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Narrative Review

# Sun Protection Advice for the South African Population for the Prevention and Management of Skin Diseases

Thuraya Isaacs[1] | Tarryn Jacobs[2] | Dagmar Whitaker[3] | Willem Visser[4] | Kim Wiid[5] | Ncoza C. Dlova[6] | Caradee Y. Wright[7,8] | Bianca Tod[4]

[1]Division of Dermatology, Department of Medicine, University of Cape Town, Cape Town, South Africa | [2]Private Practice, Pretoria, South Africa | [3]Private Practice, Cape Town, South Africa | [4]Division of Dermatology, Department of Medicine, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa | [5]LOréal Dermatological Beauty, Johannesburg, South Africa | [6]Dermatology Department, Nelson R. Mandela School of Medicine, University of KwaZulu-Natal, Durban, South Africa | [7]Climate Change and Health Research Programme, Environment and Health Research Unit, South African Medical Research Council, Pretoria, South Africa | [8]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa

**Correspondence:** Thuraya Isaacs (thuraya.isaacs@uct.ac.za) | Bianca Tod (biancatod@gmail.com)

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## ABSTRACT

Sun protection is critical for the prevention and management of skin cancer and other photosensitive dermatoses in South Africa's diverse population. This review expands on previously published sun protection advice for skin cancer prevention by providing tailored advice for individuals with specific dermatological conditions. Recent advances in sunscreen technology, including enhanced protection for long-wave UVA1, visible light, and infrared radiation; inorganic sunscreens with more cosmetic acceptability; and the addition of other active ingredients unrelated to sun protection, are discussed in the context of specific dermatoses. Visible light protection, particularly tinted sunscreens, is particularly relevant for dark to medium skin tones prone to pigmentary disorders, such as melasma and postinflammatory pigmentation. Practical advice is provided for optimizing sun protection in inflammatory conditions, such as acne, rosacea, eczema, and psoriasis, where formulation and tolerability are important for compliance. Photoprotection for photodermatoses and human immunodeficiency virus (HIV)-associated dermatoses is also discussed. Recognizing the economic barriers to sunscreen access, the paper emphasizes the critical role of sun avoidance behaviors, such as sun-protective clothing and seeking shade, in resource-limited settings.

## 1 | Introduction

Sun protection is an established intervention for preventing skin cancer and other photosensitive dermatoses and includes sunscreen use and sun avoidance measures, such as sun-protective clothing, hats, sunglasses, seeking shade, and avoidance of peak ultraviolet (UV) times [1]. We previously published sun protection advice for South Africans of all skin colors, focusing on skin cancer prevention [2]. While the general public is advised to use sunscreen (and other sun-protective measures), a more tailored approach may be beneficial in individuals struggling with specific photosensitive dermatoses [3].

Recent advances in sunscreen technology, including enhanced long-wave UVA1, visible light (VL) protection, IR protection, and the addition of active ingredients, allow sunscreen use to be optimized in the context of the prevention and treatment of specific dermatological diseases. Contemporary

sun protection recommendations for South Africa's diverse population need to consider sun protection that is relevant to individuals of all skin colors, accessible, cosmetically and culturally acceptable, and cost-effective. This follow-up review aims to offer practical, condition-specific recommendations based on current evidence.

## 2 | Methods

A panel of six dermatologists with a special interest in photoprotection, pooled from both the private and public sectors, and one public health specialist, convened monthly over a year, between April 2022 and May 2023, to develop bespoke practical South African sun protection recommendations to support and guide health care practitioners and consumers. This review expands on the recently published integrated sun protection advice for the South African population [2]. A modified e-Delphi approach was used to achieve consensus, and the methodology has been previously described [2]. A comprehensive literature search was conducted in PubMed, Embase, and Google Scholar to identify studies on sun protection for specific dermatoses.

Information on commercially available sunscreen products for the relevant tables was collected from online websites of major South African dispensaries and industry websites [4, 5]. In addition, panel members reviewed the tables for any omissions. These are not intended to be comprehensive lists of all sunscreens on the South African market, but rather a guide to sunscreens with long UVA1, tinted sunscreens with VL coverage, and inorganic filters. Panel members objectively identified sunscreens fitting the aforementioned criteria and were not influenced by industry affiliations. A comprehensive list of sunscreens sold in South Africa is not available. The price was calculated as the recommended retail price (RRP) in rands and US dollars, as of March 2025.

## 3 | Results and Discussion

UV light (290–400 nm) includes UVB (290–320 nm) and UVA (320–400 nm) light [6, 7], with UVA further divided into UVA2 (320–340 nm) and UVA1 (340–400 nm) [6]. VL includes light detected by the human eye, specifically across the color spectrum (400–700 nm) [7]. Infrared light (IR) refers to 700 nm–1 mm [7, 8].

Several recent advances in sunscreen technology have implications for the prevention and treatment of dermatological conditions [9]. These include the role of UVA1, VL, and IR protection; tinted sunscreens; mineral sunscreens with more cosmetically acceptable formulations; and the addition of active ingredients not primarily concerned with the sun protection action of the product, each discussed below [9].

### 3.1 | Role of UVA1, Visible Light, and Infrared Protection

The importance of UVA1, and especially long-wavelength UVA1, protection is increasingly recognized. It has a particular role to play in preventing hyperpigmentation in all phototypes, and particularly in individuals with dark and medium skin colors [10]. While UVA1 protection is important for all skin types, people with dark and medium skin colors and disorders characterized by hyperpigmentation should select sunscreens with higher levels of UVA protection, particularly long-wavelength UVA1 [6, 9].

South African regulations stipulate that sunscreens bearing the UVA symbol should provide UVA protection of at least 1/3rd of the sun protection factor (SPF) in vivo or up to 370 nm in vitro [11]. For people with dark skin tones, Passeron et al. [9] recommend that the UVA protection factor should be > 2/3 of the labeled SPF. There is no single internationally agreed-upon rating system for UVA, and sunscreen UVA labeling is not always clear, making comparisons for UVA ratings difficult for both consumers and clinicians. Table 1 summarizes the UV labeling/rating systems [12, 13].

According to the United States Food and Drug Administration (FDA), all sunscreens claiming broad spectrum must meet a critical wavelength of 370 nm; however, few offer very long UVA1 protection (370–400 nm). Newer filters with coverage in this range include methoxypropylamino cyclohexenylidene ethoxyethylcyanoacetate (Mexoryl 400) and phenylene bis-diphenyltriazine (TriAsorB), with a wide absorption spectrum up to 400 and 450 nm, respectively [12]. Table S1 includes commercially available sunscreens with ultralong wave UVA1 light protection (370–400 nm) available on the South African market.

Visible light, specifically the high energy portion (blue and violet light), has important effects on the skin [14]; it can induce erythema in light skin and pigmentation in medium and dark skin [7]. VL can induce pigmentation independent of UV light. Mahmoud et al. [15] demonstrated that VL can induce immediate and persistent darkening in Fitzpatrick skin types III–VI, which was darker and more sustained than that caused by UVA1. VL plays a role in skin conditions like hyperpigmentation disorders and less so in photoaging [16, 17]. Therefore, VL protection appears to be of particular importance in individuals with dark and medium skin colors [9]. Sunscreen should be visible on the skin to be effective in protecting from VL, and this can challenge cosmetic acceptability [7]. Inorganic sunscreens, also called physical or mineral sunscreens (non-nanosized), offer VL protection; however, they tend to leave a white cast on the skin [7]. Nanosized versions of mineral sunscreens (particle size < 100 nm) may improve the cosmetic acceptability of these sunscreens (although not adequately in dark skin); however, with the resultant loss of VL protection [7]. Tinted sunscreens with iron oxides or pigmentary titanium dioxide are currently the best available choice for VL protection [7]. Antioxidant-based formulations are also being investigated for VL protection, and these may present novel alternatives for all skin tones by reducing the effects of VL damage by reactive oxygen species [6, 18]. Table S2 summarizes tinted sunscreens available on the South African market.

Infrared and near-IR radiation exposure has biological effects on the skin [8, 19]. This is related to the heating effects of infrared [8]. It has specific influence in the pathogenesis of rosacea, atopic dermatitis, and photoaging [9, 17]. Traditional sunscreen

**TABLE 1** | Comparison of UVA protection rating systems or indications of UVA protection [12, 13].

| Rating systems | Measurement | Rating | Ratio | Interpretation |
|---|---|---|---|---|
| UVA in circle | — | — | — | Meets regulatory requirements of 1/3 SPF |
| Broad-spectrum | — | — | — | Meets regulatory requirements of 1/3 SPF |
| PA system | Ratio of mean UVA1 absorbance to total UV | PA* | > 0.2 | Low |
| | | PA** | > 0.4 | Medium |
| | | PA*** | > 0.7 | High |
| | | PA**** | > 0.95 | Highest |
| Boots star rating system | Ratio of UVA absorbance to mean UVB absorbance | ** | < 0.6 | Medium |
| | | *** | 0.6–0.79 | High |
| | | **** | 0.8–0.89 | High |
| | | ***** | > 0.90 | Highest |

ingredients do not offer protection from IR radiation; however, initial studies on sunscreens containing antioxidant combinations (grape seed extract, vitamin C, vitamin E, and ubiquinone) have been shown to do so [8, 19].

### 3.2 | Tinted Sunscreens

Unlike SPF and broad-spectrum labeling, there are no specific guidelines on tinted sunscreens. The ability of a tinted sunscreen to provide VL protection relies on the presence of iron oxides and/or pigmentary titanium dioxide [7]. Tinted sunscreens have been shown to be effective in reducing VL exposure [20] as well as being more effective at reducing VL transmittance than both non-tinted sunscreens containing both organic and inorganic filters [21]. Dumbuya also demonstrated that iron oxide-containing formulations were more effective in protecting against VL-induced pigmentation than mineral SPF 50 sunscreens in Fitzpatrick type (FPT) IV skin [22]. Tinted sunscreens may also have other benefits: A recent randomized trial in FPT II-IV demonstrated that tinted sunscreens significantly reduced erythema, improved transepidermal water loss, and increased skin brightness compared to non-tinted sunscreens with the same formulation [23].

Consumers should be made aware that iron oxides may be listed under inactive ingredients and may also be listed as CI77491 (red), CI77492 (yellow), and CI77499 (black); and pigmentary titanium dioxide as CI77891 [7, 24].

#### 3.2.1 | Challenges of Tinted Sunscreens in Skin of Color

Despite the benefits of tinted sunscreens in treating and preventing hyperpigmentation in skin of color, the challenges of their use in darker skin tones are often overlooked [25].

In a survey, only 42.9% of dermatologists were shown to never, rarely, or only sometimes take skin tone into account when prescribing sunscreens, and rated cosmetic elegance as the least important factor [25, 26].

In a recent review, Xue et al. [27] identified major barriers of tinted sunscreen in skin of color as poor cosmetic elegance, shade mismatch, insufficient application, and high cost. The majority of tinted sunscreens have only one "universal" shade which often fails to match darker skin tones [27]. Patients also report dissatisfaction due to a lack of tone-matching, with most negative reviews from individuals with skin types V–VI [28]. Application also tends to be suboptimal in all skin tones: in one study, only 58% used the recommended amount, thereby compromising efficacy [29]. Additionally, cost is a huge barrier as websites are more likely to recommend more expensive products to patients of color [25, 26, 28].

### 3.3 | Mineral Sunscreens With More Cosmetically Acceptable Formulations

Inorganic filters are synonymous with mineral or physical filters, whereas organic sunscreen refers to products with chemical filters [30]. Although not supported by scientific evidence, anecdotally, many consumers perceive inorganic formulations to be safer or "clean" choices and may request them. Table S3 summarizes inorganic sunscreens available in the South African market.

### 3.4 | Addition of Active Ingredients to Enhance or Target Associated Skin Conditions Other Than Sun Protection

A range of active ingredients are included in modern sunscreens. These ingredients are not specifically necessary to filter UV but rather are tailored to specific concerns of the consumer, for example, photoaging, xerosis, or pigmentation. These ingredients include antioxidants, DNA repair enzymes, anti-inflammatory agents, immunomodulators, nonprescription

**TABLE 2** | Examples of active ingredients added to sunscreens with possible utility in the management of melasma.

| Antioxidants | Anti-inflammatories | Immunomodulators | Depigmenting compounds (nonprescription) | Skin barrier support |
|---|---|---|---|---|
| Vitamin C<br>Vitamin E<br>Niacinamide<br>Liquorice extract (Glycyrrhiza inflata)<br>Feverfew extracts | Liquorice extracts (Glycyrrhiza inflata)<br>Feverfew extracts | Liquorice extracts (Glycyrrhiza inflata) | Niacinamide<br>Liquorice extracts (Glycyrrhiza inflata)<br>Resorcinol extracts<br>Isobutylamido thiazolyl resorcinol (Thiamidol)<br>Mercaptonicotinoyl glycine (Melasyl) | Emollients<br>– Dimethicone<br>Humectants<br>– Hyaluronic acid<br>– Glycerin |

depigmenting compounds, and agents that support the skin barrier. Tinted formulations, which contain iron oxides, may assist in cosmetic camouflage of skin conditions such as rosacea and postinflammatory hyperpigmentation (PIH). Several of these ingredients are presented or referred to in Tables 2–5, by relevant dermatological condition.

## 4 | Specific Dermatological Conditions for Which Sunscreen Can Be Optimized

### 4.1 | Acquired Pigmentary Disorders

Pigmentary disorders include melasma, postinflammatory pigmentation, solar lentigos, pigmented contact dermatitis (Riehl melanosis), lichen planus pigmentosus, periorbital melanosis, erythema dyschromicum perstans (ashy dermatosis), and exogenous ochronosis [13]. Hypo- or depigmented conditions include vitiligo and postinflammatory leucoderma, among others [9]. Pigmentary disorders in which sun exposure is not considered critical to pathogenesis, presentation, or management are omitted. VL has been shown to be an important driver of hyperpigmentation, particularly in dark skin colors [16]. VL protection needs to be addressed in the management of melasma, postinflammatory hyperpigmentation (PIH), and solar lentigines.

#### 4.1.1 | Melasma

UVB, UVA, and VL induce melasma [9]. Therefore, broad-spectrum, high-factor sunscreens with VL protection are a critical component in the prevention and management of melasma [32, 33]. Intensive daily use of sunscreen is recommended, irrespective of the season or weather, with reapplication throughout the day [9, 34]. Tinted sunscreens are recommended for melasma patients as they offer sun protection that includes VL protection, as well as camouflage [34, 35]. Tinted sunscreens have been shown to play a significant role in improving hyperpigmentation and reducing melasma relapse [9, 25, 36], as well as enhancing the depigmenting efficacy of topical hydroquinone [25]. The optimal sunscreen for melasma should have UVB (ideally SPF 50+), UVA (including UVA1, UPF ≥ 20, meaning ≥ 2/3 SPF), and VL protection, contain additional active ingredients (see Table 2) and be cosmetically acceptable or even aid in camouflaging [2, 34]. While SPF 30 may be adequate for skin of color [9, 10], the panel recommends SPF50 for consistency of public health messaging and to accommodate inadequate application [2]. Additional ingredients, such as antioxidants and other free radical scavengers, may have a place in the prevention and treatment of melasma. Initial studies have shown that these may decrease the deleterious effects of VL and IR [34]. Additionally, *Polypodium leucotomos* extract, an oral supplement with antioxidant and photoprotective actions, was shown to improve melasma treatment outcomes in combination with sunscreen and hydroquinone [37].

There is some evidence that the support of skin barrier function may help treat melasma. Theoretically, this can be achieved with the use of emollients, humectants or other agents which support the skin barrier [34, 38]. It is important to note that other methods of sun protection (i.e., hats, seeking shade etc.) are another critical component of melasma management [34]. These should be emphasized in patients with financial constraints.

#### 4.1.2 | Postinflammatory Hyperpigmentation

Postinflammatory hyperpigmentation refers to hyperpigmentation caused by a preceding inflammatory skin disease, a procedure, or skin trauma. Protection against VL (particularly high-energy blue or violet light) is critical in the management and prevention of PIH [9, 18]. Broad-spectrum sunscreens with VL protection are central in the prevention and management of PIH [9, 20]. Either non-nanosized mineral sunscreens or tinted sunscreens can be selected, depending on the cosmetic needs of the patient. Sunscreens with antioxidant additives reduce the risk of erythema (in light skin colors) and hyperpigmentation (in dark skin colors) induced by VL and UVA1 [18].

For therapeutic and cosmetic procedures, sunscreen with SPF 50+ and high UVA protection is recommended [39] (Table 3). Anti-inflammatory agents like licochalcone-A and glycyrrhetinate reduce the likelihood of PIH after laser therapy, when used with extremely high SPF sunscreens (60+) [9]. Avoidance of direct sunlight and the use of a broad-brimmed hat are specifically recommended for nonsurgical procedures that involve

**TABLE 3** | Advice for pigmentary disorders, photodermatoses and photoaging.

| **Acquired pigmentary disorders** |
|---|
| General recommendations for prevention and treatment of disorders of hyperpigmentation |
| Sunscreen with SPF50+ and good UVA protection are recommended |
| VL protection offers an additional benefit, especially in individuals with dark and medium skin colors. Tinted formulations containing iron oxide and pigmentary titanium dioxide are recommended |
| Physical sun protection methods (hats, sunglasses, sun avoidance) are recommended |
| Melasma |
| Intensive sun protection (sunscreen and sun avoidance) should be practiced throughout the year |
| Post-inflammatory hyperpigmentation (induced by cosmetic procedures) |
| Strict sun protection for 2–4 weeks before and 2 weeks after inflammation resolves, is recommended |
| Opaque dressings to protect the treatment area from the sun should be used if feasible |
| Vitiligo |
| Individuals with vitiligo should avoid sunburns to prevent worsening of their condition |
| Treatment with natural sunlight should be monitored by a dermatologist or clinician with appropriate training |
| **Photodermatoses** |
| General recommendations for photodermatoses |
| SPF 50+ with UVA cover is recommended |
| Vigorous sun avoidance measures (hat, clothing etc.) are recommended for all patients with a photosensitive element to their condition |
| Solar urticaria/angioedema |
| Sunscreen with VL protection is recommended (in addition to the general recommendations above) |
| Porphyrias |
| Sunscreen with VL protection is recommended, however, sun avoidance methods should be prioritized |
| Photo-aggravated dermatoses like lupus erythematosus and dermatomyositis |
| Sunscreen with VL protection is recommended (in addition to the general recommendations above) |
| Photosensitivity in HIV |
| VL protection is important, along with the general recommendations above |
| **Photoaging** |
| General recommendations for photoaging |
| Sun avoidance methods are recommended |
| It is recommended that sunscreen with SPF50+ and UVA protection should be used daily |
| VL protection offers additional benefits, irrespective of skin color |
| The use of antioxidants and other additives may be useful for the prevention and treatment of photoaging. Due to the cost factor, they should be used once all other sun protection interventions are in place since they are not a replacement for standard sun protection methods |
| Medium and dark skin colors |
| Individuals with medium and dark skin colors who want to prevent or improve photo-aging should choose tinted sunscreen with VL protection |

large areas [39]. Opaque dressings should be used for up to 15 days after the procedure-induced inflammation has resolved [9]. Depending on the procedure, sun protection up to a month before the procedure is advised [39].

#### 4.1.3 | Other Dermatoses Causing Hyperpigmentation

Conditions such as pigmented contact dermatitis (Riehl melanosis), lichen planus pigmentosus, and erythema dyschromicum

**TABLE 4** | Sun protection advice for patients with inflammatory skin disorders.

| **Inflammatory disorders [9]** |
|---|
| **General recommendations** |
| SPF 50+ with UVA cover is recommended. |
| Patients with inflammatory skin disorders should prioritize sun protection methods like sun-protective clothing and sun avoidance because of the increased risk of systemic absorption if sunscreen is applied to inflamed, lesional skin, especially if a large body surface area is affected. |
| The recommendations for PIH prevention should be followed, particularly in individuals with medium and dark skin colors. |
| Particular attention should be paid to the tolerability and cosmetic features of prescribed sunscreens in this group of patients. |
| Patients who take systemic immunosuppressives or who have had multiple PUVA treatments for their inflammatory disorder should be counseled to prioritize sun protection. |
| **Rosacea** |
| Water-based sunscreens are recommended. |
| Sunscreen with inorganic filters, such as zinc oxide and titanium dioxide, tend to be well-tolerated in rosacea and are recommended. |
| Sunscreens with additional emollients and active ingredients for rosacea may be helpful if this suits an individual's budget and preferences. |
| Sunscreens containing green pigments and cosmetic camouflage may be considered as they positively impact on patient appearance |
| **Acne vulgaris** |
| Sunscreen formulations for acne patients should be lightweight, nongreasy, and noncomedogenic (e.g., gel or liquid formulations). |
| The recommendations for PIH prevention should be followed, particularly in individuals with medium and dark skin colors. |
| Consider inorganic sunscreens, but white residue may not be cosmetically acceptable. |
| Patients on photosensitizing acne medications should be counseled to adhere to all sun protection methods. |
| **Atopic dermatitis** |
| Atopic dermatitis patients should apply a small amount of new sunscreen on the inside of the forearm for a few days to check if there is a skin reaction. |
| Consider inorganic sunscreens but white residue may not be cosmetically acceptable. |
| Sunscreens with additional supportive ingredients such as dexpanthenol, ectoine, vitamin E, and bisabolol can be used, if tolerated and affordable to the patient. |
| Patients should avoid applying sunscreen to areas of active inflammation or that are eroded. |
| Consider assessment of vitamin D levels in atopic dermatitis patients who are poorly controlled, are practicing aggressive sun protection and/or have medium or dark skin colors. |
| **Psoriasis** |
| Specific sun protection recommendations should be made for individuals with psoriasis, taking into consideration baseline predisposition to skin cancer (light skin color), exposure to immunosuppressive or photosensitizing medications and PUVA, as well as response to sun exposure. |
| Sunburn should be avoided due to the risk of koebnerisation. |

perstans (ashy dermatosis) all present with hyperpigmentation with varying distributions and require strict sun protection [37, 38, 40]. There is limited data on the role of sun protection in the treatment of exogenous ochronosis [31, 41]. A 2014 literature review found a case series of only two patients treated with sun protection and sun avoidance, and this had no effect [41]. Another review recommended strict sun protection, including hats, eye protection, and sunscreen, in combination with active treatment modalities [31]. No specific details regarding sunscreen characteristics were found.

#### 4.1.4 | Vitiligo

There is little evidence suggesting that individuals with vitiligo have a lower incidence of both melanomas and nonmelanoma

**TABLE 5** | Additional sunscreen ingredients which may have utility in supporting the management of select inflammatory conditions (adapted from Rigel et al.) [6].

| Acne vulgaris | Atopic dermatitis | Rosacea |
|---|---|---|
| Glycyrrhizinate | Bisabolol | Ceramide |
| Green tea | Ceramide | Cyclomethicone/dimethicone |
| Hyaluronic acid | Dexpanthenol | Tints |
| Lactic acid | Ectoin | |
| Iron oxide/pigmentary titanium dioxide | Hyaluronic acid | |
| | Licochalcone A | |
| Niacinamide | Iron oxide/pigmentary titanium dioxide | |
| Vitamin C | Dimethicone | |
| Vitamin E | Vitamin E | |

skin cancers [42]. This may be due to confounders like sun-related behaviors, rather than inherent differences in predisposition [42]. The British Academy of Dermatologists vitiligo treatment guideline recommends the use of an SPF 50+ and UVA protection (4-star or 5-star Boots star rating) which should be applied to both affected and unaffected skin [42]. This recommendation was derived from informal consensus [42]. UV light therapy is a common treatment for vitiligo. Some authors recommend exposure of areas of vitiligo to UV light (solar or therapeutic) until they become pink as a method of treatment [9]. This strategy needs to be carefully controlled, as sunburn can lead to koebnerisation and worsening of vitiligo [9]. Of note, the British guidelines only recommend UV therapy under controlled clinical conditions. In the South African context, where such units are rare, a treatment strategy using controlled natural light may be feasible. This presents an opportunity for research.

## 4.2 | Inflammatory Disorders

Inflammatory disorders may be aggravated or improved by exposure to sunlight. The risks and benefits of sun protection should be discussed with all patients presenting with these disorders. These patients already have a significant disease burden in terms of topical therapies. To ensure compliance, sun protection should be simplified, and special attention should be given to the tolerability of sunscreens. The risk of PIH caused by these conditions varies depending on the individual's skin color and condition. The most common inflammatory disorders have been discussed individually.

### 4.2.1 | Rosacea

UV light exposure is an established trigger for rosacea [9, 43]. It may even initiate the pathogenic process [43]. Broad-spectrum SPF 30+ (with UVA protection) sunscreen with VL and IR protection was recommended by a recent multinational expert panel [9]. Their reasons for recommending an SPF 30+ as opposed to 50+ were not given. Our recommendation is the use of SPF50+ if possible (Table 4). This is to simplify our recommendations and is contextually relevant. The recommendation regarding IR protection is logical in terms of heat being a trigger for rosacea. They recommend that antioxidants should be employed to mitigate the effects of IR [9]. There is little evidence on treatment outcomes of rosacea patients treated with sun protection—a review performed in 2021 found only six articles documenting the impact of sun protection on rosacea [43]. The precise characteristics of the optimal sunscreen for rosacea have not been adequately studied [43]. Suggested characteristics include water-based formulations, inorganic sunscreen filter ingredients like zinc oxide and titanium dioxide, and additional ingredients like emollients (dimethicone and cyclomethicone) [9], others with anti-rosacea properties, and the addition of green pigments or camouflage [43]. Individual tolerance and preference should be assessed. Oil-based formulations can aggravate rosacea [43]. Inorganic filters like zinc oxide are well-tolerated but can leave an unsightly residue and reduce compliance [43].

### 4.2.2 | Acne

UV light can play a role in the development of closed comedones; however, there is no evidence to show that sunscreen use influences acne vulgaris activity [9]. Approximately 50% of acne patients report worsening during summer [44]. Sunlight has conflicting effects on acne [44]. UVA1 and visible (blue) light can be used to treat acne but are the major drivers of PIH, especially in dark and medium skin colors [44]. UVB seems to aggravate acne [44]. The prevention of PIH, particularly in individuals with medium and dark skin colors, is critical in acne management [9]. Noncomedogenic, nongreasy sunscreens, such as lighter textured gel or liquid formulations, are recommended in this group of patients [9]. While inorganic sunscreens are noncomedogenic, the white residue limits use. Sun avoidance measures are also important, especially in acne patients on photosensitizing acne medications [9].

### 4.2.3 | Atopic Dermatitis

Atopic dermatitis may be improved with controlled sun exposure and UV therapy; however, it may aggravate the condition in some patients [6, 45]. Sunscreen ingredients like zinc oxide and titanium dioxide are considered a good choice due to reduced systemic absorption [6]. Considering the poor barrier function of atopic skin, and the deleterious effects of the sun on barrier function, this seems reasonable. Atopic dermatitis patients are thought to be predisposed to developing allergic contact dermatitis due to their impaired barrier function and increased

exposure to topical ingredients [45]. Oxybenzone is known to cause allergic contact dermatitis [6, 45]. For the same reason, the avoidance of the application of sunscreen to untreated, acutely inflamed, or excoriated skin is recommended [9, 46] Further, patients are advised to informally patch test new sunscreens prior to including them in their skincare regimens [45].

Additional ingredients in sunscreens may support atopic dermatitis treatment (e.g., dexpanthenol, ectoine, vitamin E, bisabolol) [45] (Table 5). General sun avoidance is reasonable since infrared radiation (heat) and sweating can aggravate atopic dermatitis [9, 47]. In other contexts, AD patients tend to have a higher prevalence of vitamin D deficiency [47]. Vitamin D supplementation has a beneficial effect on atopic dermatitis severity in this patient group [47]. The clinical relevance of this scenario in the South African context has not been determined. It seems reasonable that in atopic dermatitis patients who are poorly controlled, who are practicing aggressive sun protection and/or have medium or dark skin colors, assessment of vitamin D levels should be a consideration. This is an important research gap.

#### 4.2.4 | Psoriasis

Psoriasis is frequently treated with phototherapy, and sun exposure tends to improve it [9]. However, up to a quarter of psoriasis patients (in particular, erythrodermic and pustular psoriasis) find that sunlight aggravates the condition [9]. Sunburn should be avoided due to the risk of koebnerization [9]. Some systemic agents for psoriasis are photosensitizing, and patients should be counseled to avoid the sun. Psoriasis patients who received multiple treatments with psoralen and UVA (PUVA) or are on immunosuppressive therapies are predisposed to skin cancer [48]. Skin cancer can be challenging to identify if psoriasis is poorly controlled.

### 4.3 | Photodermatoses

Photodermatoses are a complex group of skin conditions characterized by pathological responses to sun exposure as a result of a variety of predisposing factors (many of which are not fully understood) [49]. Different conditions within this group demonstrate different action spectra (i.e., show sensitivity to very specific portions of the light spectrum), although the determination of this may require highly specialized investigations [49]. This group of conditions is traditionally divided into the following groups:

- Idiopathic or immunologically mediated conditions (e.g., polymorphous light eruption, chronic actinic dermatitis, solar urticaria/solar angioedema).
- Drug- and chemical-induced photodermatoses (including porphyria).
- Photoaggravated dermatoses (e.g., auto-immune diseases like lupus erythematosus and dermatomyositis).

The final group are the photosensitive genodermatoses, which have been omitted due to the specialized nature of their management. As a starting point, broad-spectrum sunscreen and sun avoidance are recommended for all photodermatoses [9] (Table 3). In some conditions, photoadaptation (hardening) is part of the management (typically UVB phototherapy) [9]. A specialist should direct this.

#### 4.3.1 | Polymorphous Light Eruption

Anecdotally, polymorphous light eruption is not commonly diagnosed in South Africa; however, no study has examined the incidence in the South African context. This may be due to photoadaptation or hardening resulting from the high levels of sun exposure most South Africans experience, or the medical underservicing of vast portions of the population. In the United States, it is reported to be more common in people with darker skin colors [49].

#### 4.3.2 | Chronic Actinic Dermatitis

Chronic actinic dermatitis (CAD) is typically driven by UVB primarily, although UVA is relevant in some patients [9, 49]. Allergic and photoallergic contact dermatitis is demonstrated in approximately 70% of chronic actinic dermatitis cases [50], with common allergens including carbamix, potassium dichromate, a sesquiterpene lactone, and colophony. Sunscreen ingredients have also been implicated as allergens in some cases of CAD [49, 50]. Patients may be treated with UVB phototherapy and/or immunosuppressants. Clinicians should remember that patients on systemic immunosuppressants are predisposed to skin cancer [51, 52]. Broad-spectrum sunscreen (bearing in mind the possibility of photoallergic contact dermatitis) and sun avoidance measures are recommended. Sun avoidance should be prioritized due to the risk of allergy to sunscreen ingredients.

#### 4.3.3 | Solar Urticaria

Solar urticaria and angioedema may be triggered by UVB, UVA, or VL [9]. If the patient's specific action spectrum is known, sunscreen recommendations can be tailored to their needs; however, if not, it is reasonable to include VL protection as routine.

#### 4.3.4 | Drug-Induced Photodermatoses

Photosensitizing agents causing drug- and chemical-induced photodermatoses may be endogenous (e.g., porphyrins) or exogenous (e.g., photosensitizing drugs). Due to the action spectrum in porphyria (400–410 nm), sun avoidance is critical, and a broad-spectrum sunscreen with VL coverage is preferable but cannot replace sun avoidance [9].

Drug-induced photodermatoses take the form of either phototoxicity or photoallergy [9]. Phototoxic reactions are typically triggered by UVA [9]. The most implicated medications include amiodarone, chlorpromazine, doxycycline, hydrochlorothiazide (HCTZ), naproxen, and piroxicam, among others [53].

Photosensitizing drugs should be discontinued if possible [53]. If this is not possible, sun avoidance and broad-spectrum sunscreens

should be used (among other treatment strategies) [53]. Phototoxic (commonly) and photoallergic (uncommonly) reactions can result in PIH, particularly in individuals with medium or dark skin colors [9, 54]. Photoallergic reactions are more commonly triggered by topical agents, with sunscreens (specifically oxybenzone, octocrylene, and para-aminobenzoic acid derivatives) being the most likely culprit [54]. Some photosensitizing medications may confer an increased risk of skin cancer in the long term, making sun protection particularly important [53, 54].

#### 4.3.5 | Photoaggravated Dermatoses

An extensive list of photoaggravated dermatoses exists. Conditions such as atopic dermatitis, acne vulgaris, and rosacea may be photoaggravated and have already been discussed. Some conditions are classically associated with photosensitivity, and counseling about sun protection is a routine part of their management. These include but are not limited to lupus erythematosus and dermatomyositis [9, 49]. In lupus erythematosus and dermatomyositis, it is prudent to first treat active skin lesions to improve skin barrier function before applying sunscreen to reduce systemic absorption [9]. In this case, sun avoidance measures should be prioritized. Action spectra for these conditions include UVA and UVB [9]. Since PIH may be prominent in patients with medium and dark skin colors, the addition of VL protection is reasonable [7].

#### 4.3.6 | HIV Photodermatoses

Up to 5% of human immunodeficiency virus (HIV)-infected patients develop photosensitivity [55]. Since photosensitivity may be a presenting feature of HIV, testing is reasonable in patients who complain of photosensitivity [56]. The spectrum of photodermatoses reported in HIV includes polymorphous light eruption, CAD, photodistributed drug eruptions, pellagra, and porphyria cutanea tarda. The pathogenesis of photosensitivity in HIV is not completely understood and may be multifactorial, for example, due to medications used to treat HIV as well as the HIV infection itself [49, 55, 57, 58]. A recently published review has summarized the clinical spectrum of HIV-associated photodermatoses in South Africa and Africa [58]. Chronic actinic dermatitis may be the first sign of HIV infection. CAD cases in HIV tend to be younger and usually have significant immunosuppression at presentation (CD4 counts of $< 200$ cells/mm) [59]. Actinic lichenoid leukomelanoderma of HIV is a photosensitive eruption anecdotally observed in the South African clinical setting [55, 58]. Further research is needed to characterize this condition. Most patients are sensitized to UVB, but as HIV disease progresses, sensitization to UVA and VL increases [49]. Sun avoidance methods and sunscreen with high SPF, UVA, and VL protection are best since photosensitivity in this patient population can be caused by UVA, UVB, or VL. It has been recommended that physical blockers like zinc oxide or titanium dioxide may be preferable, although the reason for this is not clear [55].

### 4.4 | Photoaging

Chronic sun exposure leads to many of the visible signs of aging [17]. It acts in conjunction with intrinsic or chronological aging [17]. Different patterns of photoaging are observed throughout the range of skin colors [17]. Photoaging in individuals with light skin colors presents with features like rhytides (both coarse and fine), solar lentigos, and telangiectasia, whereas individuals with darker skin colors tend to experience later onset photoaging, with deep rhytides and pigmentary irregularities [17]. Photoaging is caused by exposure to UV, VL, and infrared light [17]. Table 3 shows recommendations for sun protection to prevent photoaging.

There is evidence that sunscreen is effective in preventing and improving photoaging [10]. This has been demonstrated in individuals with medium and dark skin colors too [10]. Optimal sunscreen characteristics are not clear—a randomized trial in India showed that participants with medium and dark skin colors using sunscreen improved their pigmentary irregularities and "skin radiance" significantly; however, there was no statistically significant difference between the groups who used SPF50 or SPF 19 (both with high UVA protection) [60]. VL protection is recommended to prevent pigmentary disturbances associated with photoaging [10]. As discussed above, protection from VL and UVA is especially important in individuals with medium and dark skin colors [9, 18]. Again, tinted sunscreens are a desirable choice, both from an efficacy and a cosmetic perspective [35].

The addition of antioxidants to sunscreens has shown some use in the prevention of infrared-mediated skin damage [19]. At present, the IR protection offered by sunscreen is not regulated [19]. This makes sun avoidance measures a priority for individuals wishing to prevent photoaging. Other factors collude to accelerate photoaging and visible aging in general, including tobacco smoking, air pollution (both components of the exposome), and genetic polymorphisms [10, 17]. While some studies have suggested that exposure to digital devices emitting VL may contribute to photoaging [61], a systematic review concluded that blue light from digital devices did not contribute to photoaging [62].

Agents like DNA repair enzymes and nicotinamide may assist in treating and preventing photoaging, but this is not established [10, 35]. Table S4 presents sunscreen additives which may offer benefits in the treatment or prevention of photoaging. The cost of such formulations is prohibitive for most of the South African population, and for this reason, individuals wanting to prevent or treat photoaging should use sun avoidance measures and affordable sunscreen. The optimal sunscreen is an SPF50+ with good UVA protection, VL protection, and antioxidant or other additives.

## 5 | Optimizing Sun Protection in Patients in Resource-Constrained Environments

If commercially tested sunscreen is available, it should be used. Sunscreens with lower SPFs (30 and up) are acceptable, but attention to proper application in adequate amounts is crucial. Traditional forms of clay-based sunscreen used in southern Africa do offer low-level, broad-spectrum coverage, and if they are the only agents available, they can be used [63]. In individuals with financial constraints who cannot access sunscreen, sun avoidance methods, such as the use of broad-brimmed hats,

protective clothing (if not ultraviolet protection factor [UPF] rated, then densely woven, polyester, and/or darkly dyed), shade-seeking behavior, and planning to avoid peak solar hours, need to be emphasized [64].

A huge barrier to implementing photoprotection strategies in South Africa is product accessibility, especially in the public sector [2]. Many of the recommended formulations remain unaffordable and cosmetically unacceptable for darker skin tones, impacting user adherence. Inexpensive tinted sunscreens with VL protection tailored to diverse skin tones are urgently needed. Strategies to enhance user adherence should include culturally appropriate education, consistent public health messaging, and the development of sunscreens that are tone matched and cosmetically acceptable. Table S5 includes cost-effective (less than R200 ZAR) sunscreens on the South African market.

## 6 | Limitations

This review does not discuss the importance of and evidence for sun protection in the prevention of skin cancer, nor does it explore evidence related to the use of sun protection measures other than sunscreen. For the purpose of brevity, it is assumed that sunscreen is used in adequate amounts, reapplied appropriately, and offers broad-spectrum protection (SPF of preferably 50, with a UVA protection rating of at least 1/3 of SPF, unless otherwise specified), and that sun avoidance measures are adhered to. This narrative review did not evaluate levels of evidence. Further, the available evidence was frequently limited or inadequate. Another limitation is that the sunscreen tables may not represent a comprehensive list of all sunscreens available on the South African market. Prices may not be precise, as they may have changed over the review period.

## 7 | Conclusions

Sun protection has become increasingly personalized, considering individual skin types and specific dermatoses. A multimodal approach, including sunscreen use and sun avoidance, remains the foundation of photoprotection. The biggest barriers to adequate and tailored photoprotection in resource-constrained environments, particularly for medium to dark skin tones, are tone mismatching, lack of cosmetic elegance, and high cost. There is a critical need to address these disparities through the development of inexpensive sunscreens, locally adapted guidelines, and inclusive public health messaging.


### Conflicts of Interest

Bianca Tod, Caradee Y. Wright, and Dagmar Whitaker have nothing to disclose. Willem Visser has received consultancy fees and honoraria from L'Oréal, Naos, Eucerin, Galderma, ISDIN, Genop, and Avéne. Thuraya Isaacs has received speaker's fees from La Roche Posay (L'Oréal). Kim Wiid is the medical manager for L'Oréal South Africa. Tarryn Jacobs has served as a consultant for Pfizer, Eli Lilly, and L'Oréal. Ncoza C. Dlova has served as a key opinion leader and advisor for L'Oréal, Unilever, VisualDx, and conducts clinical trials with Sanofi, Pfizer, GSK, Boehringer. The meetings and discussions surrounding this publication were facilitated by L'Oréal Dermatological Beauty, South Africa. However, it is crucial to note that all data and conclusions were independently determined by the healthcare practitioners involved. Kim Wiid, the Head of Medical at L'Oréal Dermatological Beauty South Africa, had no influence over the conclusions presented in this publication and contributed to the conceptualization and literature review contained in this manuscript.

### Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.


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**Supporting Information**

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Commercially available sunscreens with ultralong wave UVA1 light protection (370–400 nm). **Table S2:** Commercially available tinted sunscreens. **Table S3:** Commercially available sunscreens with purely inorganic filter ingredients. **Table S4:** Sunscreen additives with varying levels of evidence for efficacy in preventing or treating photoaging [29]. **Table S5:** Cost-effective commercially available sunscreens.