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Review

Integrated sun protection advice for the South African population

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Abstract

Exposure to solar ultraviolet radiation (UVR) is associated with several cutaneous adverse effects. However, to the best of our knowledge, in South Africa there are no formal guidelines on sun protection. A group of South African dermatologists and researchers convened over the course of 1 year to deliberate on integrated advice for sun protection among the multi-ethnic South African population. For people with light skin and those with genetic skin disorders (e.g., oculocutaneous albinism), sun protection was identified as critical to prevent sunburn, skin cancer, and photoaging. The evidence is less clear for people with medium and darker skin types, especially the latter, in whom melanin may confer a degree of protection against some parts of the solar spectrum. Recent studies have demonstrated that visible light can cause pigmentary changes in individuals with darker skin types in particular. Sun protection for people of all skin colors is beneficial to protect against photoaging and ocular damage. Herein sun protection advice is suggested for South Africans of all skin colors to reduce morbidity and mortality from sun exposure, particularly relating to skin cancer. Several knowledge gaps are identified as future research priorities.

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Introduction

Solar ultraviolet radiation (UVR) exposure can have both beneficial and detrimental photobiological effects on human beings. Beneficial physiological (e.g., production of 1,25-hydroxyvitamin D) and psychological effects (e.g., prevention of seasonal affective disorder) are associated with sufficient UVR exposure, whereas detrimental effects are associated with either excess or insufficient exposure. A balance is required to obtain the beneficial effects of sufficient exposure while avoiding the detrimental effects of either excessive or insufficient UVR exposure. The adverse effects of excess solar UVR exposure include increased risk of immunosuppression (e.g., activating latent virus infections), sunburn, photodermatoses, basal cell carcinoma (BCC), cutaneous squamous cell carcinoma (SCC), and most types of cutaneous melanoma.[1]

Solar UVR comprises part of the solar electromagnetic spectrum and is divided into three parts (UVA, UVB, UVC) based on its biological effects. Only UVA and UVB reach the Earth's surface since stratospheric ozone absorbs all UVC.[2] Other parts of the solar electromagnetic spectrum including high energy visible light (VL) have also been associated with adverse health effects such as photoaging and pigmentary disorders, especially in people with medium and dark skin colors.[3–5] Infrared light (heat) is postulated to have a role in photoaging, rosacea, and may aggravate atopic dermatitis.[4]

Exposure to solar UVR is an important modifiable risk factor to prevent the adverse health effects associated with excess solar UVR exposure. By reducing exposure to solar UVR, one can prevent sunburn and other adverse consequences from solar UVR exposure. Personal sun protection (also known as photoprotection) is the most effective mechanism for reducing solar UVR exposure and includes the use of sunscreen as well as sun avoidance methods via several mechanisms, that is, use of physical barriers such as clothing, hats, sunglasses, shade (i.e., trees and physical awnings/shade sails, etc.), and avoiding peak solar UVR hours between 10 and 16 hours.[6] In addition to personal sun protection methods, regulation via supporting policies and guidelines is critical.

The World Health Organization (WHO) provides a set of recommendations that support sun protection with the intent to reduce adverse health impacts from solar UVR exposure such as skin cancer. Globally in 2020, over 1.5 million skin cancer cases were diagnosed and over 120,000 skin cancer-associated deaths were reported.[6] To prevent the global burden of disease associated with adverse health effects of solar UVR, the WHO recommends limiting time in the midday sun, seeking shade, wearing protective clothing including a broad-brimmed hat and wrap-around sunglasses, use of broad-spectrum sunscreen, and avoiding artificial tanning devices. Several countries, including Australia and Brazil, regulate or have banned the use of tanning beds or sunbeds.[7]

South Africa is located in the subtropical mid-latitudes and receives relatively high levels of solar UVR all year around. In South Africa, there is no overarching policy or guideline related to solar UVR exposure and its reduction, or prevention of the adverse health effects of solar UVR exposure. The Cancer Association of South Africa (CANSA, Not-For-Profit Number: 000-524) and the Skin Cancer Foundation (SCF, Not-For-Profit Number: 188-234) conduct several activities to raise skin cancer awareness and prevention around the country; however, there are no national guidelines or advice to help inform the public, physicians and clinicians, and others about the methods of sun protection that may be applied to prevent the adverse health impacts of solar UVR exposure. In addition, the South African population is multi-ethnic with four population groups, that is, Black African, Indian/Asian, Colored (individuals of mixed

ancestry), and White.[8] Each population group includes individuals with a range of skin colors and sun exposure susceptibility. Given the lack of available advice for such multi-ethnic populations, this review aimed to draw together the available evidence to support the development of integrated sun protection advice and actions for the South African population with relevance to all multi-ethnic populations. The recommendations are made to inform sun protection and sun avoidance behaviors and to suggest interventions to reduce mortality as well as the burden of disease associated with solar UVR exposure.

Skin color and the South African population

The South African population comprises approximately 60 million people as of mid-2022 with 51% female and 28% younger than 15 years of age. By population group, there were 81% Black Africans, 9% Colored people, 2% Indian/Asians, and 8% White people.[8] Among these population groups, constitutive skin color or pigmentation (based on melanin content) varies substantially from dark to medium to light. In 1975, the Fitzpatrick phototype classification system was developed and focused on personalized responses to sun exposure.[9,10] There were four different categories (Fitzpatrick groups I-IV), although later groups V and VI were added to include people with more pigmented, constitutional skin colors.

Another method for identifying skin color is using the individual typology angle (°ITA) based on the spectrophotometric measurements of the colorimetric parameters *L**(luminance) *a** (red/green component) and *b** (yellow/blue component) and allows skin types to be classified into six groups which range from very light to dark skin.[11] Although not currently being used by most dermatologists to assess various skin types, °ITA values have been shown to correlate with biologically efficient dose, DNA damage of skin following UVR exposure, and to be an accurate assessor of Asian and African skin types.[12] Research suggests that South African individuals span the skin color range of dark to light and that population group does not reliably predict constitutional skin color.[12] While the evidence supporting the occurrence of adverse solar UVR exposure-related impacts among people with different skin colors is limited, the group attempted to consider the variability and skin color nuances in the process of developing sun protection advice for all population groups. Advice has been tailored to three groups where relevant—individuals with dark, medium, or light skin colors. These broadly refer to Fitzpatrick V and VI, III and IV, and I and II, respectively. The reason for this decision is that with the limited available evidence, there is at present no reason to suggest that more specific advice is necessary.

Materials and methods

Process

A group consisting of six dermatologists from private and public practice and one public health specialist (based at a research council)—all with an interest to develop sun protection recommendations for South Africa—convened monthly between April 2022 and May 2023 to develop practical advice to support the public, dermatologists, clinicians, and others in making decisions about which sun protective measures to apply for South Africans of different skin colors.

Using an approach similar to an eDelphi consensus method, the group reviewed and discussed the literature and shared personal experiences regarding sun exposure and sun protection.[13] The group members independently ranked sun protection statements using a three-point Likert scale of "agree, neither agree or disagree, and disagree". The group then conducted an online discussion and shared comments to help guide consensus.

Sunscreen, sun-protective clothing, and accessories and sun-related behaviors were included in the sun protection advice provided. Where little to no evidence was available for people with different skin colors, the group erred on the side of caution and recommended sun protection for all individuals, irrespective of skin color, to protect against the harmful effects to the skin and eyes from sun exposure. This process has revealed several critical research gaps in the field, and these are discussed at the end of the results section.

Terminology

Sun protection methods encompass the following strategies:

1 The correct use of broad-spectrum sunscreen (i.e., sunscreen with UVB and UVA protection) and
2 Sun avoidance methods including the use of physical barriers such as:
   a Sun-protective clothing
   b Broad-brimmed hats
   c UV-rated, good quality, wrap-around sunglasses
   d Seeking shade (i.e., trees and physical awnings/shade sails, etc.)
   e Avoiding peak solar UVR hours between 1000 and 1600 hours

Results and discussion

Sun protection: general recommendations

The group agreed on a range of sun protection methods that may be applied to protect against excessive solar UVR exposure (Table 1). Sunscreen should be applied in adequate amounts at a dose of 2 mg/cm^2 or 35 ml for the average adult body surface area to render a Sun Protection Factor (SPF) close to what is indicated on the sunscreen product.[14] As a practical estimate, the 2-finger method directs the user that each body area in the 'Rule of Nines' (from burn wound assessment, for example, the head, neck, and face counts as one area) requires two fingers full of sunscreen—that is the amount squirted from a tube on the index and middle fingers from palmar crease to fingertips, to achieve the labeled SPF.[14]

Table 1 Sun protection and sun avoidance measures, sun protective clothing/accessories, as well as sunscreen and alternatives

General advice
Sun protection should be a daily consideration, whether deliberate or incidental sun exposure is expected.
We strictly advise against sun tanning.
We strictly advise against the use of indoor tanning devices.
If sunscreen is not accessible or affordable, other sun avoidance methods in combination with each other should be prioritized (see terminology section above for sun avoidance methods).
Children under the age of 6 months should not be exposed to direct sunlight (discussed below). If unavoidable, the use of sun avoidance methods is recommended (see above). An inorganic sunblock may be selected for use on small areas.
Sunscreen
Daily application of sunscreen is recommended to individuals of all skin colors, especially for individuals with light skin.
If sunscreen is not affordable to the individual, then use alternative sun avoidance methods (see above). Sunscreen use should be more vigorously promoted and encouraged for lighter skin colors to prevent skin cancer.
Sunscreen must be applied in adequate amounts-use the 2-finger method as a guideline (see above).
Sunscreen should be applied to all exposed areas of skin (including bald areas of the scalp, ears, and tops of hands).
Sunscreen should be applied 15–30 minutes before sun exposure and re-applied after perspiring or swimming, or every 2 hours. Re-application of sunscreen is not always possible; therefore, sun avoidance methods are recommended to ensure ongoing protection.
A sunscreen with the following properties is recommended as the gold standard: SPF50+ with UVA protection and cosmetic acceptability to the user.
Sunscreens with lower SPFs (30 and up) with UVA protection are acceptable, but attention to proper application is then crucial.
Traditional clay-based 'sunscreens' can be used if sunscreen is not available, however, the user should understand that they offer lower levels of protection than commercially available sunscreens (see below). For this reason, sun avoidance methods are particularly important.
Sun avoidance methods
A combination of sun avoidance methods (see above) is recommended.
Sun protective clothing
Wear clothing with a clear ultraviolet protection factor (UPF) rating where possible and if affordable. Otherwise, select tightly woven fabrics in darker brightly dyed colors (see below for examples). High collars, long sleeves, and long pants are preferred.
Broad-brimmed hats
Wear a hat with a brim that extends around the entire circumference of the head, with a brim of at least 6–7.5 cm.
Sunglasses
UV-rated, good quality, large, wraparound sunglasses are ideal.
Seeking shade
Trees, physical awnings/shade sails, and so forth should be deliberately planned and sought out.
Avoiding peak solar UVR hours
Plan to avoid sun exposure between 1000 and 1600 hours.
Sun exposure before or after these times still requires sun protection.
Shadow rule: if one's shadow is shorter than one is tall, there are high levels of UVR, and it is important to avoid the sun or limit sun exposure.

Sunscreen should be applied to all exposed areas of skin (including bald areas of the scalp, ears, and tops of hands) 15–30 minutes before sun exposure and reapplied every 2 h or sooner if perspiring or swimming.[15]

SPF measures the protection against sunburn (also known as erythema) which is predominantly caused by UVB. Randomized double-blind split face trials have shown an SPF100 as being superior to SPF50 in preventing sunburn, and a double-blind intraindividual study showed an SPF50 as being more effective than SPF15.[16–18] In terms of sunscreen specifications, the group recommends an SPF50 as the gold standard. The reason for this is that most sunscreen trials examining outcomes of interest test ideal, not real-world, sunscreen application. Commercial sunscreen SPFs are rated based on high concentrations of sunscreen use.[19,20] Observational studies show that consumers typically apply sunscreen at levels equivalent to half or less of the recommended quantity.[20–22] Hence, a higher SPF of 50 would compensate for the common underapplication of sunscreen by consumers.

Passeron et al.[4] recommend that the UVA protection factor be >1/3 of the labeled SPF for individuals with light skin color and >2/3 for individuals with dark skin color. They further tailor the ratio of SPF/UVA protection factors based on the condition they are aiming to treat or prevent.[4] Our group did not follow this precedent since this information is not readily available to South African consumers or clinicians, and the evidence for this approach is not clear. In terms of what the group refers to when recommending UVA protection, UVA protection should be a minimum of 1/3 of SPF, in line with South African regulations.[23] Some individuals (i.e., people with darker skin colors and hyperpigmentation disorders) will benefit from higher levels of UVA protection, however, it is not always easy for South African consumers to identify these products.[4]

Visible light protection is a relatively new concept in sun protection. VL includes (but is not synonymous with) high energy, blue or violet light, which are approximately synonymous with each other.[24] This is the portion of the visible spectrum that appears to have the most relevant biological effects (with this

research mainly conducted among people with light skin). To protect the skin from VL, sunscreen needs to be visible on the skin.[25] Inorganic sunscreens partially protect from VL but are not cosmetically acceptable, particularly on dark skin colors.[25] At present, tinted sunscreens containing iron oxides and pigmentary titanium dioxide appear to be the best option for VL protection.[25]

Traditional clay-based sunscreens are used in South Africa. Chemical testing showed that these offer low-level, broad-spectrum coverage.[26] They are not a replacement for rigorously tested and more efficient commercial sunscreens, but the group sees no reason to discourage their use if no alternative is available (assuming the safety of the clay, as it may be contaminated with arsenic in some areas).[26] The group felt it was important to emphasize that sunscreen use is only one component of sun protection. If it is inaccessible for economic or practical reasons, individuals can still practice sun avoidance measures and attain reasonable levels of protection.

An Australian and New Zealand consensus report recommends that citizens apply sunscreen every day when the UV Index (a measure of the level of solar UVR ranging from 0 to 11+ where the higher the value, the greater the potential for damage to the skin) is predicted to be 3 or greater.[27] This recommendation is irrespective of whether planned activities involve deliberate (e.g., participating in outdoor sports) or incidental (e.g., running errands) sun exposure.[27] The UV Index is available for the South African context but is not broadcast widely and widespread compliance with this sort of directive is questionable.

Suntans, whether acquired from natural sun exposure or indoor tanning, are associated with an increased risk of skin cancer and should be avoided.[28–30] Indoor tanning devices (sunbeds and similar) are recognized by the WHO as a carcinogen.[28]

Sun protection of children should be a priority. Infants under the age of 6 months and children under the age of 3 years have been identified as priority groups.[31] This is due to an inherent increased vulnerability to damage from the sun, and the potential long-term increases in skin cancer risks from childhood sun exposure.[31] The question of appropriate levels and types of sun protection in children with dark skin colors remains unanswered. This is particularly relevant in the South African context, where economic factors are a major concern and sunscreen is relatively expensive.

Finally, the questions about vitamin D, sun exposure, skin color, and how this relates to the South African context require discussion. Pediatric vitamin D sufficiency is critical for the prevention of calcipenic rickets and other negative health outcomes.[32] The group agrees with the recommendations of Ncayiyana et al. regarding the need for nutritional supplementation of vitamin D in at-risk infants.[33] The group advocates against reliance on sun exposure for vitamin D sufficiency. Sunscreen should be used, if possible, particularly in children with light and medium skin colors. There is evidence supporting this recommendation for children with light skin colors but less certainty for children with dark and medium skin colors.[34]

The efficacy of sun avoidance measures is not as extensively investigated as that of sunscreens. While studies have demonstrated a reduction in solar UVR exposure with shade seeking, in another study, use of beach umbrellas alone was shown to not be as effective as sunscreen (SPF100, correctly applied).[35,36] Backes et al. demonstrated the limitations of hats, in that even extremely wide-brimmed hats (circumferential brim of 17 cm) did not offer 100% UVR protection due to diffuse and reflected UVR, particularly at midday in summer.[37] Brims of this size are impractical in many scenarios.[37] More reasonable recommendations are of brims between 6–7.5 cm, with a compromise in efficacy.[15,37] Peak caps and helmet-style hats are least effective in most scenarios.[37]

A study of the sun protection efficacy of sunglass style demonstrated varying levels of protection depending on the size of the frames. The level of protection varied with sunglass geometry, wearing, and head positions, and environmental conditions.[38] Wraparound or side-shielded styles are considered optimal.[39] The contribution of solar UVR to ocular pathology (including melanoma) advocates for eye protection from the sun for all individuals.[40]

Sun-protective clothing may be designed to be sun-protective (with ultraviolet protection factor [UPF] ratings) or incidentally sun-protective.[41] Normal clothing with higher levels of sun protection is densely woven, often composed of polyester fabrics, and/or has high-intensity dyes, for example, dark polyester.[41] Thick fabrics like linen and denim are a good choice.[42] Frequent laundering may reduce UVR protection by reducing fabric density.[41] The garment protection factor (GPF) scale incorporates UPF and body surface area coverage and emphasizes the importance of the extent of clothing coverage.[41]

The use of physical barriers is important because the South African population includes many unemployed people (32.9% in 2023), and sunscreen is unlikely to be a financial priority to many individuals.[43] However, physical barriers are generally accessible and more pragmatic in this context. The use of these interventions in combination with each other should always be emphasized.

Sun exposure and skin color

Sun exposure may be acute or short-term, such as a vacation at a sunny place, or chronic as in the instance of occupational solar UVR exposure, respectively. Sun exposure may also be incidental given the ubiquitous nature of solar UVR or recreational, occupational, or purposeful, as in the case of suntanning.[44] Several factors influence sun exposure patterns and associated adverse health outcomes; some are related to the physical environment such as latitude, altitude, albedo (reflection), cloud cover, and so forth and others pertain to the individual, for example, age, gender, melanin content (skin color), occupation, lifestyle, sun protection habits, and so forth.

Several at-risk groups have been identified as being susceptible to the harmful effects of solar UVR. Children and adolescents with light skin are particularly vulnerable to the adverse effects of solar UVR exposure due to their skin structure, as well as since sunburn in early life leads to a higher risk of some types of skin cancer in later life.[45] Other at-risk groups include people with light skin, a high number of nevi, a family history of melanoma, those on photosensitizing medication, and the immunosuppressed (e.g., transplant patients). Also at risk are people with oculocutaneous albinism (OCA) (discussed below).

Melanin content relates to skin color where darker skin has a higher melanin content compared to lighter skin.[46] Population group, race, and ethnicity do not necessarily correlate with skin color. Sun protection advice can be given for three different skin colors: dark, medium, and light, and should primarily be based upon an individual's response or reaction to sun exposure. It is important to emphasize that there is little to no evidence about efficacious sun protection that protects against the major adverse effects of solar UVR, for example, skin cancer, for individuals with dark and medium skin color.[47] The value of sun protection for skin cancer prevention has an inverse relationship with the degree of melanin pigmentation in the skin, that is, sun protection is important for people with light skin and less melanin compared to the value of sun protection for people with dark skin (Figure 1). Despite the high protection to epidermal DNA afforded by dark skin color, especially in the basal epidermis, sun protection for people with darker skin colors could still be important to reduce photoaging, pigmentary disorders, and the risk of BCC.[48] This is a critical research gap.

While there are many unknowns about the evidence of the benefits of sun protection to prevent skin cancer among people with dark and medium skin, the group decided to err on the side of caution and develop general advice for sun exposure for people of all skin colors (Table 2). The group was not in unanimous agreement in this regard; however, this was a majority opinion.

Oculocutaneous albinism (OCA) is a genetically inherited autosomal recessive condition in which individuals lack melanin and are therefore highly susceptible to the harmful effects of solar UVR.[49] SCC is the most commonly occurring skin cancer among Black Africans with OCA, with BCC less often and melanoma only seen occasionally.[49] These skin cancers typically appear on sun-exposed body sites, that is, head and neck, therefore sun protection is essential—as suggested in Table 2.

Skin cancer

Table 3 presents the group's sun protection advice concerning skin cancer. Solar UVR has been identified by the International Agency for Research on Cancer (IARC) as a carcinogen and a risk factor for the development of skin cancer, that is, keratinocyte carcinomas and malignant cutaneous melanoma, especially in people with light skin color.[50] Sunburn in children has been associated with the development of skin cancer in later life.[51,52] Chronic sun exposure, such as those experienced by people who work outdoors, is also associated with skin cancer.[53,54]

For people with dark skin, there is little to no evidence that suggests solar UVR exposure is a risk factor for the development of melanoma. However, melanoma does occur in people with dark skin and is often diagnosed at an advanced stage raising the need for self-skin examination.[55] These melanomas are not sun-related in most cases.[56]

Individuals with medium skin color may have an intermediate risk of sun-related skin cancers. A 2022 systematic review of non-melanoma skin cancer and UVR exposure found a small

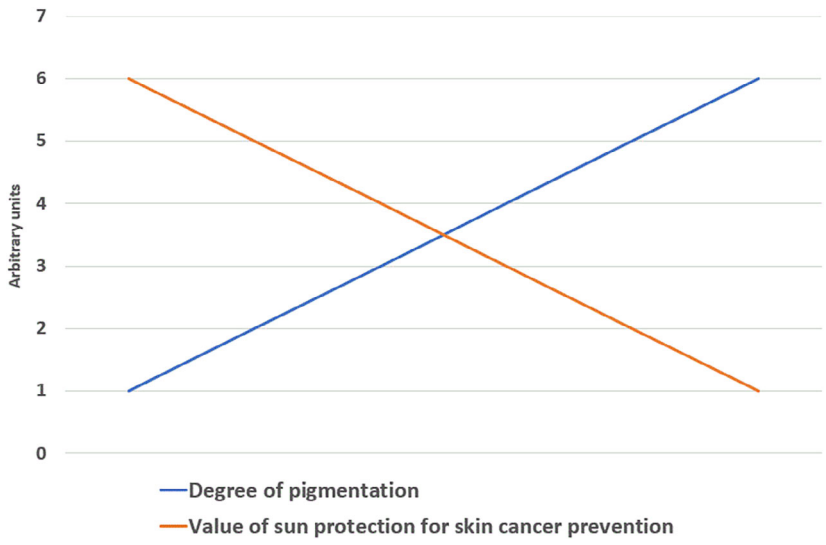

Figure 1 Schematic depicting the relationship between degree of pigmentation in the skin and the value of sun protection for skin cancer prevention. The scale on the *y*-axis is arbitrary

Table 2 Sun exposure and skin color

General advice
An individualized sun protection regime should ideally be provided for all patients—but is not always possible.
Individuals should consider their personal history of sun sensitivity or predisposition to skin cancers and upgrade their sun protection accordingly.
Sun protection is recommended for all children but especially for children with light and medium skin color. Eye protection is recommended for all children irrespective of skin color (note: an evidence-based review of eye health and UVR was not performed).
Individuals with dark skin colors
Sun avoidance methods and sunscreen are recommended to prevent photoaging and acquired pigmentary disorders and possibly skin cancer.
Sunscreen should include VL protection (see 'Sun protection: General recommendations').
Individuals with medium skin colors
Sun avoidance methods and sunscreen are recommended to prevent skin cancer, photoaging and acquired pigmentary disorders.
Individuals with light skin colors
Sun avoidance methods and sunscreen are recommended to prevent skin cancer, photoaging and, to a lesser degree, acquired pigmentary disorders. Sun protection should be rigorous due to the high risk of sun-related skin cancers.
Individuals with OCA
Sun avoidance methods and sunscreen with a high SPF (50+) and UVA protection should always be applied (see below).

Table 3 Skin cancer prevention advice

General advice
Sun avoidance and sunscreens with SPF50+ and UVA protection are recommended to prevent skin cancer (i.e., keratinocyte carcinomas, and melanoma).
Sunscreen should be applied rigorously according to the guidance provided above.
Sunscreen should be applied daily.
Childhood sun exposure should be minimized using a combination of sun avoidance methods and sunscreen.
These recommendations apply specifically to individuals with medium and light skin colors. At present, it is not known if these actions will prevent skin cancer in healthy individuals with dark skin colors. However, the group recommends sun protection for people with dark skin colors to err on the side of caution.

positive association in East Asian individuals (presumably with what we have defined as 'medium skin color').[57] This argues for increased attention to sun protection in this group and represents another research gap.

Other negative impacts of UVR

In addition to skin cancer, there are other skin-related adverse health impacts associated with excessive sun exposure including acquired pigmentary disorders, inflammatory disorders, photodermatoses, and photoaging.[4] These include several disorders, for example, vitiligo, rosacea, and chronic actinic dermatitis.[4] Each condition could benefit from tailored sun protection advice, which is beyond the scope of this article. However, since melasma, post-inflammatory hyperpigmentation, photosensitivity in HIV, and photoaging are common, contextually relevant concerns, they are referred to in more detail here, and specific advice is presented in Table 4.

Table 4 Advice for the prevention support of treatment of other negative impacts of solar UVR

Hyperpigmentation
Broad-spectrum sunscreens with high-SPF (SPF50+) and UVA protection are recommended for the prevention and treatment of hyperpigmentation disorders.
Sunscreens with VL protection should be selected, especially for individuals with medium and dark skin colors. Tinted iron oxide- and pigmentary titanium dioxide-containing sunscreens are preferable.
Year-round, intensive use of sunscreen and other sun protection methods is recommended to augment prescribed treatment and prevent relapses of melasma.
Photosensitivity in HIV
Sunscreen with VL protection is recommended (in addition to the general recommendations above).
Photoaging
General recommendations
Sun avoidance measures are an essential (and accessible) intervention.
Sunscreen with SPF50+ and UVA protection is recommended.
Sunscreen with VL protection adds an anti-photoaging effect (to all skin colors).
Medium and dark skin colors
Tinted sunscreen with VL protection is recommended in particular for individuals with dark and medium skin colors who are concerned about photoaging.

Hyperpigmentation: melasma and post-inflammatory hyperpigmentation

Melasma is seen more frequently in skin of color and is induced by UVB, UVA, and VL.[4] The efficacy of broad-spectrum sunscreens has been demonstrated in the prevention and management of melasma.[58,59] Studies typically emphasize the necessity of year-round, regular, and frequently reapplied sunscreen.[4,60] VL protection reduces relapses and increases treatment efficacy.[4,61]

Post-inflammatory hyperpigmentation (PIH) is induced by primary dermatoses or by therapeutic or cosmetic procedures. In general, broad-spectrum tinted sunscreens with VL protection are recommended for the prevention and management of PIH.[4,62] Mitigating the effects of VL (specifically the HEV portion) is an emerging strategy in the management of PIH.[4,5]

Visible light has been demonstrated to have the ability to induce more intense and longer-lasting pigmentation in dark skin types than UVA1 alone.[17] Tinted sunscreens are products that combine different concentrations of iron oxides and pigmentary

titanium dioxide with UV filters to protect against visible light.[25] Tinted sunscreens reduce VL transmission by 93–98%.[62] Therefore, tinted sunscreens are beneficial for patients with melasma and PIH and can camouflage hyperpigmentation.[60,63]

HIV-associated photosensitivity

Photodermatoses are seen in 5% of HIV-infected patients and may be the presenting feature of HIV.[64,65] Considering the potential for photosensitivity to be triggered by UVA, UVB, or VL, and the wide range of photosensitivity reactions in this group of patients (e.g., photo-distributed drug eruptions, porphyria cutanea tarda), it is recommended that general sun protective measures and sunscreen with high SPF, UVA, and VL coverage be used.[64,66–68]

Photoaging

Photoaging refers to skin damage accelerated by sun exposure, which leads to many of the characteristic features we associate with aging.[3] Patterns of photoaging vary with skin color and tend to be more prominent and of earlier onset in light skin colors.[3] It is established that photoaging is caused by UVR exposure.[3] VL and infrared are now recognized as contributing factors too.[3,69] Several studies have demonstrated the efficacy of sunscreen in the prevention and improvement of the features of photoaging, including in dark and medium skin colors.[69] VL and UVA protection is particularly relevant in individuals with medium and dark skin colors to prevent irregular hyperpigmentation.[4,5] Tinted sunscreens which render VL protection and good color matches for medium and dark skin colors are considered a good choice.[63]

Other

Solar UVR exposure is associated with several eye conditions such as photokeratitis, photoretinitis, cataract, pterygium, SCC of the cornea and conjunctiva, and cancers of the eyelids.[70]

Sun protection education

Raising awareness about the risks of solar UVR exposure is critical to prevent the adverse associated health effects. Education is crucial and should be included in the school curriculum from a very early age if life-long positive sun behaviors including sun protection are to be fulfilled (Table 5). Such curricula changes have shown positive effects, e.g., reducing skin cancer incidence.[71] Moreover, school sun protection policies and practices, as implemented in Australia (Education Victoria), New Zealand (Cancer Society), and the United States (CDC), have been successfully adopted and in part contributed towards sun protection practices taken up by children and their families.[72–74] Larger community-wide, multi-pronged sun awareness and skin cancer prevention programs have had positive impacts on reducing melanoma incidence, in particular, in Australia.[75]

Table 5 Educational advice related to sun protection

Sun protection education is necessary for all children regardless of skin color.
Schools should adopt sun protection initiatives that include providing shade in outdoor areas, sunscreens in large dispensers and appropriate uniforms when children are sun-exposed.
There should be special attention to sun protection provided to children with albinism and xeroderma pigmentosum.
A sun protection policy should be mandatory in all schools.

Other recommendations

Relative to international best practices and locally relevant recommendations and in the context of South Africa, we suggest several points related to bans and advocacy (Table 6).

Gaps in research

During the process of the group's discussions, several gaps in the literature were identified, and these present opportunities for future research. They include:

- What is the role of solar UVR exposure in skin cancer development among people with dark and medium skin colors?
- Does childhood sun exposure predispose individuals with dark skin colors to an increased risk of skin cancer or other negative outcomes later in life?
- What is the optimum balance between sun protection and vitamin D production in an under-resourced country like South Africa, with a sunny climate and a population with predominantly dark and medium skin colors?
- What is the utility and safety of natural sunlight as a treatment for vitiligo and psoriasis, especially in under-resourced countries like South Africa?
- Is there a relationship between the use of skin depigmenting or lightening agents and skin cancer?
- What is the role of sun protection and vitamin D levels in people with atopic dermatitis in the South African context?
- What is the role of photosensitivity in HIV-positive individuals and the effect of antiretroviral therapy?

Table 6 Bans and lobbying actions related to sun protection and sun exposure

Bans
Banning of all types of sun beds.
Banning of all (unregulated) skin-lightening agents.
Advocacy
Lobbying for the development of and access to affordable sunscreens.
Lobbying for the development of and access to sunscreens with cosmetic acceptability on dark skin colors.
Lobbying for a sun protection policy for South African schools.
Lobbying for an occupational sun protection policy for outdoor workers.

Conclusions

This is the first attempt at the development of integrated sun protection advice for the multi-ethnic South African population. Taking into consideration the body of available evidence as well as vulnerable groups and people with different skin colors, advice for sun protection has been proposed to help protect South Africans. This advice is relevant to countries with similar multi-ethnic populations. Vulnerable groups such as parents and caregivers of children, immunocompromised individuals, people with OCA and xeroderma pigmentosum, and others at risk of solar UVR exposure impacts should be guided by the advice made by the group. Additional research and sun protection advice is needed for different parts of the solar electromagnetic spectrum, for example, VL and others. Moreover, evidence to understand the impacts of solar UVR exposure on people with dark and medium skin colors is required to better inform the development of sun protection guidance for all individuals in the future.

True/false questions (answers provided after references)

1 Solar ultraviolet radiation exposure has both positive and negative effects on human health.
2 Exposure to solar ultraviolet radiation is a modifiable risk factor to prevent adverse health effects.
3 All people in a population group have the same skin color.
4 SPF stands for Sun Protection Factor.
5 It is safe to use an indoor tanning bed.
6 When spending time at the beach, it is OK to put sunscreen on only when you get to the beach.
7 It is important for schools to implement a sun protection policy.
8 UPF stands for Ultraviolet Prevention Factor.
9 On cloudy days, you do not need to use sun protection because the cloud blocks the sun's rays.
10 In general, darker colored clothing offers more sun protection than light colored clothing.

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Answers to questions

1 True
2 True
3 False
4 True
5 False
6 False
7 True
8 False
9 False
10 True