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Photoaging and Sunscreen

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This review summarises the mechanisms of skin photoaging and the role of sunscreen as an adjunctive sun protection measure in the prevention of photoaging. Louise Reiche (Palmerston North, NZ) and Deshan Sebaratnam (Sydney, Australia) provide expert comment. This review is intended as an educational resource for health care professionals and is sponsored by Johnson and Johnson Pacific.

Ultraviolet radiation (UV) from the sun is a major risk factor for the development of skin cancers.[1] Photoaging of the skin, which is more prevalent than skin cancer, also results from high cumulative solar UV exposure.[2] Hence, both skin cancer and skin photoaging are largely preventable by people taking photoprotective measures.

Evidence is emerging that appearance-focussed messaging (i.e., prevention of skin photoaging), as opposed to health-focussed messaging (i.e. prevention of skin cancer), is effective in facilitating the adoption of sun protection behaviours, including increased use of sunscreen.[3,4]

Skin aging

There are two forms of skin aging: intrinsic and extrinsic aging.[2,5]

- **Intrinsic (or chronological) aging** is the natural aging process of the skin caused by physiological factors, including genetic, metabolic, hormonal, and nutritional influences.[5] The main biological features of naturally aged skin are atrophy of the dermis due to loss of collagen, degeneration in the elastic fibre network, skeletal remodelling and ptosis of the fat pads. Naturally aged skin is characterised by fine wrinkling, thinning, a propensity to dryness, and is generally smooth and unblemished.[2,5]
- **Extrinsic (or environmental) aging** is due mainly to exposure to UV radiation and atmospheric pollution.[5] An association between air pollution and skin aging is well established.[6,7] However, because exposure to UV radiation is the principal cause of extrinsic aging it is referred to as photoaging.[7] Photoaged skin is characterised by being, dry, leathery, and irregularly pigmented with coarse wrinkling due to the loss of skin elasticity.[2] A distinguishing biological feature of photoaging is solar elastosis.

A graphic example differentiating intrinsic and extrinsic ageing can be seen in this case study of a truck driver who drove a delivery truck for 28 years and was found to have a much greater degree of sun damage on his left side, where his face was exposed to the sun while driving.[8]

The process of skin aging is driven primarily by acute stress responses, including upregulation of extracellular matrix degrading enzymes and proinflammatory cytokines, and chronic damage responses, which are caused by the accumulation of macromolecular damage (e.g., mitochondrial DNA damage and oxidized proteins) in non-proliferating skin cells.[7]

An individual's susceptibility to photoaging is strongly influenced by the skin's endogenous protection mechanisms, including pigmentation, DNA repair, and antioxidant defence.[7]

Skin photoaging

Photoaging affects the three layers of the skin: the epidermis, dermis, and hypodermis (subcutaneous tissue) [**Figure 1**].[7] Sunlight is composed of electromagnetic rays of different wavelengths and energy values:[5,7]

- **UV radiation** (5% of the total solar spectrum): is short wavelength (100–400 nm) and high energy.
- **Visible light** (50%): medium wavelength (400–740 nm); and
- **Infrared (IR) radiation** (45%): long wavelength (740 nm to 1 mm) and low energy.

UV radiation, visible light, and IR radiation penetrate the skin to varying degrees (**Figure 1**).[5]

Ultraviolet radiation

UV radiation consists of UVC (100–280 nm), which does not reach the skin because it is filtered by atmospheric ozone, and UVB (280–315 nm) and UVA (315–400 nm), which do reach the skin.[7]

UVB radiation is the most energetic but penetrates only the epidermis.[7] UVA radiation, which is subdivided into UVA2 (315–340 nm) and UVA1 (340–400 nm), is less energetic than UVB but accounts for most of the UV radiation that penetrates the skin. UVA1 penetrates deeper into the skin than UVB, reaching the dermis.

Exposure of the skin to UV radiation is strongly correlated with photoaging, and could be responsible for 80% of visible facial aging signs.[9,10] UV radiation activates transcription factors that inhibit collagen expression and increase expression of matrix metalloproteases.[5] This leads to increased degradation of matrix proteins, which contributes to the formation of cutaneous rhytids (fine wrinkles).

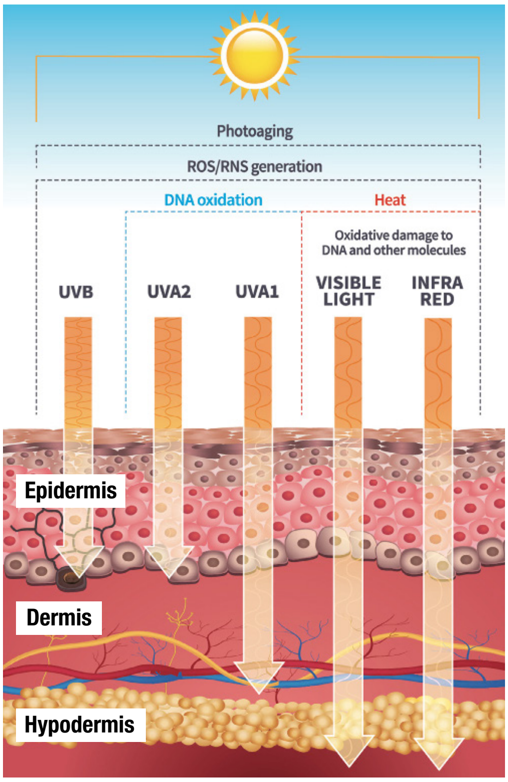

Figure 1. UV radiation as a biological stressor in skin aging. The solar spectrum is composed of various wavelengths, which penetrate into skin at different levels.[7] Longer wavelengths penetrate deeper into the skin than shorter wavelengths and each wavelength has individual and common effects.
UV = ultraviolet radiation, ROS = reactive oxygen species, RNS = reactive nitrogen species.

Sun exposure could be responsible for 80% of visible aging signs

UVB radiation affects keratinocyte production, induces epidermal thickening, stimulates melanin production, and is responsible for tanning. It induces DNA mutation as well as immunosuppression in the skin.[5]

Penetrating the deep layers of the skin, UVA rays act on the connective tissue and the endothelial cells of blood vessels.[5] UVA1 and UVA2 rays act directly to intensify the darkening of the melanin pre-formed by UVB exposure and act indirectly by inducing production of free radical oxygen species that attack proteins, membrane lipids, and DNA.

Visible light and infrared radiation

Visible light penetrates deeply into the skin, with about 20% reaching the hypodermis.[7] IR radiation also penetrates into the deeper layers of the skin, with ≥10% reaching the hypodermis.[7]

Historically, visible light and IR radiation were not thought to exert major effects on the integrity of skin.[7] However, there is now evidence that visible light and IR radiation activate matrix metalloproteinases, reduce collagen production, and contribute to dermal aging.[5,7] Visible light is also able to induce pigmentation.[7]

Blue light, which has the highest energy in the visible light spectrum and is emitted by light-emitting diodes (LEDs) used for artificial lighting and the screens of electronic devices as well as being present in sunlight,[11] generates free radicals and induces oxidative stress in the skin similar to that of UVA.[5,7] Blue light also leads to sustained melanogenesis that may contribute to the pigmentation. Although the blue component in sunlight peaks at midday, the extensive use of LEDs in modern life potentially exposes people to relatively higher amounts of blue light throughout the day and especially at night.[11] Exposure to artificial blue light in the evenings and at night disrupts the circadian rhythm in humans, which has been linked to some age-related disorders, including depression, diabetes, and cancer.[11,12] There is also evidence that blue light-induced disruption of the circadian rhythm results in increased oxidative stress, DNA damage, and inflammatory mediators in skin cells.[13]

IR radiation is not as strong as UV radiation but accounts for more than half of the solar energy that reaches the skin (versus 7% for UV rays).[5] Under direct IR radiation exposure, the conversion of IR to heat can increase skin temperature to >40°C.[7] Acute heat shock in human skin can stimulate new blood vessel formation and inflammatory cell recruitment as well as induce oxidative DNA damage. Heat exposure also appears to contribute to the accumulation of elastotic material in skin.

Skin aging: prevention

To help to delay both the emergence and progression of skin aging, it is essential to avoid prolonged unprotected sun exposure, minimise exposure to polluted environments and pollutants, avoid temperature stresses (**Table 1**).[5,7] Daily photoprotection is of additional importance as UV radiation appears to potentiate the damaging effects of pollutants on the skin.[7]

It is also beneficial to maintain a suitable daily skincare routine to protect the skin against the damaging effects of solar radiation and air pollutants and provide it with the means to repair itself (**Table 1**).[5,7]

The application of sunscreen, which protects against UV radiation, is an integral component of daily photoprotective regimens.[14-16] Indeed, the Sunscreen Summit Policy Group's 2019 consensus statement for Australia and NZ advises that people should apply sunscreen daily if the UV index is forecast to reach ≥3.[15] Further evidence recommends sun protection if people are likely to be outdoors for a lengthy period to achieve a similar cumulative dose, when the UV index less than 3,[17] suggesting daily application of sunscreen throughout the year would be wise for most active Australasians.

Lifestyle	Daily skin care regimen	
	Morning	Evening
• Avoid artificial UV radiation exposure (tanning beds). • Avoid natural UV radiation exposure. When outdoors: - Seek shade whenever possible. - Use protective clothing (i.e., hats, sunglasses, long-sleeved shirts) in addition to skin photoprotective care. • Minimise artificial blue light exposure (e.g. from LED screens), which contributes to skin photoaging and certain age-related disorders.	• Avoid over-cleansing the skin as it may damage skin barrier function. Use a gentle skin cleanser rather than soap. • Use skin care products to support skin barrier function, e.g., those with topical antioxidants to reduce skin aging effects of IRA. • Use photoprotective care: broad-spectrum UVA-UVB sunscreen to block UV radiation and to prevent production of photo-reactive compounds.	• Use rinse-off skin cleansers to remove pollutants from the skin surface. • Use skin care products to support skin barrier function if the skin is dry (via maintenance of skin hydration), repair the effects of oxidative stress (by scavenging free radicals), promote elastin and collagen synthesis, and protect the extracellular matrix (via inhibition of matrix metalloproteinases).

Table 1. Recommendations for general skin care and primarily the prevention of photoaging of the skin.[7,11,12]

Sunscreen should be applied daily if planning to be outdoors for a prolonged length of time or the UV index is forecast to reach ≥3

Most sunscreens do not protect against visible light and IR radiation,[16] although a few examples of sunscreens claiming protection against visible light have been developed.[18] Hence, in addition to avoiding excessive sun exposure, maintaining a daily skin care regimen that involves skin cleansing and application of products with visible light protection, e.g. foundation makes sense. Healthy lifestyles including regular adequate sleep and nutrient-rich diets (largely seasonal, locally grown, fresh vegetables and fruit) providing skin repair ingredients is also crucially important, perhaps supplemented by certain skin care products.[19-22] For example, a sunscreen containing antioxidants (grape seed extract, vitamin E, ubiquinone, and vitamin C) has been shown in a randomised controlled trial to suppress the IR-induced generation of matrix metalloproteinases.[23]

Skin cleansing and use of topical antioxidants also helps to reduce the skin aging effects of air pollution.[7,20]

Sunscreen efficacy

Given the common cause, i.e., cumulative UV exposure, it follows that both skin cancer and photoaging are largely preventable by avoiding or minimising prolonged sun exposure.[2]

Exposure to solar radiation can be avoided by staying indoors during the hours of highest UV intensity and reduced when outdoors by wearing protective clothing, sunglasses, and a hat as well as seeking shade.[1,2] The application of sunscreen, as an adjunctive strategy to covering up and sun avoidance, plays an important role in the prevention of skin aging as well as skin cancer.

Two randomised controlled trials have investigated the efficacy of sunscreens in preventing or moderating skin aging.[24,25]

The first of these studies randomly assigned elderly men (mean age 63 years) who had previously been diagnosed with skin cancer to apply sunscreen or placebo twice daily for 2 years.[25] Skin biopsies were taken and evaluated by blinded assessors. They found that there was significantly ($p=0.0001$) less solar elastosis in the sunscreen users than in the placebo users at 24 months.

The second study, the Australian Nambour Trial, compared daily with discretionary sunscreen use in young and middle-aged adults because skin aging at this age range is caused primarily by photoaging rather than by photoaging in combination with natural intrinsic aging.[24,26] Daily sunscreen users showed no detectable increase in skin aging after 4.5 years compared with discretionary users.[24] From the start to the end of the study, daily sunscreen users were 24% less likely to show increased aging than discretionary sunscreen users (relative odds = 0.76; 95% CI = 0.50–0.98).

The Nambour Trial used a broad-spectrum SPF-16 sunscreen that has since been superseded by products with higher protection from UVA and UVB.[24] Hence, if the Nambour trial was repeated today, the magnitude of the protective effect of sunscreen demonstrated would likely be greater than that originally reported. As with other sunscreen studies, a limitation of the Nambour Trial is that many users fail to achieve maximum sunscreen efficacy due to suboptimal application, i.e., applied too thinly applied and some areas of skin not covered.[24] Application of a higher SPF sunscreen may therefore mitigate the effects of suboptimal application.

Also noteworthy is the finding of a 1-year prospective non-comparative study that demonstrated that daily application of a broad-spectrum sunscreen to the face statistically significantly (vs baseline) reduced all photoaging parameters from as early as week 12 through to week 52.[27]

Sunscreen ingredients

Active ingredients in sunscreen products are broadly categorised as either organic (chemical) or inorganic (mineral) UV filters.[16,28] They work by intercepting UVA and UVB radiation and dissipating the photon energy that causes dermal damage. Different types of organic and/or inorganic filters are combined to produce a sunscreen that provides broad spectrum coverage.[16,29,30]

Sunscreen use: appropriate application

A sunscreen product should have a sun protection factor (SPF) of ≥50 and be broad-spectrum, photostable, and cosmetically acceptable to users (**Table 2**).[16]

Sunscreen is only effective if applied at the correct times and frequency and in a large enough quantity (**Table 2**), which is defined as 2 mg/cm^2 on the skin surface.[16] For practical purposes this approximately equivalent to:

- At least 35mL of sunscreen applied as one teaspoon (5 mL) to the face, head, and neck; one teaspoon to each arm and forearm; two teaspoons to the front and back of the trunk; and one teaspoon to each thigh and leg, i.e., a total of seven teaspoons.[31]

Ideal sunscreen properties	• SPF ≥50. • Broad spectrum (UVA and UVB). • Cosmetically elegant. • Water resistant.
Application of sunscreen (quantity and timing)	• Apply 20 minutes before going outside. • Apply sunscreen every morning to face, neck, and hands. • For full-body coverage, apply a thick layer, using ≥35 mL (7 teaspoons). • Re-apply frequently, e.g. every 2 hours while in the sun. • Re-apply after swimming, sweating, or towelling off.
Sunscreen as adjuvant sun protection	• Use in combination with other sun protection methods: - Wearing hats, sunglasses, clothing (long-sleeved tops, trousers, etc). - Seeking shade whenever possible.

Table 2. Recommendations for the application of sunscreen.[15,16,32]

Given that people often do not apply a sufficient amount of sunscreen and often do not repeat application every 2 hours when outdoors, advising the use of higher SPF value and longer-lasting (e.g. water-resistant, nanoparticle) sunscreens may make up for these shortcomings.[33]

Effective sun protection requires application of a total of seven teaspoons of sunscreen (SPF≥50) to the body: one teaspoon to the face, head, and neck; one teaspoon to each arm and forearm; two teaspoons to the front and back of the trunk; and one teaspoon to each thigh and leg

Sunscreen use: addressing concerns

Dermatologists should ensure that they are aware of particular controversies associated with sunscreen and are well placed to address common concerns that patients have about sunscreen use.[34,35]

Skin reactions

Sunscreens have the potential to cause irritant, allergic contact, and photo-contact dermatitis.[15] In the Nambour Trial, however, skin reactions were reported in <2% of participants.[36] Although oxybenzone has the highest rate of photo-contact dermatitis among the organic filters, the rate is low considering the number of individuals exposed to oxybenzone.[16] The authors of a meta-analysis of human patch tests and photo-allergy studies concluded that oxybenzone-based sunscreen products did not possess major sensitisation or irritation potential.[37]

Nanoparticle safety

Zinc oxide and titanium dioxide are used in inorganic sunscreens as nanoparticles (size <100 nm) because the smaller size of these mineral particles increases the cosmetic acceptability of the sunscreen by users.[38,39] However, safety concerns surround zinc oxide and titanium dioxide nanoparticles due to the potential for these particles to penetrate the skin and exert cellular toxicity.

A comprehensive scientific review of the safety of zinc oxide and titanium dioxide nanoparticles present in sunscreen conducted by the Australian Therapeutic Goods Administration concluded that these nanoparticles only minimally penetrate the stratum corneum and, based on current evidence, neither ingredient is likely to cause harm when sunscreens are used as directed.[39] Other reviews of the published literature have concluded that topical use of sunscreens containing nanoparticulate titanium dioxide and zinc oxide does not appear to adversely affect human health given their lack of percutaneous absorption.[38,40,41]

Due to a potential health risk of systemic exposure via inhalation, there has been a recommendation against using metal oxide nanoparticles in spray-on sunscreen products.[38]

Hormonal effects

There are concerns that oxybenzone (benzophenone-3), which is a phenolic compound, used as an organic UV filter in sunscreen products, negatively affects human reproductive function via endocrine disrupting effects.[15]

A 2017 systematic review of human and animal studies of the potential effects of oxybenzone on reproductive function found little evidence to suggest major harms of benzophenone-type compounds, albeit based on limited available evidence.[42] Moreover, the quantity of sunscreen that a human would need to apply to their skin to obtain systemic levels of oxybenzone equivalent to those in an animal model that demonstrated oestrogenic effects after oral administration of oxybenzone are essentially unattainable.[43]

Hair loss

Concerns have been expressed about sunscreen use and the development of hair loss, specifically frontal fibrosing alopecia (FFA), due to a temporal association between increasing sunscreen use and increasing incidence of FFA.[44] Currently, there is insufficient evidence to establish a direct causal relationship between sunscreen and FFA, although the need for additional research is advocated.

Vitamin D deficiency

Conversion of 7-dehydrocholesterol in the skin to pre-vitamin D3 by UVB is the main source (>90%) of vitamin D in humans,[45] adequate levels of which are needed to prevent osteoporosis and fractures in the elderly.[46]

In theory, sunscreen use could significantly reduce the solar-induced synthesis of cutaneous pre-vitamin D3 if administered under strictly controlled conditions; in practice, however, normal usage of sunscreen has not been shown to be associated with vitamin D deficiency.[45] In prospective studies, adequate levels of vitamin D were maintained in individuals who intensively avoided sun exposure by use of protective clothing and sunscreen when outdoors,[47,48] as well as in individuals who regularly used sunscreen.[49-51]

Observations that regular use of sunscreen does not affect vitamin D levels are likely explained by the lack of total skin cover and the fact that sunscreens do not block all UVB.[45,49,52]

According to the Sunscreen Summit Policy Group consensus statement for Australia and NZ: ". . . the 'pragmatic' findings of field trials (i.e., that daily sunscreen is effective in preventing skin cancer with no measurable reduction in Vitamin D levels) outweigh the largely 'theoretical' effects of diminished vitamin D synthesis observed under laboratory conditions".[15]

Environmental effects

Organic (or their by-products) and inorganic UV filter compounds in sunscreen products have been detected in freshwater, coastal, and marine ecosystems and may affect the development of corals as well as some other types of marine life.[53-58]

Although increasing seawater temperature is generally considered to be the most significant cause of coral reef bleaching,[16] eco-friendly sunscreens for minimising or avoiding the impact on marine life while protecting human skin from UV damage are under development.[15] For example, xanthommatin, a biochrome present in arthropods and cephalopods, is being investigated as an alternative chemical UV-filter that may also have antioxidant properties.[59,60]

In the meantime, inorganic UV filter sunscreens could be used by those concerned about the potential negative effects of sunscreen on the environment.[38] Current research suggests that the incorporation of zinc oxide or titanium dioxide nanoparticles to form an inorganic UV filter sunscreen poses limited ecological risk, especially relative to combined organic plus inorganic UV filter sunscreen products.[38]

Sunscreen use: facilitating adherence

The health benefits of sunscreen as an adjunctive UV protection modality are only realised if people are aware of the harms of sun exposure, have confidence in sunscreen products, and remember to regularly apply sunscreen.[1,61,62]

Appearance-based messaging

Educational initiatives have been linked to greater adoption of sunscreen use.[63] There is increasing evidence that appearance-based education may be more effective than health-based education in modifying sun protection awareness and behaviours, including sunscreen use adherence:[4]

- In a cross-sectional survey of adults, knowledge of the photoaging effects of sun exposure was shown to be positively associated with sunscreen use adherence.[4]
- In a pilot study, a facial-aging smartphone app (Sunface, available from App Stores) was effective in increasing the motivation of adolescents to adopt sun protection behaviours.[3]
- In a randomized trial, adolescents who viewed a video on UV-induced premature skin aging applied sunscreen at significantly ($p<0.001$) greater frequencies than adolescents who viewed a health-based video emphasising UV exposure and skin cancer risk.[64]
- In a randomised double-blind study, being shown photos of photoaged skin was significantly ($p<0.05$) more effective than being shown photos of skin cancer in motivating dermatology patients to reduce their sun exposure.[65]

Formulation and user preference

In the dermatology clinic, shared decision-making that incorporates patient choice is a key factor in improving adherence to sunscreen and other sun protection behaviours.[66] Sunscreens that fail to meet consumer preferences in terms of colour, appearance, and sensory profile may lead to their sub-optimal use and hence inadequate UV protection.[1]

Research suggests that user preference for cosmetically-elegant sunscreen products is an important factor in encouraging regular use of sunscreen, as exemplified by dermatology practice patients preferring lighter cream-based emollients to greasier emollients.[66] Outdoor workers tend to prefer more liquid formulations (e.g. lotions and sprays) because of their ease of application compared with formulations of thicker consistency (e.g. creams and gels).[67,68] However, sweat resistance, not easily rubbed off, and non-irritation of eyes are also priority factors in outdoor workers' daily use of a sunscreen product.

The aesthetic qualities 'not greasy', 'feels just right', 'absorbs just right', 'not sticky', and 'not irritating' were included in a product performance survey for a broad-spectrum, high-SPF value, water-resistant sunscreen lotion, with the majority of surveyed patients agreeing that the product displayed these qualities (≥81%).[69]

Reminder technologies

Simple forgetfulness is a factor in poor adherence to sunscreen use.[70] Reminder initiatives have been linked to increased sunscreen use.[63] Smartphone text-messages reminding users to apply sunscreen have been shown to significantly ($p<0.001$ vs control group) increase sunscreen adherence rates.[71] Also, text-messages detailing sun protection or skin self-examination behaviours have produced significant ($p\leq0.035$ vs control group) improvements in sun protection behaviours.[72]

Other technologies are available to help people improve their adherence to sunscreen use and sun protection measures in general. These include Australia's SunSmart app (a smartphone app that has a reminder alert and an alert prompt as to the quantity of sunscreen to apply), SunSmart seeUV app (an augmented reality smartphone app showing what your skin could look like without sun protection), and SunSmart Widget (a website widget showing sun protection times for a person's location in Australia). Young adults using the SunSmart phone app spent significantly less time unprotected and exposed to UV on weekends ($p=0.04$ vs baseline); however, more research into the app's influence on other sun protection behaviours is needed.[73]

New Zealand has the Sun Protection Alert app (a website widget that tells people time each day that they need photoprotection) and NIWA's uv2Day app (a smartphone app that allows users to check UV levels for their location).

EXPERT'S CONCLUDING COMMENTS – Louise Reiche

Appearance of skin quality, reflecting health, has driven behaviours since ancient times, e.g. Queen Cleopatra took milk baths, applied honey, wore gold masks (which certainly would have blocked the sun) and partook of wide-ranging natural plants for these purposes. Lepers were excluded for fear of contagion spreading poor health (akin to current Covid-19 societal impacts).

Holistic behaviours impact on the quality of our modern-day skin and general health too, now backed by growing scientific evidence. Pollution exposure harms our lungs and prematurely ages our skin. The corollary is also true, that time spent in nature mitigates these effects through increasing telomere length (inversely associated with aging) along with factors such as relaxation/reducing stress, and regular quality diet, sleep, and exercise boosted by a range of sun protection strategies.

Long-term preventative strategies need to be safe. Concerns about sunscreen potential absorption and detrimental environmental impact support the need for sun protection strategies to be holistic and broad, such as seasonally-adjusted timing and duration of outdoor exercise; appropriate shade use including broad-brimmed hats, practical use high ultraviolet protection factor (UPF) clothing of extensive coverage and wrap-round sunglasses; liberal and frequent application of broad-spectrum SPF ≥50 sunscreen on sun exposed sites. Greater skin surface coverage restricts exposed skin needing sunscreen, providing benefits while reducing potential risks to individuals and the environment.

Performing large epidemiology double-blinded studies on different clothing types and/or multiple measures in real-life situations is more complex than quantifiable sunscreen use, so explaining disproportionate sunscreen ranking as a preventative tool in academic literature. Years of clinical observation confirm for me and my fellow dermatologists that patients who rely on clothing, and hat coverage more than or in addition to sunscreen, achieve better photodamage and skin cancer genesis and production, reduction.

In summary, all these broad measures will improve skin appearances rewarding incentives towards behaviours that mitigate morbidity, financial costs, and mortality from skin cancer consequences. Win-win!

EXPERT'S CONCLUDING COMMENTS – Deshan Sebaratnam

The 'Slip, slop, slap' campaign of the 1980s is one of the most well recognised public health campaigns in Australia and the annual iterations of this campaign have contributed to the shift in sun protection attitudes over the past three decades.

Dermatologists are perfectly placed to educate patients regarding the importance of sun protective measures. Routine full skin examinations are an excellent opportunity to enquire about photoprotection habits. It also affords an opportunity to offer specific guidance in terms of volume and frequency of sunscreen application. Similarly, when patients present with cosmetic concerns, it is an excellent setting to discuss primary prevention of photoaging through simple measures such as diligent photoprotection.

Patients will often enquire about which sunscreen is the best and my advice is generally that as long as a product is SPF ≥50, the best sunscreen is the one that they like and are going to use regularly.

Proactively offering that regular application of sunscreen will not only minimise the risk of skin cancer but help mitigate some of the effects of photoaging contributes to adherence as the studies in this review highlight. It's also important to challenge misconceptions propagated through mediums such as social media regarding to adverse effects of nanoparticles and impaired vitamin D synthesis.

TAKE-HOME MESSAGES

- Photoaging is caused by cumulative exposure of the skin to UV radiation, visible light (especially blue light), and IR radiation; hence, minimising exposure to these forms of radiation should help to reduce skin photoaging.
- Sun exposure could be responsible for 80% of the visible signs of facial aging.
- Clinical studies indicate that regular and appropriate application of sunscreen delays photoaging of the skin, in addition to reducing skin cancer risk.
- Sunscreen and other skin care products containing antioxidants may help to mitigate the photoaging effects of visible light, IR radiation, and pollution.
- A total of seven teaspoons of sunscreen (SPF ≥50) should be applied to the body for effective sun protection.
- Sunscreen should be applied daily if the UV index is forecast to reach ≥3 (Sunscreen Summit Policy Group) and at lower UV levels if there may be prolonged outdoor exposure.
- Adherence to regular sunscreen use is facilitated by photoaging prevention messages, cosmetic elegance, and technologies that remind people to apply sunscreen.
- Substantial data supporting the regular use of sunscreen for photoprotection outweigh the limited data on its potential side effects and environmental risks.

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