Living a "shady life": sun-protective behaviour for Canadians

Education

Éducation

John E. Adam, MHA, MD

Dr. John Adam was Chair of the Sunscreen Product Education Program (1995–1998) and is currently Chair of the Sun Protection Clothing Program (1997–1999), Canadian Dermatology Association. He is also Professor of Medicine (Dermatology) at the University of Ottawa, Ottawa, Ont.

This article has been peer reviewed.

CMAJ 1999;160:1471-4

For many years there has been increasing awareness of the deleterious effects of sun exposure on the skin. Dermatoheliosis or photo-damage is most prevalent in people over 40 years of age who have had a lot of sun exposure over their lifetime.

Epidemiologic studies have identified sunlight exposure as a major risk factor for skin cancer.[1,2] Nonmelanocytic skin cancers — basal and squamous cell carcinomas — are the most common forms diagnosed in Canada.[3] The incidence of malignant melanoma rose during the 1970s and early 1980s, but since the mid 1980s the incidence and mortality rates have tended to level off.[4]

A person's risk of sun-induced skin damage and probably skin cancer increases with his or her level of total cumulative exposure to the sun and number of sunburns. More frequent sunburns increase risk. Early childhood and adolescent sun exposure appears to be a major predictor of basal cell carcinoma.[5] Intermittent exposure may be worse than continuous exposure.[6] People with fair skin, such as those with Scandinavian ancestry, are more prone to sun damage than people with darker skin. Risk increases with the number and type of moles.[7] There is a 12-fold increase in the risk of melanoma in patients with 10 or more dysplastic nevi,[8] and melanoma risk rises rapidly with increasing exposure to ultraviolet (UV) light in childhood.[8]

Although controversy exists regarding the role of sunlight in the development of skin cancer and the potential beneficial effects of sun avoidance techniques,[7,9] there is little doubt that exposure to sunlight is an important factor. Sun protection involves a combination of lifestyle changes and sun avoidance techniques. If these are continued over many years, the risks and consequences of excessive sun exposure will decrease. SCHEGS, an easily remembered mnemonic, can be used to encourage behaviour modification and promote lifestyle activities that will protect the skin against chronic sun damage.[10]

Ultraviolet radiation

Sunlight contains the entire UV spectrum, but only about 0.5% of sunlight reaching the earth is in the UVB spectrum and at least 5% is UVA (Table 1). The intensity of UV radiation varies according to time of day and season. Maximum penetration of the ozone layer by UVB is between 10 am and 2 pm. The thickness of the ozone layer in North America varies with the seasons — thickest in late winter and thinnest in late summer and early fall. Cloud cover and air pollution have a minimal filtering effect on UV radiation. UV radiation can penetrate 1 m of water. UV rays also reflect off water, snow, sand and pavement, magnifying their effects. Window glass filters out UVB radiation but allows UVA rays to pass through.

The depth of penetration of UV light into the skin is wavelength dependent. Although 90% or more of UVB photons are absorbed by the epidermis, 50% of UVA photons may penetrate to the basal layer of the epidermis or deeper. Thus, there are more potential targets for UVA photons.

UVB rays cause sunburn, photo-aging and skin carcinogenesis.[7] Experiments have shown that UVB induces atypical melanocytic lesions and melanoma in human skin.[11] Sunlight exposure, especially to UVB light, has also been implicated as a cause of cataract formation in all races and both sexes.[12] UVA radiation is more abundant, penetrates deeper into the skin and is thought to augment the damaging effects of UVB. Tanning beds commonly use UVA light and should be avoided.

UV light can induce mutations in the p53 tumour suppressor gene, which nor-

Doing the "SCHEGS"

The following components of sun-protective behaviour will help protect against sunburn and may reduce long-term damage to the skin from sun exposure

- **S** Sunscreen with an SPF of 15 or higher
- **C** Clothing that is sun protective (tightly woven and dark in colour)
- **H** Hats with a wide brim all around
- **EG** Eyeglasses that block both UVA and UVB light
- **S** Shade, especially between 10 am and 4 pm

mally allows cells with epidermal DNA that has been damaged by UV light to either repair the DNA or undergo apoptosis. Mutations of this gene are thought to play an important role in the development of nonmelanoma skin cancer and actinic keratosis. The use of sunscreens has been found to reduce these mutations in animal models.[13]

Both UVA and UVB radiation (the latter even at suberythemal doses) can induce immunosuppression,[7,14] although the role of UV-induced immunosuppression in the development of skin cancer requires further study.

Sunscreens

Sunscreens either reflect or absorb UV radiation. Physical formulations, which are opaque, reflect and scatter UV and visible light. Recent evidence suggests that some physical sunscreens such as those containing titanium dioxide or zinc oxide may also absorb some UV light.[15] Microfine titanium has also been shown to be absorbed by the skin,[16] which may have health implications. Chemical sunscreen formulations are not opaque; instead they contain agents that absorb UV radiation.[17] Some absorb only within the UVA or UVB spectrum, others absorb in both (Table 2).

Sun protective factor (SPF) is the standard means of expressing a sunscreen's effectiveness in protecting the skin. SPF is related to UVB radiation; there is no effective measure for UVA radiation. SPF is the ratio of the time required to produce minimal erythema through a sunscreen product to the time required to produce the same degree of erythema without the sunscreen. For example, if an unprotected person can stay in the sun for 15 minutes before experiencing erythema, a sunscreen with an SPF of 4 will extend this period by a factor of 4, i.e., to 60 minutes. An SPF 15 product filters out more than 93% of the UVB radiation in sunlight, allowing about 7% penetration; a sunscreen with an SPF of 30 filters out 97%. A product with an SPF of at least 15 should be used.

Substantivity is the ability of a sunscreen to bind to the skin and resist removal during swimming or sweating. "Water resistant" implies that a sunscreen's photoprotective effect remains after 40 minutes of active immersion in water; "waterproof" implies that the sunscreen can withstand 80 minutes of immersion. Newer products may be waterproof for up to 6 or 8 hours.

Sunscreens are tested under controlled conditions using volunteers and artificial sources of sunlight. The amount of sunscreen applied to the skin during these tests varies from country to country depending on local regulations.[7] It has been suggested that some people do not use a thick enough coating of sunscreen under real-life conditions and, therefore, may not be getting the amount of protection indicated by the SPF on the product label.[18] It is important to follow the manufacturer's application instructions to receive the full benefit.

Sunscreens are available as creams, gels, sprays and lotions. The choice depends on what feels comfortable to the individual. The product should be applied generously a short time before going outdoors to allow for absorption, and it may have to be reapplied after swimming or according to the manufacturer's recommendation. Many lip gloss sunblocks are also available.

Some people experience teary eyes if the sunscreen gets near their eyes or after sweating, when the sunscreen might run down from the forehead into the eyes. To avoid this problem, they should use a sweatproof sunscreen or try another brand. Using a lip gloss sunblock around the eyes and on the eyelid will usually prevent the sunscreen from running into the eyes.

Adverse skin reactions due to sunscreens are uncommon and are usually of the irritant type. Sunscreens can cause burning and stinging on open skin abrasions. Photoallergic reactions to some ingredients, such as oxybenzone and PABA (*p*-aminobenzoic acid), have been reported.[7] Parsol 1789 can also cause contact dermatitis and has been found to yield positive reactions on a skin patch test (personal observation).

Concern has arisen about the ability of sunscreens to block vitamin D metabolism. However, in one study,[19] a sunscreen with an SPF of 17 used over the course of one summer did not significantly alter serum vitamin D levels in middle-aged and elderly subjects. Whether this effect would be true at other latitudes is unknown. Although sunscreens do not block 100% of sunlight, we do not know how much sunlight is necessary to maintain appropriate vitamin D levels at different ages.

Sunscreens can prevent sunburn and reduce some of the damage of photo-aging.[7] They help prevent actinic ker-

Table 1: Ultraviolet (UV) light spectrum

Radiation band	Wavelength, nm	Absorption by ozone layer
UVA	320–400	None
UVB	290–320	Variable
UVC	200–290	Full

Table 2: Active ingredients commonly used in sunscreens

Chemical sunscreens

UVA absorbing

- Benzophenones (*p*-aminobenzoic acid [PABA], padimate 0, roxadimate, lisadimate)
- Anthranilate (menthylanthranilate)
- Dibenzoylmethone derivative (parsol 1789, arbenzone)
- Camphor derivatives (mexoryl Sx)

UVB absorbing

- Benzophenones (dioxybenzone, oxybenzone, sulisobenzone)
- Cinnamates (octocrylene, parsol MCX)
- Salicylates (homosalate, octylsalicylate, tralamine salicylate)
- Other (phenylbenzimidazole)

Physical sunscreens

- Red petrolatum
- Titanium dioxide
- Zinc oxide

atoses,[20] which are often precursors of squamous cell carcinoma.[7] Sunscreens have been shown to reduce the immunosuppressing effect of UV light, but they do not prevent it.[21]

Because there is a considerable latent period between sun exposure and sun-induced skin damage, the use of sun protection at the earliest possible age after infancy provides the best long-term protection. Although modest doses of UV light have been used to treat newborn jaundice, prolonged exposure to UV light in infancy is not recommended.

The Canadian Dermatology Association (CDA) has established a set of criteria for the labeling and advertising of sunscreen products. Products submitted to the CDA have been meticulously tested at independent laboratories to ensure that the manufacturer's SPF and durability claims are accurate. Testing for irritancy, allergenicity and comedogenicity are also required before the CDA recognizes the product and permits its logo and official statement — "the Canadian Dermatology Association recognizes that the regular use of this product will help protect against sunburn and may reduce long-term damage to the skin produced by sun exposure" — to be used on the product package. The CDA reviews and revises sunscreen products on an ongoing basis. Products that do not display the CDA logo and statement are not necessarily inferior or unsafe.

Sun-protective clothing

In recent years the CDA has received many requests from clothing manufacturers, UV sunglass manufacturers, window glass manufacturers and others to recognize their products as effective UV radiation blockers. However, controlled studies of the effects of these items are extremely difficult to carry out.

For example, a recent study showed that people who wear hats when exposed to sunlight had more squamous cell cancers of the head and neck than those who did not wear hats.[22] However, the authors did not identify the type of hats worn, what they were made of, the size of the brims, the effect of reflected light or how long the subjects had worn hats. In addition, a single factor, such as a hat, sunscreen or T-shirt, is only one part of the entire sun-protection equation.

The transmission of UV radiation through a fabric is measured using a spectrophotometer or spectroradiometer. Ultraviolet protection factor (UPF), rather than SPF, has been recommended as a measure of the sun-protective properties of fabrics. It is calculated using a formula based on UV transmission through the fabric and the erythema response for human skin. For example, if a fabric has a UPF of 20, then only 1/20 of the UV radiation reaching the surface of the fabric actually passes through it. In Australia and New Zealand, where much research in this area has been carried out,[23] the UPF system has been simplified by classifying clothing into 3 categories (Table 3).[24]

Table 3: Classification system for sun-protective fabrics

UPF range	Category of protection	UV radiation transmission, %
15–24	Good	6.7–4.2
25–39	Very good	4.1–2.6
≥ 40	Excellent	≤ 2.5

Note: UPF = ultraviolet protection factor.

Any fabric that is woven does not provide complete coverage, because the holes between the threads permit transmission of UV radiation. In an ideal fabric, the yarn is completely opaque to UV transmission and the spaces between the threads are small. If the fabric shrinks after washing, the holes will decrease and thus allow less UV penetration.[25,26] In addition, certain optical brighteners are UV absorbing agents and can be used to treat fabrics to decrease UV transmission. Dyes used to colour cloth may also absorb UV radiation. Darker shades such as black, blue and green increase the UPF value, whereas very light colours have little effect.

UPF is reduced when clothing is wet. Water is thought to reduce the scattering of UV radiation and thus increase its transmission.[25] Therefore, contrary to popular belief, wearing a cotton T-shirt, which has an average UPF of only 7 or 8, into the water does not provide good sun protection.

If clothing is tight fitting or stretched when worn, the holes between the threads increase in size and the UPF decreases. For example, Lycra has a very high UPF (about 50), but when worn it is stretched by about 15%. In an experiment in which various Lycra items were stretched 10% under wet conditions, the UPF of some dropped to as low as 5.[26]

A sun-protective lifestyle

Ensuring protection against the sun's harmful rays requires a lifestyle based on a number of behavioural factors. It should start in early childhood and must continue throughout life. Sun avoidance requires the wearing of hats, sunglasses, sunscreens and proper sun-protective clothing.[10] It should also include spending more time in the shade, especially between 10 am and 4 pm.

The conscientious use and appropriate application of a sunscreen that has an SPF of at least 15 and contains a UVA blocker will help protect against sunburn and may reduce long-term damage to the skin from sun exposure. A higher SPF gives better protection and should be used regularly on all exposed surfaces.

The ideal sun-protective garment is dark in colour, and has a tight weave and a UPF rating of 30 or more. Hats should have a wide brim, and sunglasses should be coated with UVA and UVB blockers.

As a useful public health policy, physicians should recommend that their patients live a "shady life" by "doing the SCHEGS."

Competing interests: None declared.

References

1. Rodenas JM, Delgado-Rodriguez M, Herranz MT, Tercedor J, Serrano S. Sun exposure, pigmentary traits and risk of cutaneous melanoma: a case–control study in a Mediterranean population. *Cancer Causes Control* 1996;7:275-83.
2. Armstrong BK, Kricker A. How much melanoma is caused by sun exposure? *Melanoma Res* 1993:3:395-401.
3. National Cancer Institute of Canada. *Canadian cancer statistics 1997.* Toronto: The Institute; 1997.
4. Gaudette LA, Ru-Nie Gao. Changing trends in melanoma incidence and mortality. *Health Rep* 1998;102(2):29-38.
5. Gallagher RP, Hill GB, Bajdik CD, Coldman AJ, Fincham S, McLean DI, et al. Sunlight exposure, pigmentation factors and risks of non-melanocytic skin cancer. II. Squamous cell carcinoma. *Arch Dermatol* 1995;131:164-9.
6. Kricker A, Armstrong BK, English DR, Heenan PJ. Does intermittent sun exposure cause basal cell carcinoma? A case–control study in western Australia. *Int J Cancer* 1995;60:489-94.
7. McLean DI, Gallagher R. Sunscreens: use and misuse. *Dermatol Clin* 1998; 16:219-26.
8. Tucker MA, Halpern A, Holly EA, Hartge P, Elder DE, Sagebiel RW, et al. Clinically recognized dysplastic nevi: a central risk factor for cutaneous melanoma. *JAMA* 1997;277:1439-44.
9. Finkel E. Sorting the hype from the facts in melanoma. *Lancet* 1995;351:1866.
10. Adam JE. Sun protective clothing. *J Cutan Med Surg* 1998;3:1-4.
11. Atillasoy ES, Seykora JT, Soballe PW, Elenitsas R, Nesbit M, Elder DE, et al. UVB induces atypical melanocytic lesions and melanoma in human skin. *Am J Pathol* 1998;152:1179-86.
12. West SK, Duncan DD, Munoz B, Rubin GS, Fried LP, Bandeen-Roche K, et al. Sunlight exposure and risk of lens opacity in a population-based study: the Salisbury Eye Evaluation Project. *JAMA* 1998;280:714-8.
13. Ananthaswamy HN, Loughlin SM, Cox P, Evans RL, Ullrich SE, Kripke ML. Sunlight and skin cancer: inhibition of p53 mutations in UV-irradiated mouse skin by sunscreens. *Nature Med* 1997;3(5):510-4.
14. Wallcer SI, Yorency AR. Sunscreens of the same UVB protection factors for inflammation and immunosuppression in the mouse. *J Invest Dermatol* 1997;108:133-8.
15. Gonzales E, Gonzales S. Drug photosensitivity, idiopathic photodermatoses and sunscreens. *J Am Acad Dermatol* 1996;35:871-85.
16. Tan MH, Commens CA, Burnett L, Snitch PJ. A pilot study on the percutaneous absorption of microfine titanium for sunscreens. *Australas J Dermatol* 1996;37:185-7.
17. Cornish P. Sunscreens. *Pharm Pract* 1994:2-7.
18. Bech-Thomason N, Wulf H. Sunbathers' application of sunscreens probably inadequate to obtain the sun protective factor assigned to the preparation. *Photodermatol Photoimmunol Photomed* 1992;9:242-4.
19. Marks R, Foley PA, Jolley D, Knight KR, Harrison J, Thompson SC. The effect of regular sunscreen use on vitamin D levels in an Australian population: results of a randomized controlled trial. *Arch Dermatol* 1995;131:415-21.
20. Thompson SC, Jolley D, Marks R. Reduction of solar keratosis by regular sunscreen use. *N Engl J Med* 1993;329:1147-51.
21. Mo KKL, Halliday GM, Barneston R. Sunscreens protect epidermal langerhans cells and Thy-1+ cells, but not local contact sensitization for the effects of ultraviolet light. *J Invest Dermatol* 1992;98:720-4.
22. Bajdik CD, Gallagher RP, Hill GB. Finchams sunlight exposure, hat use and squamous cell carcinoma on the head and neck. *J Cutan Med Surg* 1998;3(2): 68-73.
23. Curiskis J, Pailthrope M. Apparel textiles and sun protection. *Textile Magazine* 1996;4:13-7.
24. *New Australian/New Zealand standard: Sun protective clothing — evaluation and classification* [AS/NZS 4399:1996]. Homebush (AS): Standards Australia / Wellington (NZ): Standards New Zealand; 1996.
25. Stanford GS, Georgouras KE, Pailthorpe MT. Sun protection by a summer-weight garment: the effect of washing and wearing. *Med J Aust* 1995;162:422-5.
26. Moon R, Pailthorpe MT. Effect of stretch and wetting on elastone fabrics. *Aust Textiles* 1995;15(6):39-43.

Reprint requests to: *Dr. John E. Adam, 507–1081 Carling Ave., Ottawa ON K1Y 4G2*