# Skin cancer prevention and sunscreens

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**What you need to know**

- The global burden of disease from melanoma is high and increasing; it occurs predominantly as a result of exposure to ultraviolet (UV) radiation (from sunlight or sunbeds) most commonly in people with fair, sun sensitive skin
- The World Health Organization recommends sun protection measures when the UV index is forecast to reach 3 and above
- ·Regular use of sunscreen can prevent melanoma and squamous cell carcinoma; however, the effectiveness of sunscreen is dependent on the amount applied, coverage of exposed skin, and reapplication
- Opportunistic behavioural counselling from healthcare professionals can increase sun protection behaviours and is recommended for parents of young children, adolescents, and groups at high risk
- Tailor sun protection recommendations to individual risk factors, considering skin pigmentation, concurrent risk of vitamin D deficiency, immune system status, and UV radiation exposure

*A parent visits their general practitioner with their 1 year old child, who is due to receive several vaccinations. During the appointment, the parent asks whether it is OK to start using infant sunscreen formulations, as they have heard there is a risk that sunscreens can be unsafe for infants, and that they can cause skin reactions. You observe that the infant has fair skin. The parent notes their child has sensitive skin, which is easily irritated, and asks for your recommendation.*

Skin cancer is the most commonly diagnosed cancer worldwide.[1] The Global Burden of Disease study shows rates of skin cancer continue to rise, largely owing to an aging population.[1,2] The most common skin cancers include keratinocyte cancers, basal cell cancer and cutaneous squamous cell cancer, and melanoma.

Deaths due to melanoma are projected to increase by about 68% from 2020 to 2040.[1] Although improvements in treatments for advanced melanoma have reduced mortality rates globally, these therapies are expensive and contribute to the high economic burden of skin cancer.[3,4] Access to healthcare and the financial costs of skin cancer diagnoses and treatments are barriers to early detection and survival in low and middle income countries,[2,5] emphasising the importance and cost effectiveness of prevention.[6,7]

Here, we discuss the current evidence regarding skin cancer prevention and sunscreens, including the role of the clinician and how to provide evidence based, tailored behavioural counselling for skin cancer prevention.

**What is the relationship between ultraviolet radiation and skin cancer?**

Solar ultraviolet (UV) radiation, which is part of the electromagnetic spectrum, can be divided into three bands based on wavelength: UVA (315–400 nanometres), UVB (280–315 nanometres), and UVC (<280 nanometres). All UVC is absorbed by the atmosphere, and all UVA and 90% of UVB passes through the Earth's atmosphere and is absorbed by human skin.[8,9]

Exposure to UV radiation, either from the sun or artificial sources (sunbeds), is the leading cause of skin cancer.[9] UV radiation can also cause sunburn, skin damage, and eye damage, including cataracts and pterygium.[4,9] The WHO identifies children and adolescents as particularly vulnerable to the harmful effects of UV radiation, because of their functionally immature skin and eye structure, which provide less protection from UV radiation.[9,10]

The International Agency for Research on Cancer estimates that 76% of new melanoma cases are attributable to UV radiation exposure.[11] This estimate varies according to skin phototype, melanoma subgroup, and geographical location. For example, the proportion of melanoma attributed to UV radiation ranges from 1% in East Asia to 96% in Oceania.[11]

Age standardised melanoma incidence rates are highest in countries where populations with predominantly fair, sun sensitive skin types are exposed to high ambient solar UV radiation levels, such as in Australia and New Zealand.[12] However, melanoma rates are also high in some regions with relatively low solar UV radiation levels, such as in northern Europe, where cultural norms support intense and episodic exposure, for example during vacations or from sunbeds.[1,12] As a result, Danish women under 40 have higher melanoma rates than similar aged women in Australia and New Zealand (36.5 *v* 28.5 per 100 000, respectively),[13] reinforcing that skin cancer is relevant globally, and not just concerning for countries with high solar UV radiation levels.

The Global Burden of Disease study shows that the age standardised melanoma rate increased by 39% over the 30 years to 2021; however, incidence rates are declining in some (31 of 204) countries.[3] In Australia, the decline among younger cohorts has been attributed primarily to decades of comprehensive efforts to prevent skin cancer, including public health campaigns, settings based policies to protect high risk populations, and regulatory action to ban commercial

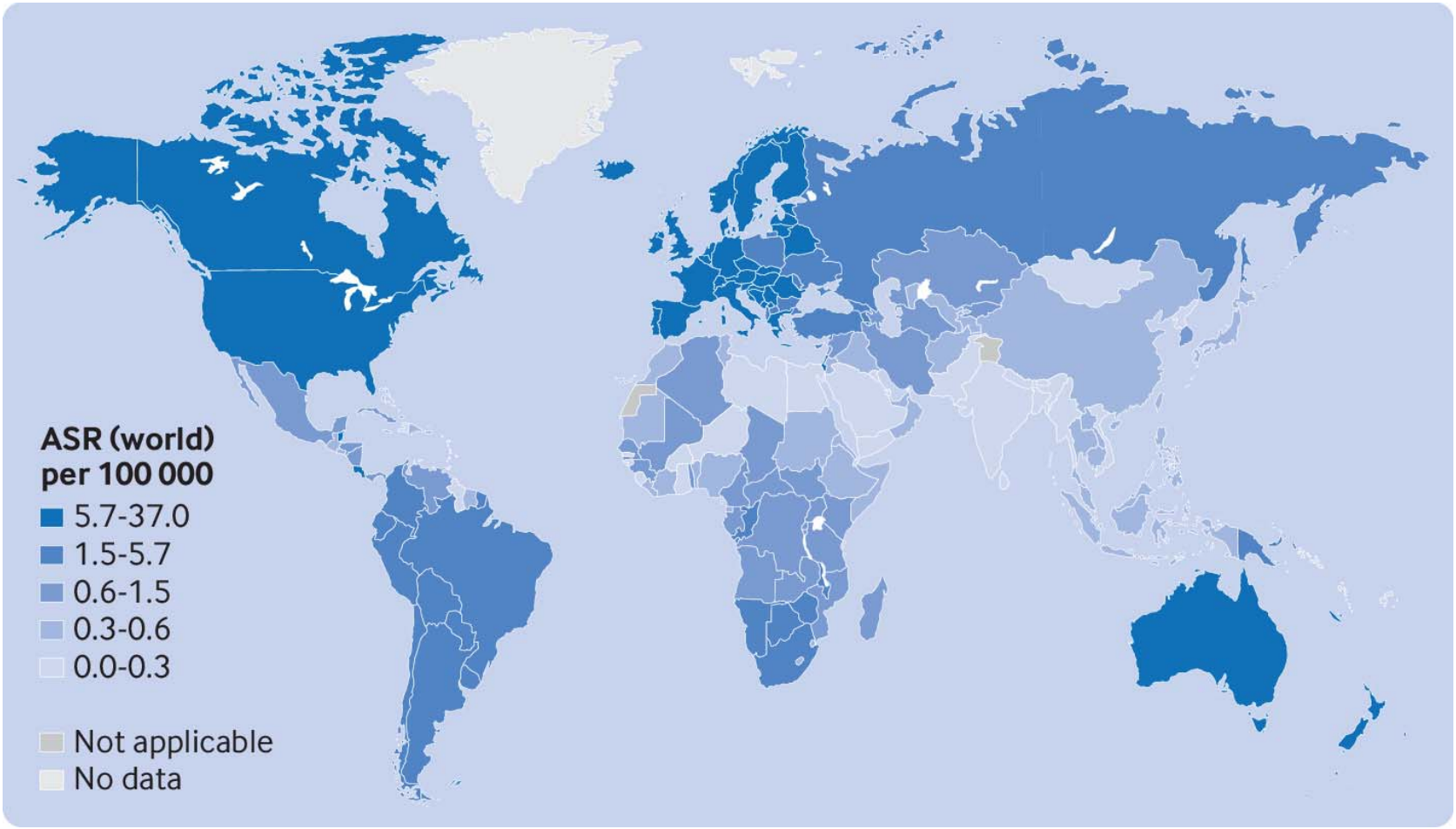



**Fig 1.** Global age standardised incidence rate (ASR) (per 100 000) of men and women of melanoma of the skin (2022). Reproduced from Global Cancer Observatory: Cancer Today (version 1.1). Ferlay J, Ervik M, Lam F, Laversanne M, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F. Age-Standardized Rate (World) per 100 000, Incidence, Both sexes, in 2022. Melanoma of skin. https://gco.iarc.who.int/today/en/dataviz/maps-heatmap?mode=population&cancers=16. © International Agency for Research on Cancer (2024)

sunbeds.[14,15] Other demographic and lifestyle factors, including changes in population ancestry, leading to an increase in low risk phenotypes, and changes in recreational activities, leading to less time spent outdoors, have also contributed to population declines.[15,16]

**Who experiences melanoma?**

Phenotypic characteristics, including eye colour, hair colour, skin pigmentation, and propensity to develop naevi, are controlled by melanin pigmentation. Melanin (especially eumelanin and pheomelanin) determines individual susceptibility to DNA damage and tumour development.[17]

In general, people who have fair skin, high sun sensitivity, freckles, light eyes, and red or light hair are at increased risk of melanoma[17,18] (table 1). Other clinical predictors include personal history of melanoma and other skin cancers, family history of melanoma, and immune system deficiency.[18,19,20,21,25] These clinical risk factors, combined with age and patterns of exposure to UV radiation (including sunbed use), determine overall risk of melanoma. Online risk calculators can assist healthcare professionals to consider how multiple risk factors combine to assess an individual's absolute risk of first and subsequent melanoma.[26,27] Polygenic risk scores provide modest gains in risk prediction (ie, above demographic, clinical, and UV exposure risks), which are insufficient to support their use in routine clinical practice.[28]

Solar UV radiation is the predominant cause of melanoma, but genetic risk factors are particularly important for people with a low propensity to develop naevi, and for melanomas that develop in less sun exposed areas.[29,30]

Acral lentiginous melanoma is a rare subtype that accounts for 2-3% of melanomas and affects people with more deeply pigmented skin disproportionately, including black, Hispanic, and Asian populations.[31] The cause of acral lentiginous melanoma remains unknown. However, as acral lentiginous melanoma appears in areas of the body that experience repetitive stress commonly, such as the palms, soles, and nailbeds, it has been suggested that mechanical factors (and not UV radiation) may be an important contributing factor.[31]

**What role do clinicians play in melanoma prevention?**

Clinicians and healthcare professionals working in primary care are well placed to identify individuals with risk factors for melanoma and provide tailored advice. A 2018 US Preventive Services Taskforce systematic review recommended that clinicians should provide behavioural counselling for prevention of skin cancer to young adults, adolescents, children, and parents of young children, as well as adults with fair, sun sensitive skin types (table 2).[32] Although the review concluded that behavioural interventions can lead to small to moderate improvements in sun protection behaviours in children and adults, it also reported a paucity of evidence demonstrating effectiveness in reducing sunburn and skin cancer.[33] Notably, no studies included in the review extended beyond three years' follow-up, which limited the evidence available to evaluate reductions in naevi and skin cancers.[33]

Consultation record audits and survey data on skin cancer related medical appointments show that opportunistic counselling for this highly preventable cancer is sporadic.[34,35,36] In one cross-sectional study of 1506 US medical professionals, awareness of the US Preventative Services Taskforce Recommendations increased the odds of frequently providing behavioural counselling on sun protection (adjusted odds ratio (AOR) 1.56, 95% confidence interval (CI) 1.24 to 1.95) and indoor tanning (AOR 1.89, 95% CI 1.31 to 2.72).[35] However, clinicians from

**Table 1** Risk factors associated with developing melanoma

| Relative risk | Risk factors |
|---|---|
| **Reduced relative risk** | Deeply pigmented brown-black skin that never or rarely burns |
| **Increased relative risk** | · Fair skin that burns or minimally tans, freckling, light eye colour, light or red hair colour<br>· Actinic damage indicators, including actinic keratoses (a precursor to cutaneous squamous cell carcinoma)<br>· Past history of keratinocyte cancer<br>· Medical history of compromised immunity, including immunosuppressive treatments for solid organ transplant, HIV-AIDs co-infection, some lymphoproliferative disorders (eg, chronic lymphocytic leukaemia)<br>· Family history of melanoma in first degree relative<br>· Social history of high sun exposure and sunburns during childhood, and/or high intermittent, intense UV radiation exposure from suntanning or sunbed use |
| **High-very high relative risk** | · >5 atypical (dysplastic) naevi<br>· >100 common naevi<br>· Medical history of previous melanoma |

Reduced relative risk=<1.00 (compared with unexposed group); increased relative risk = 1.00-4.99: high to very high relative risk= ≥5.00. Estimates for relative risk synthesised from systematic reviews and meta-analyses.[18] [19] [20] [21] [22] [23] [24] There is uncertainty around the increased relative risk among people receiving treatment for immune-mediated inflammatory diseases (eg, inflammatory bowel disease, rheumatoid arthritis), owing to a lack of large studies for inclusion in meta-analytic studies[25]

**Table 2** US Preventive Services Taskforce clinical summary: Behavioural counselling to prevent skin cancer[32]

| Population | Young adults, adolescents, children, and parents of young children with fair skin type | Adults over 24 with fair skin type |
|---|---|---|
| **Recommendation** | Counsel about minimising exposure to UV radiation.<br>Grade: B* | Selectively offer counselling about minimising exposure to UV radiation.<br>Grade: C** |

* The US Preventive Services Taskforce recommends this service. There is high certainty that the net benefit is moderate, or there is moderate certainty that the net benefit is moderate to substantial.

** The US Preventive Services Taskforce recommends selectively offering this service or providing this service to individual patients based on professional judgement and patient preferences. There is a least moderate certainty that the net benefit is small.

high income countries, where the global burden of skin cancer is concentrated,[1] report significant resource constraints to providing behavioural counselling within standard consultations.[27,35]

Regarding how to counsel people's behaviour, the Taskforce review found no clear or consistent patterns to recommend specific intervention components or characteristics.[33] Similarly, a 2024 narrative review identified 31 mixed methods studies relating to the provision of skin cancer prevention interventions in a primary care setting.[27] The study's findings on effectiveness of behavioural counselling echo those of the Taskforce review; however, it additionally found limited evidence to support the use of risk assessment tools and new technologies, such as smartphone apps, to tailor sun protection advice.[27]

In the absence of dedicated interventions to support behavioural counselling and healthcare resourcing, healthcare professionals are encouraged to consider how tailored skin cancer prevention could be implemented by opportunistically counselling high risk patients during skin lesion checks and physical examinations,[27] or as an add-on to presentations for other reasons. Furthermore, behaviour change theory suggests that health service funding models that incentivise and resource clinicians to provide risk tailored skin cancer prevention counselling may be needed to increase uptake of this intervention.[37]

**When is sun protection needed?**

WHO recommends using sun protection when outdoors on days when the UV index is forecast to reach 3 and above.[9] Although the UV index is central to determining when to protect the skin, population level use of the UV index to inform sun protection is low across all regions globally.[38,39]

Reflexive responses, whereby sunshine and warm temperatures drive sun protection behaviour, rather than the UV index, leave people vulnerable to UV damage, which can also occur on overcast and cloudy days. Tools like the WHO's SunSmart Global UV app, which is free, non-commercial, and available in multiple languages, can be used to support patients to use the UV index to establish sun protection routines globally.

Sun protection measures recommended by WHO including limiting time in midday sun, seeking shade, wearing protective clothing that reaches the wrists or ankles and a broad brim, bucket, or legionnaire style hat, wearing sunglasses that provide 99% to 100% UVA and UVB protection, and applying broad-spectrum, high SPF sunscreen to remaining areas of exposed skin.[9] Use sunscreen in combination with other sun protection measures, as a last line of defence.[40]

**How effective are sunscreens?**

The degree to which sunscreens protect against sunburn is indicated by their sun protection factor (SPF). Importantly, sunscreens also reduce the risk of other forms of UV damage. Evidence reviews conclude consistently that regular sunscreen use can reduce the risk of melanoma, cutaneous squamous cell carcinoma and precursor lesions, as well as signs of aging, including wrinkles, telangiectasia, and UV radiation induced pigmentary alterations.[41,42,43] However, although there is compelling, consistent evidence that regular sunscreen use prevents DNA damage, conclusions about prevention of skin cancer are drawn from a small number of experimental trials.

An Australian randomised controlled trial that compared daily to discretionary sunscreen use found that, relative to the discretionary use group, a 40% reduction in cutaneous squamous cell carcinoma and no effect on basal cell carcinoma in the daily sunscreen use group at the end of the 4.5 year study.[44] Treatment effects (ie, of daily sunscreen use) were similar at 8 year follow-up.[45] Ten years after trial cessation, there were 11 melanomas in the treatment group and 22 in the control group (hazard ratio (HR) 0.50, P=0.051), and a statistically significant reduction in invasive melanoma in the treatment group (HR 0.27, P=0.048).[46] Two additional randomised controlled trials, conducted with Australian and US adults, found that daily or routine sunscreen use also reduces the risk of new actinic keratoses.[47,48]

The effectiveness of sunscreen is dependent on how well it is applied, and studies that assess this report low compliance with directions for sunscreen thickness, coverage, and reapplication.[40,41,49] Changing people's behaviour to apply sunscreen correctly is critical to improving population benefits of sunscreen use for prevention of skin cancer.[40] The infographic offers tips for effective sunscreen application.

**How can sun protection and sunscreen recommendations be tailored to meet a patient's needs?**

Tailor sun protection recommendations to balance individual risk factors for skin cancer (table 1) against those for vitamin D deficiency, because of the beneficial effects of sunlight for vitamin D synthesis.

The absence of diversity in skin cancer prevention studies is an impediment to the development of standards on how to tailor skin cancer prevention, particularly for people with deeply pigmented skin. This may leave health professionals uncertain as to what advice to give to whom. Box 1 provides guidance for use in such circumstances.

Box 1

**How to tailor prevention advice for different population groups**

**Infants and children under 2**

- Recommend that infants and children under 2 are kept out of direct sunlight where possible, as their skin is vulnerable to UV damage, and they are susceptible to overheating and dehydration[50,51]
- When outdoors, encourage complete protection using a combination of shade, light weight, loose, closely woven clothing that covers the skin, wide brim/legionnaire style hats, and sunglasses as appropriate for age
- Infants and young children are at increased risk of systemic drug absorption because of their small body mass to surface area ratio. As such, parents and carers should be advised that sunscreen is not recommended for young babies (<6 months)[42,50,51]
- For children over 6 months, sunscreen can be used as a last line of defence on small areas of unprotected skin. Advise parents and carers to:
    - Choose a fragrance free, low irritant, or special infant formulation to minimise potential allergens. Formulations that use inorganic UV filters, for example zinc oxide and titanium dioxide, will reduce potential for irritation, sensitisation, and skin penetration[51,52,53]
    - Avoid aerosol sunscreens. Further to application challenges, they may trigger or exacerbate asthma and allergy symptoms in children[50]

**People who work outdoors**

- Encourage the use of all available protective measures. This includes good quality shade (from above and the sides) and personal protective equipment (ie, clothes that cover as much of the skin as possible, a wide brimmed hat or hardhat with sun shields, ear and neck guards, lip balm with SPF 15 or more, and a broad spectrum, high SPF sunscreen that is reapplied frequently) whenever outdoors[54,55]
- To protect the eyes, recommend that people who work outdoors routinely wear safety glasses, sunglasses, or prescription eyeglasses with UV protective lenses in combination with headwear[54,55]
- Water and sweat resistant, "dry touch" sunscreens may be preferable, but there are no international standards to evaluate sunscreen biostability during activity or in response to environmental challenges such as dust, dirt, and salinity[54]
- Wherever possible, recommend that employers restructure work duties to avoid working in unshaded outdoors areas during peak UV radiation times[54,55]

**People who are immunocompromised**

- Include patient education on fostering photoprotective behaviours as a vital component of routine care for people who are immunocompromised, especially for those receiving solid organ transplant[56,57]
- Advise patients to be diligent about sun protection and avoid unnecessary UV radiation exposure.[56,58] Phone apps with reminders may help to establish sun protection routines[59]
- Early detection is key: educate patients on skin self-examination and refer to local skin cancer services if indicated
- The evolving role of neoadjuvant strategies, targeted therapy, and immunotherapy requires further exploration[56]

**People with deeply pigmented skin**

- Photo-exacerbated pigmentary disorders are among the most common dermatology consultations for people with skin of colour[60]
- To protect against photo-aging, acquired pigmentary disorders, and other adverse skin effects, recommend sun protection if outdoors for an extended period (eg, ≥2 hours) when the UV index is 3 and above, and that sunglasses are routinely used for eye protection[61,62]
- Few articles (5%) on sunscreens consider people with skin of colour.[63] Further, there is a lack of experimental evidence regarding efficacy and potential harm of routine use of high SPF sunscreen among people with deeply pigmented skin.[4] Daily sunscreen application may not be needed for this patient group unless they are out for extended periods in high solar UV radiation environments. Therefore, discuss sun protection recommendations with consideration to vitamin D requirements[61]
- Advise patients with deeply pigmented skin to choose broad spectrum sunscreens that provide protection against long wave UVA (340-400 nm) and visible light,[53,60,62] such as a tinted sunscreen that contains iron oxides and pigmentary grade titanium dioxide.[64,65] There is a need for research and development of effective and cosmetically appealing sunscreen formulas for people with deeply pigmented skin[60]

**People with oculocutaneous albinism**

- Undertake patient education on fostering photoprotective behaviours from an early age for people with oculocutaneous albinism, who lack melanin and are highly susceptible to UV radiation damage and skin cancer, especially cutaneous squamous cell carcinoma[66.67]

- Advise people with oculocutaneous albinism to be diligent about sun protection and avoid unnecessary UV exposure.[62,66] Encourage making use of shade (both built and natural) and reducing outdoor activities during maximal UV radiation period
- Recommend that sun protective measures include daily use of protective clothing, hats, sunglasses with a UV 400 rating and broad spectrum, high SPF (50+) sunscreen on the ears, lips, eyelids, and neck as well as all other exposed bodily sites
- To provide adequate protection to the head, neck, and ears, hats should have a broad brim, or legionnaire style neck covering. When worn in conjunction with sunglasses with a UV 400 rating, this will also reduce the amount of UV radiation reaching the eyes[42]

- There are no internationally endorsed standards for sun protection for high risk population groups. As such, most of the recommendations are drawn from topical, narrative style evidence summaries,[4,42,50,51,52,54,56,58,60,64,65,66] in addition to one systematic review,[67] one scoping review,[57] two Delphi studies,[53,55] and two evidence based position statements.[61,62]

**Are there safety concerns associated with sunscreen use?**

The only established adverse effects of sunscreens to human health are contact dermatitis, contact allergies, or photoallergies.[69] Meta-analyses and narrative review articles conclude consistently that any positive correlation between sunscreen use and sunburn, naevi counts, and skin cancer diagnoses stem from methodologically flawed observational and case-controlled studies, which are confounded by the predominance of sunscreen use among those most susceptible to skin damage and by those who spend extended periods of time outdoors.[30,41,42,59] People should continue to use sunscreens on exposed areas of skin, while also prioritising covering with clothing and hats when UV index levels are 3 and above.[30,41]

When feasible, clinicians can help counter misinformation and safety concerns about sunscreens, for example, issues that may be prevalent on parenting blogs and social media[70,71,72] (box 2).

Box 2

**What evidence can I use to respond to common patient questions and concerns about sunscreen?**

**What is the difference between organic (chemical) or inorganic (physical) sunscreens?**

Sunscreens contain compounds called UV filters. Some sunscreens contain organic (chemical) sunscreen filters, such as oxybenzone, avobenzone, octocrylene, and ecamsule, that primarily absorb UV radiation. Inorganic (physical) sunscreens, such as zinc oxide and titanium dioxide, also primarily absorb UV radiation, with minimal reflecting and scattering.[73] Each UV filter has different properties, and has a characteristic absorption spectrum, so these are typically combined to create formulations that provide broad spectrum protection, photostability, and cosmetic appeal.[65,73]

**Are organic (chemical) or inorganic (physical) sunscreens better?**

All types of high SPF broad spectrum sunscreen provide effective UV radiation protection.[42] Inorganic sunscreens, such as zinc oxide and titanium dioxide, are often micronised, ie, broken down to a nanometre scale. As a result, these formulations are less visible on the skin,

more lightweight, and provide greater cosmetic elegance, so tend to be more effectively applied.[41,42,74] People tend to apply less inorganic sunscreen, which may leave them vulnerable to UV radiation damage.[42] To address this, provide information on how much sunscreen to apply and encourage people to look for a formulation that feels good on their skin. Recommend inorganic UV filters such as zinc oxide and titanium dioxide (physical sunscreens) to reduce potential for irritation, sensitisation, and skin penetration for infants and children under 2.

**If higher SPF values are better, why can't I get SPF 100 sunscreen where I live?**

Recommend that people apply high protection sunscreen of SPF 30 or greater to any skin not covered by clothing. There is limited experimental evidence that sunscreens with an SPF rating of at least 85-100 may be better than SPF 50 sunscreen at preventing sunburn during prolonged sun exposure.[75,76] However, because of the difficulty producing reliable testing results to determine the SPF values over 70, many countries restrict the maximum claimable SPF to 50+.

**Are sunscreens that contain nanoparticles bad for you?**

Based on current evidence, reviews of in vivo human studies have concluded there is minimal to no absorption of zinc oxide and titanium oxide nanoparticles (that are <100 nm in scale) beyond the stratum corneum.[68,69,77,78] This means the likelihood that nanoparticles cause cytotoxicity or pathology in internal organs or tissues is very low.[77] Importantly, over decades of use, no evidence shows harm to human health from sunscreens that contain nanoparticles.[42,69]

**I have heard some sunscreen ingredients are unsafe. Which ones should I avoid?**

The only established adverse effects of sunscreens to human health are contact dermatitis or contact allergies.[69] Although concerns have been raised from in vitro and animal studies that suggest some organic UV filters could result in endocrine, reproductive, and neurological toxicity, evidence reviews consistently conclude that it would be unattainable to reach similar concentrations from real world sunscreen use in humans.[69,77,79] Inorganic UV filters zinc oxide and titanium oxide have been designated by the US Food and Drug Administration as "generally recognised as safe and effective" and could be recommended to patients who raise safety concerns.[80]

**Are sunscreens harmful for coral reefs and marine life?**

Sunscreens enter waterways when swimming and through waste water, via skin wash off and manufacturing waste run off. Due to their lipophilic nature, wastewater plants are unable completely to remove some UV filters, and these filters can be detected in water samples.[69,81] Reviews of prospective studies conducted to date conclude there is no evidence of a causal link between sunscreen use and harm to marine life and aquatic ecosystems, or coral bleaching; however, studies caution that different species will be affected differently, and real-world data are lacking on concentrations and toxicity thresholds for all UV filters.[68,69,78,79] Although some sunscreens claim to be "reef safe," no international standards or validated testing methods exist with which to evaluate and regulate the environmental safety of UV filters (both organic and inorganic) that are contained in sunscreens.[82] To

protect the skin and the environment, patients should be recommended to maximise shade and clothing cover, and apply water resistant sunscreen to remaining areas of exposed skin.[81]

**I'm concerned about vitamin D levels. Will regular sunscreen use affect these?**

Vitamin D monitoring and supplementation should be discussed with individuals at high risk of deficiency, including people who avoid sun exposure and people with deeply pigmented skin who routinely cover or protect their skin when outdoors.[61,80] Reviews of experimental studies published to date conclude that regular sunscreen use does not reduce circulating vitamin D levels; however, there is low certainty in the available evidence, owing to a limited number of randomised controlled trials, interventions using high SPF formulations, study populations that include diverse skin types, and outcomes for people with deeply pigmented skin.[4,69] Sun protection recommendations should be balanced against skin cancer risk.[4,61] In Australia, an updated position statement now recommends that adults with deeply pigmented skin, who are at low risk of skin cancer, do not need to apply sunscreen daily and can spend up to two hours in the sun unprotected when UV Index levels are 3 and above.[61]

**I have heard that sunscreen can cause skin reactions and sunburn. Is that true?**

Commercial sunscreens are tested in accordance with international standards to evaluate their efficacy, and many countries have additional regulatory requirements to ensure the safety of ingredients.[83] Rarely, people can experience allergic reactions to ingredients contained within some sunscreens.[41,69] To reduce the risk of skin reaction, recommend that patients, particularly children and people with a history of skin reactions, conduct a patch test before using a new sunscreen product. Additionally, to ensure their stability and efficacy, sunscreens should be stored at room temperature and not used past their expiration date.[40] Furthermore, it is common for sunburn to occur when using sunscreen, owing to poor application or spending a prolonged time in the sun without reapplication or additional protective measures.

**Do sunscreens cause hair loss?**

Evidence is insufficient to support a direct causal link between sunscreen application to the face and frontal fibrosing alopecia.[69]

**Does clay work as a sunscreen?**

Clays have been used as photo-protectants by indigenous people around the world. These clays, either white or red, afford a low SPF but offer broad spectrum protection.[84] More research is needed to understand any cutaneous side effects from the use of clay as a sunscreen.

**I want to make my own sunscreen. What do you recommend?**

Home-made sunscreens are discouraged. Even though they may be perceived to be "natural", it is not possible to evaluate their safety and efficacy. Laboratory testing of home-made formulations has found they are commonly unstable, which can cause a change in odour, colour, and phase separation.[85] Additionally, some natural ingredients can cause skin irritation, allergic reactions, or toxicity if used improperly or in high concentrations.[85]

## Future directions

A greater focus on prevention is necessary to reduce the toll of skin cancer on individuals and the health system. Evidence from countries such as Australia suggests melanoma incidence can be reduced through sustained investment in comprehensive efforts to prevent skin cancer, including through public education campaigns, regulatory action to ban sunbeds, and policies that protect children and outdoor workers from damaging UV radiation exposure.[14]

As part of this comprehensive approach, clinicians also play a vital role to reach and counsel groups at high risk of skin cancer during routine medical appointments and skin examinations. Recommendations to inform routine and effective sunscreen application behaviours on days when the UV index is forecast to reach 3 and above will help to address common knowledge gaps and counter public concerns regarding sunscreen safety.

Further evidence from more diverse study samples is needed to understand the risks and benefits of routine high SPF sunscreen use among people with deeply pigmented skin. Further evidence is also needed to establish long term benefits and safety risks of the role of oral photoprotective agents.

**Education into practice**

- How do you identify patients at greatest risk of skin cancer, and what behavioural counselling do you provide to them?
- What evidence based recommendations for sun protection are you aware of and how do you tailor these by skin type, UV radiation exposure, and other risk factors?

**Additional education resources**

- Melanoma Institute Australia: Risk calculators for clinicians
- Country specific guidelines for melanoma prevention:
    - UK: National Institute for Health and Care Excellence guideline: Sun exposure: risks and benefits
    - Australia: Balancing the risks and benefits of sun exposure: a revised position statement for Australian adults (and YouTube summary video)
    - US: National Cancer Institute Skin Cancer Prevention: Health professional version and the American Society of Clinical Oncology position statement on skin cancer prevention
    - European countries: European consensus-based interdisciplinary guideline for melanoma. Part 1: Diagnostics: update 2024

**Information resources for patients**

- WHO. SunSmart Global UV app
- ·WHO. Protecting against skin cancer Q&A and Science in 5 video: UV radiation
- Primary Care Dermatology Society. Patient information leaflet: skin cancer prevention
- British Association of Dermatologists. Sun protection advice for children and babies
- Cancer Council Australia sunscreen factsheet and instructional video on how to apply sunscreen effectively

**Questions for future research**

- What behavioural counselling model is most effective to prevent UV radiation damage among patients at risk of skin cancer (eg, mode and timing of delivery, educational content, intensity, integration with other activities)?
- What are the enduring and long term benefits and safety risks of oral photoprotective agents, such as oral nicotinamide (a form of vitamin B3) and oral retinoids? How should these be prescribed to reduce skin cancer risk, and to whom?
- How do the action spectra for vitamin D synthesis and solar UV radiation damage vary by skin type, and what are the implications for clinical advice on sun exposure, sun protection, and vitamin D supplementation?
- Does routine use of high factor sunscreen affect vitamin D levels among people with medium and deeply pigmented skin, and those who are fastidious about skin cancer prevention? How should patient advice be tailored accordingly?

**How was this article created?**

This article was written using the authors' knowledge of existing guidelines, published reviews, and emerging evidence, and supplemented with targeted searches for additional systematic reviews and meta-analyses where required. Findings from peer reviewed systematic reviews, meta-analyses, and narrative reviews were prioritised over individual studies. The Cochrane Library and bmj.com were also searched to identify additional papers from the past decade (no additional papers were identified).

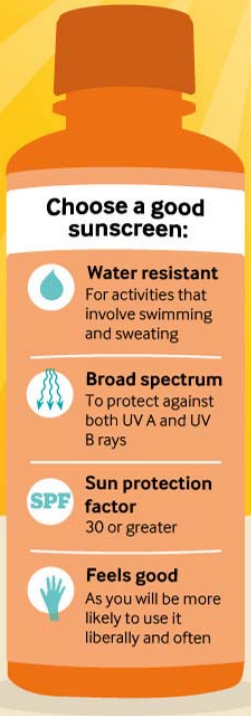
thebmj Visual summary

# Sun protection: How to avoid being caught out

Skin cancer is the most commonly diagnosed cancer worldwide. Tailored skin cancer prevention could be implemented by opportunistically counselling high-risk patients during skin lesion checks and full-body examinations. This graphic presents recommendations for using sun protection

## Combine sunscreen with other forms of sun protection

- For greatest protection, avoid midday sun or seek complete shade cover
- Use protective clothing:
  - Clothes that reach the wrists and ankles
  - Broad brim, bucket, or legionnaire style hat
  - Sunglasses with a UV 400 rating
- Avoid using sunscreen in isolation, or to extend time in the sun



## Choose a good sunscreen:

- **Water resistant** For activities that involve swimming and sweating
- **Broad spectrum** To protect against both UV A and UV B rays
- **Sun protection factor** 30 or greater
- **Feels good** As you will be more likely to use it liberally and often

## Use lip protection

Lip protection sunscreen (or balm) is recommended for the prevention of lip cancers

## Avoid aerosol spray sunscreens

- It can be difficult to judge whether they have been applied evenly and generously
- Up to 1/3 aerosol sunscreens can be lost in even light wind (10 kph)

## Make sunscreen part of your daily routine

- Apply sunscreen on days when the UV Index is forecast to reach 3 and above
- Use the SunSmart Global UV app to check the UV index forecast and set notifications

## Apply generously on all areas of exposed skin

Use 1 teaspoon for:

- Each limb
- Front and back of torso
- Head and neck

**Total:** 7 teaspoons (35 mL)

## Re-apply when needed

Re-apply after swimming, sweating, and towel drying (including for water resistant sunscreens)

Re-apply every 2 hours during prolonged exposure

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**Footnotes**

- The case in this article is fictitious and no patient consent was needed.
- No patients were involved in the creation of this article.
- AN and CS contributed to the planning of the article and are responsible for the overall content as guarantors. All authors (AN, RA, CW, PK, CS) contributed to the drafting and editing of the article.
- Competing interests: *The BMJ* has judged that there are no disqualifying financial ties to commercial companies. The authors declare the following other interests: AN and CS are employed by Cancer Council Victoria, which is a member of Cancer Council Australia. Both are not-for-profit organisations. Cancer Council Australia derives income from the sale of sunscreen products; this income is used to fund cancer research, prevention and support activities. Cancer Council Victoria is a World Health Organization Collaborating Centre for UV Radiation, for which CS is the appointed director. Cancer Council Victoria is the developer of the free and not-for-profit SunSmart Global UV app.
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