treated at an early stage; however, metastasis persistently occurs in a small minority of such lesions, at which point cure is rare. Although the overall rate of death from SCC is low, the high incidence of this form of cancer means that it accounts for up to 25% of skin cancer-related deaths \cite{11}. The International Agency for Research on Cancer (IARC) reported a 2.5 times greater risk for SCC and a 1.5 times increased risk for BCC associated with the use of tanning beds \cite{38}. Early life UVR exposure increases the risk of BCC, whereas chronic or total exposure is associated with increased risk for SCC \cite{8,38}.
Other systemic and behavioral effects of UVR exposure

In addition to the perception of a seemingly improved appearance [40], individuals who seek to tan report a feeling of relaxation and a sense of well-being as reasons for seeking UVR exposure [28][41]. Repeated UVR exposures, and the use of indoor tanning beds specifically, may have important systemic and behavioural consequences, including mood changes, compulsive disorders, pain and physical dependency [26][42]. Indoor tanners report mood enhancement, relaxation and socialization consistent with reinforcement patterns observed in smoking addiction [42]. Frequent tanners appear to be able to distinguish between UV-radiating and faux devices, and the administration of an opiate-receptor blocker has induced withdrawal-like symptoms among frequent tanners, suggesting an opiate-like addiction [43]. Studies of youthful tanning bed users also have demonstrated the addictive features of indoor tanning [44]. A biologic explanation may be that melanin stimulating hormone (MSH) production in the UV-tanning response is accompanied by the release of B-endorphin, which shares the same precursor peptide (propriomelanocortin) [45]. While not yet formally recognized as a psychiatric disorder, a condition known as “tanorexia”—becoming obsessed with, even addicted to tanning, and believing oneself to be unattractively pale even when quite tanned—has been described, and appears as a formal entry in the current Oxford dictionary [46].

Up to one-quarter of sunbed users report one or more adverse health effects other than skin cancer. Erythema and sunburn are the most common artificial UVR-exposure complications [14][47]. Also reported are more serious burn and other injuries, as well various potential infections [48][50]. Other frequent side effects include skin dryness, pruritus, nausea, photodrug reactions (including popular acne medications used by teens), disease exacerbation and disease induction [7]. Long-term health effects include skin-aging and effects on the eyes similar to that arising from natural UVR exposure [7].

Vitamin D and indoor tanning

Relying on UVR as a source of vitamin D has been challenged because of the substantial overlap of DNA damage from such exposure and the production of vitamin D [51][52]. Moreover, exposure to UVR is complicated by the quantity of skin exposed, the darkness or pigmentation of that skin, the wavelength or energy of the source (which varies with the time of year and latitude), and the degree of one’s vitamin D deficiency [4]. Artificial UVR exposure further compounds matters with the mix, intensity and variability of UVA and UVB generated by tanning bed emitters [53], and is neither a reliable or advisable source of vitamin D [54].

Humans can acquire vitamin D from dietary sources and vitamin supplements [8][55]. While it may be challenging to consume sufficient vitamin D in typical North American diets, oral supplements and intermittent testing of blood levels are probably more effective than tanning, without incurring a carcinogenic risk [8]. Given the reported increased prevalence of hypovitaminosis D [56] and recent changes in recommended intake [57], renewed attention must be paid to the adequacy of vitamin D intake and to promoting dietary and supplemental routes [7].

Current Canadian guidelines include a recommendation for increasing the current daily intake of vitamin D [58]. The Institute of Medicine (IOM) also has completed an exhaustive review of vitamin D benefits and requirements [57]. The IOM reports that, at present, conclusive evidence of vitamin D benefit exists only for bone health; however much other aspects of health may benefit, they require further study [59]. Avenues of research include the relationship of vitamin D concentrations to risks of cancer, heart disease, multiple sclerosis and glucose dysregulation [7], as well as how vitamin D concentrations in the prenatal period or in childhood may influence the risk of type 1 diabetes mellitus [60][61].

The industry

Tanning industry growth was modest in the 1960s [37][62], and it was not until the late 1980s that a rapid expansion in the number of facilities began, to a point where tanning salons now outnumber fast food restaurants in some American inner-city neighbourhoods [63]. The public primarily tan indoors at solaria/tanning salons (72.3%), but fitness studios (15%), recreation centres (15%) and saunas/spas (7.7%) are also sources of artificial UVR [64]. Fewer individuals use a sunbed at home (2.4%). A quarter of respondents in one study reported that the indoor tanning experience was unsupervised [30]. Currently, the indoor tanning business is estimated to represent a
$5 billion per year enterprise in North America [65], employing as many as 160,000 people [66].

When artificial UVR was introduced commercially, tanning devices emitted a UVA and UVB ratio similar to that of the sun (up to 5% UVB) [62]. Due to increasing concerns in the 1980s and 1990s over UVB carcinogenicity, predominately high UVA-emitting UVR bulbs were developed and promoted as being lower risk, even though these devices still emitted small amounts of UVB [62][67]. Because UVB is responsible for causing sunburn [1][5], the reduction of emitted UVB allowed tanning bed users to tan much longer without getting sunburned, thus increasing the odds of receiving a larger dose of UVA compared to outdoor sunbathing [67]. In the late 1990s, the trend in artificial tanning reverted again toward using devices which emitted a more ‘natural’ spectrum of UVR, thus increasing the emitted UVB ratio up to 4% [62].

Recently, in order to achieve more efficient tanning in shorter sessions, high-intensity UVA-emitting lamps have been introduced [62][67]. These high-intensity sunbeds are capable of emitting up to 10 to 15 times more UVA compared to midday sunlight [67].

At a time when health issues surrounding the use of artificial UVR are mounting [4][7][13], the industry’s reaction and recent behaviors have been reminiscent of the tobacco industry [68][69]. The tanning business is seeking to establish and maintain a client-base among teenagers. Tactics include championing teen access to tanning salons, challenging the authority of opinion- or policy-makers to deny parents the ‘right’ to permit their teen’s tanning activities [70][71], placing advertisements in high school newspapers, providing coupons for discounts, and offering unlimited tanning deals [72][74]. Their marketing and lobbying practices have served to obscure or even deny the hazards and potential carcinogenicity of tanning beds. However, industry efforts to frame artificial UVR as a product associated with health and fitness [75][77] have not gone unchallenged [78]. In Canada, industry representations generated a complaint by the Canadian Cancer Society to the Competition Bureau in 2005. The subsequent consent agreement with the largest chain of tanning salons in the country stipulated that they must:

• “stop making representations to the public linking indoor tanning with the unproven benefits of vitamin D”;

• acknowledge in any promotion of artificial UVR that: “Tanning is not required to generate vitamin D. Vitamin D levels in the body may be maintained by oral supplements without tanning”;

• “pay an administrative monetary penalty of $62,500” [78].

Legal action, based on damage to health, is at a formative stage in the United States [79].

Regulation

Technical regulations around artificial tanning devices usually are confined to equipment specifications at the point of purchase and non-binding guidelines on operation by the purchaser [80][81]. Currently there are no enforceable limits to the amount of artificial UVR exposure available year-round to the public through indoor tanning [82], and indoor tanners can even tan at various locations on the same day [83].

The International Commission on Non-ionizing Radiation Protection, the Centers for Disease Control, the National Institutes of Health, the US Federal Trade Commission, the US Food and Drug Administration (FDA) and Health Canada have all provided consumer health and safety alerts. The FDA Center for Devices and Radiological Health is establishing more stringent regulations for personnel training, education and operation of tanning equipment, while Health Canada is revising its guidelines for operators to increase their recommended age restriction from 16 to 18 years.

Legislation

The WHO, the International Agency for Research on Cancer, the American Medical Association, the American Academy of Pediatrics, the Canadian Medical Association, the American Academy of Dermatology, and the Canadian Dermatology Association all support legislation that would prohibit the use of artificial tanning devices by people younger than 18 years of age.

In Canada, children and youth under 18 years of age are banned from commercial indoor tanning facilities only in Nova Scotia and on southern Vancouver Island. To date, in the US, only Howard County, Maryland has legislated such a restriction. Most American states have weaker parental consent exemption clauses, which in their turn are shown to be largely
unsuccessful in controlling underage tanning [84] or in lowering age limits [85]. Internationally, England, Scotland and Wales, Finland, France, Germany, as well as parts of Australia have the WHO ban in place. Meaningful enforcement of regulations must accompany legislation or underage artificial UVR exposures will continue to occur [86] [67].

A tanning tax of 10% has been implemented for facilities in the US. Taxation may help to decrease cancer incidence, to lower skin cancer-related health care costs, and to reduce skin cancer suffering, morbidity and mortality, as well as sending a cautionary message to consumers who engage in a hazardous and potentially habit-forming pastime [88] [89].

Skin cancer prevention is very much a paediatric issue. Young people receive much of their lifetime UVR exposure during childhood and adolescence [90]; it is all the more imperative that they avoid the additional burden of artificial UVR exposure. Until there is a shift in social norms and practices around ‘ideal’ beauty and what constitutes a healthy appearance, action must be taken to protect children and adolescents from an established carcinogen. Regulation of the tanning industry may offer one of the more profound cancer-prevention opportunities of our time [81].

**Recommendations**

To protect children and adolescents from skin cancer and other risks posed by indoor tanning, the Canadian Paediatric Society recommends the following:

- Children and youth under the age of 18 years should be prohibited by law from using commercial indoor tanning facilities.

- Governments should enact tanning industry regulations and ensure that such legislation is enforced. Regulatory actions are to be preceded and/or accompanied by public education campaigns to raise awareness concerning the dangers of exposure to artificial sources of UVR. These campaigns need to include messages from authoritative groups such as health care professionals and educators and to target children, adolescents and parents. Involving young opinion-leaders as well as celebrities and sports figures would bolster such campaigns.

- The tanning industry should be required to acknowledge their product is carcinogenic and to advise the public that artificial tanning has no health benefit. Also, they should not be allowed to promote ‘pre-vacation’ or pre-event (eg, ‘prom’) tanning.

- A tax should be imposed on all commercial tanning bed operations and harmonized with levies on tobacco.

- All unsupervised commercial tanning bed operations and the use of coin-operated machines should be banned.

- Paediatricians, family physicians and other health care providers should screen for the use of artificial tanning activities by children and adolescents and provide anticipatory guidance to families to discourage this practice. Health care professionals should advocate that individuals under the age of 18 years be banned from commercial tanning facilities.

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**Liason:** Mark Norris MD, CPS Adolescent Health Section

**Principal authors:** Danielle Taddeo MD; Richard Stanwick MD

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