

## REVIEW ARTICLE

# Photoprotection according to skin phototype and dermatoses: practical recommendations from an expert panel

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## Abstract

Increasing evidence on the impact of the different wavelengths of sunlight on the skin demonstrates the need for tailored recommendations of sunscreen according to skin phototype and dermatoses, which is now possible due to advances in the filters and formulations of sunscreens. A selective literature search was performed by an international expert panel, focusing on the type of sunscreen to recommend for photoaging, skin cancers, photodermatoses, pigmentary disorders and skin inflammatory disorders. Protection against ultraviolet (UV)B is especially important for light skin as there is a high risk of sunburn, DNA damage and skin cancers. Darker skin may be naturally better protected against UVB but is more prone to hyperpigmentation induced by visible light (VL) and UVA. Protection against UVA, VL and infrared A can be helpful for all skin phototypes as they penetrate deeply and cause photoaging. Long-wave UVA1 plays a critical role in pigmentation, photoaging, skin cancer, DNA damage and photodermatoses. Adapting the formulation and texture of the sunscreen to the type of skin and dermatoses is also essential. Practical recommendations on the type of sunscreen to prescribe are provided to support the clinician in daily practice.

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### Introduction

General measures of photoprotection include seeking shade when outdoors, application of sunscreen, and wearing protective clothing, hats and sunglasses. Although sunscreen is only one measure, it remains essential in many circumstances. Studies have shown that users should be encouraged to apply appropriate amounts of sunscreen to obtain the recommended 2 mg/cm<sup>2</sup> concentration (sun protection factor [SPF] test conditions), which can be achieved following the teaspoon rule<sup>1</sup> or reapplication within an hour.<sup>2</sup> As an example, one teaspoon of sunscreen is the recommended amount for covering the face. The SPF of a sunscreen is a universal quantitative index of protection against sunburn from ultraviolet UVB. However, long-wave UVA (UVA1; 340–400 nm) is known to play an important role in pigmentation, photoaging, skin cancer, DNA damage and photo-dermatoses.<sup>3,4</sup> Furthermore, there is increasing evidence on the role of visible light (VL) in pigmentary disorders in dark-skinned subjects and immediate erythema in light-skinned individuals.<sup>5–7</sup> Adapting the formulation and texture of the sunscreen to account for skin phototype (SPT) and any associated dermatoses is also essential. However, when it comes to choosing a sunscreen, most people rely only on the SPF.<sup>8</sup>

An international panel of 12 experts convened in July 2020 to develop practical recommendations to support clinicians/ dermatologists on the type of sunscreen to prescribe depending on skin phototype and dermatoses. The panel reviewed and discussed the current available literature. When appropriate literature was scarce, personal experiences were discussed and all the

recommendations were based on the consensus of the group. Oral and injectable photoprotective agents are outside the scope of these recommendations.

### Skin phototypes

Skin phototype can be classified using the Fitzpatrick phototype classification or by using the evaluation of individual typology angle (ITA), which is more precise but requires colorimetry measurements (see Fig. 1).<sup>9–11</sup> Different SPT responds differently to the sun, but most individuals can benefit from using daily photoprotection.<sup>12,13</sup> A recent review of the literature showed that the regular use of sunscreen will not compromise the vitamin D status in healthy individuals.<sup>14</sup> However, in mid to high latitudes, regular use of high-SPF sunscreen might theoretically compromise vitamin D levels and thus might require a vitamin D supplementation.<sup>15,16</sup> Secondly, although percutaneous absorption of organic UV filters has been reported, no well-documented systemic side-effects have been reported to be caused by the use of sunscreens; in fact, the authors of those studies clearly specified that the results do not indicate that individuals should refrain from the use of sunscreen.<sup>17,18</sup> Compared to light skin, dark skin has a higher quantity of melanin distributed in the upper layers of the epidermis and a higher eumelanin/ pheomelanin ratio. After UVB exposure, DNA damage is mainly observed in the upper layers of the epidermis in dark skin, while in light skin it also affects the basal layers where the stem cells are located. Moreover, DNA repair is more efficient in dark skin than in light skin.<sup>19</sup> Thus, protection against UVB is

Fitzpatrick phototype	Description	Individual Typology Angle (ITA)	Skin color (ITA classification)	UVB protection (SPF)	UVA protection (UVA-PF)	High energy visible light protection (VL-PF)
I	Always burns, never tans	ITA° >55°	Very light	SPF50+	UVA-PF +++ (>1/3 labelled SPF)	
II	Burns easily, sometimes tans	41° <ITA° <55°	Light			
III	Sometimes burns, always tans	28° <ITA° <41°	Intermediate			
IV	Rarely burns, tans easily	10° <ITA° <28°	Tan			
V	Rarely burns tans easily; moderately pigmented	-30° <ITA° <10°	Brown			
VI	Rarely burns, tans promptly and intensely; highly pigmented	ITA° <-30°	Dark	SPF30+	UVA-PF +++ (> 2/3 labelled SPF)	VL-PF+++

**Figure 1** Spectral absorption profiles of sunscreens suitable for different skin phototypes. This figure represents the absorption profile of sunscreen recommended for healthy individuals with different skin phototypes for the prevention of skin cancers and photoaging. The latitude of where the individual lives should also be taken in consideration. Individuals with skin conditions (such as photodermatoses or pigmentary disorders) should follow the specific recommendations described in Table 1. ITA individual typology angle, SPF sun protection factor, UVA-PF ultraviolet A, VL visible light, PF protection factor.

more important for individuals with light skin as there is a higher risk of sunburn, DNA damage and the development of skin cancers. Protection against UVA/UVA1 is essential as it penetrates deeper into the skin compared to UVB and causes photoaging.<sup>14, 20</sup> Importantly, UVA1 affects all skin types and optimal protection against UVA1 is thus essential for all individuals.<sup>21</sup> Although darker skin is naturally better protected against UVB, it is more prone to hyperpigmentation induced by VL and UVA.<sup>5-7,22</sup> Providing optimal protection against UVA1 and VL is thus beneficial in dark-skinned individuals. VL (specifically high-energy violet light [HEV]) protection with tinted sunscreens containing iron oxides and/or pigmentary titanium dioxide is important for dark-skinned individuals, and these products should preferably be colour matched to the constitutive skin colour of the user to maximize compliance.<sup>23</sup> There is a need for clear and practical recommendations to highlight the importance of regular sunscreen use even in darker skin types to prevent pigmentation and photoaging. The spectral absorption profile of the sunscreen should be chosen depending on the SPT (Fig. 1).<sup>24</sup>

### Photoaging

Sunscreens protect against wrinkles and uneven pigmentation, including actinic lentigines, in Caucasian, East Asian and South

Asian skin. In a randomized controlled trial in 46 adults of mean age 63 years old with a previous diagnosis of skin cancer and/or actinic keratoses, the percentage of solar elastosis were 30.1% after 24 months application of SPF29 UVB/UVA (short wavelength UVA2) sunscreen vs 39.4% in the placebo group ( $P = 0.0001$ ).<sup>25</sup> In 903 adults under 55 years old, daily use of broad-spectrum SPF15+ sunscreen for 4.5 years slowed down the process of photoaging.<sup>26</sup> Compared to discretionary sunscreen users, daily SPF15+ sunscreen users had 24% less skin wrinkling and coarse skin (relative odds 0.76; 95%CI 0.50–0.98).<sup>26</sup> Daily use of a broad-spectrum sunscreen (SPF30) in 32 subjects for 52 weeks significantly improved clinical signs of photoaging, e.g. crow's feet, fine lines, mottled pigmentation, discrete pigmentation and evenness of skin tone.<sup>27</sup>

In Caucasian skin, wrinkles generally appear 10 to 20 years earlier than in Asian skin, while Asian and dark-skinned individuals are more prone to actinic lentigines and hyperpigmentation.<sup>28,29</sup> In 14 elderly Japanese people, changes in the number of spots and skin tone uniformity were negatively correlated with the amount of sunscreen used over 18 months.<sup>30</sup> In 216 Indian subjects, significant improvement in the density of pigmented spots and skin radiance was observed after 12 weeks of sunscreen use (SPF50, UVA-PA+++), compared to baseline ( $P < 0.001$ ).<sup>31</sup> These studies have been performed in people with

different skin phototypes and living at different latitudes as a daily photoprotection may be more beneficial for those living in locations with higher UVR irradiances.

Protection against infrared A (IRA) is also required to prevent photoaging. In a vehicle-controlled, randomized study in 30 healthy volunteers, the application of SPF30 sunscreen supplemented with an antioxidant cocktail protected human skin against changes induced by IRA radiation.<sup>32</sup> Until new sunscreens are developed to protect against IRA, broad-spectrum sunscreens containing topical antioxidants could provide the best protection.

The role of VL in skin aging is less clear, and there has been no demonstration of skin wrinkling induced by VL. However, the use of a broad-spectrum UVB/UVA-VL sunscreen (containing pigments) for 60 days significantly decreased the hyperpigmented area of actinic lentigo compared to the use of sunscreens containing only UV filters.<sup>33</sup>

### Skin cancers

While there is good evidence that both UVB and UVA promote melanoma development in fair-skinned individuals, a recent systematic review suggests that UV exposure may not be an important risk factor for melanoma development in people with skin of colour.<sup>34</sup> Sunscreen use cannot completely prevent melanoma, but the majority of melanoma (around 70%) have a high mutational burden and UV signature.<sup>35</sup> A randomized trial in Australia over 4.5 years with an 8-year follow-up period showed a reduction of the rate of melanoma in those randomly assigned to daily sunscreen use (hazard ratio [HR], 0.50; 95% CI, 0.24 to 1.02;  $P < 0.051$ ). The reduction in invasive melanomas was substantial (HR, 0.27; 95% CI, 0.08 to 0.97) compared with that for preinvasive melanomas (HR, 0.73; 95% CI, 0.29 to 1.81).<sup>36</sup>

A strong positive correlation has been observed between incidence of melanoma and keratinocyte cancers and a history of sunburn in childhood, presence of atypical naevi, light skin, freckles, red hair, photoaging, sunbed use and family history of skin cancer.<sup>37,38</sup> Both physical barriers and sunscreens can partially prevent UVB effects on naevi.<sup>39</sup>

Both UVB and UVA cause DNA damage and immune suppression, which play crucial roles in skin carcinogenesis, and both UV types are also involved in skin carcinomas.<sup>40</sup> Basal cell carcinomas (BCC)<sup>41,42</sup> and squamous cell carcinomas (SCC)<sup>43,44</sup> have higher mutational burden than melanoma and also exhibit a strong UV signature.<sup>41-44</sup> A Cochrane report concluded that low-quality evidence was unable to demonstrate whether sunscreen was effective in preventing keratinocyte cancer (BCC and SCC).<sup>45</sup> A randomized controlled trial in 1621 subjects with 1383 followed up for 4.5 years, 55% of whom had light skin, provided low-quality limited evidence that daily use of SPF15+ sunscreen resulted in a small reduction of SCC and no difference in BCC incidence compared to the discretionary sunscreen

group.<sup>46</sup> After an 8-year follow-up, regular sunscreen use possibly reduced the number of cases of SCC (RR 0.65, 95% CI 0.45 to 0.94) but not BCC;<sup>45</sup> an explanation could be that BCC may take many years to develop compared to SCC.<sup>47,48</sup>

Limited, low-quality evidence has been obtained from short-term randomized trials suggesting that regular use of sunscreens protects against the development of solar keratoses/ actinic keratosis (AK).<sup>49,50</sup> A 24-month prospective, case-control study provided limited evidence that regular use of sunscreen (SPF > 50, high UVA-PF) may help prevent the development of further AK and invasive SCC in immune-compromised organ transplant recipients.<sup>51,52</sup>

Equivocal results obtained on the effect of sunscreen on AK and keratinocyte carcinomas may be due to the use of older less well-balanced sunscreens, poor adherence and improper application of sunscreen, or poor study design with insufficient numbers of fair-skinned and older people to be able to detect differences. Education is needed on the proper amount and frequency of application and the importance of UVA protection in addition to a high-SPF sunscreen.

### Photodermatoses

The three most common categories of photodermatoses are immunologically mediated (polymorphous light eruption [PMLE], chronic actinic dermatitis, solar urticaria/solar angioedema), drug- and chemical-induced photodermatoses and photoaggravated dermatoses (e.g. lupus erythematosus and dermatomyositis). The fourth category, DNA repair-deficient photodermatoses are beyond the scope of this publication.<sup>53</sup>

In a study of 1080 photosensitive patients from four US academic dermatology clinics over a 10-year period, PMLE was the most common photodermatosis.<sup>54</sup> Furthermore, it was observed that PMLE was more common in the Black racial group, while phototoxic drug eruption, cutaneous porphyrias and solar urticaria were more common in Whites.<sup>54</sup>

It is now well-documented that photodermatoses significantly affect quality of life (QoL).

A recent systematic analysis showed that one-third of adult and child patients with photosensitivity experience very or extremely large impact on QoL, with effects on clothing choices, anxiety and depression.<sup>55</sup> Therefore, effective photoprotection measures are essential for these patients.

### Polymorphous light eruption

PMLE can be induced by UVB or UVA depending on the patient.<sup>56</sup> Broad-spectrum sunscreens are essential but not always sufficient alone; a widely used effective treatment is narrowband (NB)-UVB hardening (in certain latitudes, it may be beneficial to avoid high-SPF sunscreen in winter for photoadaptation). Other treatments include hydroxychloroquine and oral antioxidants.<sup>57</sup>

### Chronic actinic dermatitis

Chronic actinic dermatitis, presenting with lichenified eruption in a photodistribution pattern, is more often caused by UVB than UVA.<sup>58,59</sup> Aside from photoprotection, other treatments include NB-UVB hardening, topical calcineurin inhibitors, azathioprine, mycophenolate mofetil, methotrexate, cyclosporine and dupilumab (IL4/IL13 inhibitor).<sup>60</sup>

### Solar urticaria

Solar urticaria/solar angioedema is induced by UVB/UVA/VL; the use of tinted sunscreens is required for those with VL as the action spectrum.<sup>61</sup> Other treatments include antihistamines, UVA/UVA1 rush hardening, cyclosporine and omalizumab.<sup>62-64</sup>

### Drug-induced phototoxicity and photoallergy

Drug-induced phototoxicity from the interaction of topical or systemic agents with UVA<sup>65</sup> manifests as an exaggerated sunburn reaction with rapid onset. This is not to be mistaken with photoallergy, which generally has delayed onset at 24–48 h after sun exposure, and requires only a minimal concentration of the photoallergen to induce the lesions in photosensitized individuals. Photosensitivity induced by systemic drugs has been documented in 5% to 16% of patients referred to photodermatology centres.<sup>66-68</sup> Phototoxicity and photoallergy can result in postinflammatory hyperpigmentation (PIH), especially in dark-skinned individuals. Non-steroidal anti-inflammatory agents (topical and systemic) are a common cause of drug-induced phototoxicity.

### Cutaneous Porphyrias

The action spectrum of cutaneous porphyrias lies in the visible range at 400–410 nm (Soret band) requiring physical photoprotection and sun avoidance.<sup>69</sup> For areas not covered by clothing, a sunscreen with VL photoprotection (tinted sunscreen) is recommended. Treatments for porphyria cutanea tarda include phlebotomy and low-dose hydroxychloroquine. Erythropoietic protoporphyria can be effectively treated with afamelanotide (alpha-melanocyte stimulating hormone analog), which requires an implant every 60 days.<sup>70</sup>

### Photoaggravated dermatoses

The action spectrum for both lupus erythematosus and dermatomyositis lies in the UVB and UVA range.<sup>71</sup> Regular use of a well-balanced UVB/UVA sunscreen is mandatory.

## Pigmentary disorders

### Solar-induced pigmentation

As well as UVB, sunscreens used for treating or preventing hyperpigmentary disorders must also cover UVA1 and VL.<sup>5,6,24,72,73</sup> VL induces hyperpigmentation in SPT III to VI subjects, but not in SPT II subjects. VL-induced pigmentation is

more intense and more prolonged compared to that induced by UVA1. Furthermore, VL and UVA1 have a synergistic effect.<sup>5,7,73,74</sup> Blue-violet light (HEV) is responsible for hyperpigmentation induced by VL and can be prevented by inorganic sunscreens containing iron oxides.<sup>6,75,76</sup> More effective filters against VL/HEV could provide even better protection in the future.

### Melasma

Melasma requires a comprehensive therapeutic approach including the use of broad-spectrum, tinted sunscreen all year-round as it involves UVB, UVA and HEV wavelengths.<sup>77</sup> The regular use of sunscreen (SPF50+, UVA-PF28) for 12 months was found to be effective in preventing melasma relapses in pregnant women (2.7% new cases vs 53% in usual conditions).<sup>78</sup> Sunscreen (SPF19 and PA+++)<sup>3</sup> times daily for 12 weeks improved the melasma area severity index (MASI) and Melasma Quality of Life Index in 100 South Asian melasma patients.<sup>79</sup> In a randomized controlled trial in 40 Caucasian melasma patients, tinted sunscreen containing iron oxides for VL protection provided better protection against melasma relapses than the same sunscreen without VL protection.<sup>80</sup> Furthermore, sunscreen protecting against UV and VL enhanced the depigmenting efficacy of hydroquinone compared with UV-only sunscreen in the treatment of melasma.<sup>81</sup>

### Postinflammatory hyperpigmentation

Ambient light is sufficient to promote PIH in dark skin.<sup>82</sup> Opaque dressings are recommended for at least 15 days after the inflammation has subsided.<sup>83</sup> If not possible, broad-spectrum tinted sunscreen (including HEV protection) is mandatory. A split-face study in 30 patients with SPT IV demonstrated that use of broad-spectrum SPF60+ sunscreen containing anti-inflammatory agents (licochalcone-A and glycyrrhetinate) reduced the incidence of PIH at one week after laser treatment.<sup>84</sup>

### Lichen planus pigmentosus/ Riehl melanosis

The role of UV exposure on the pathogenesis of lichen planus pigmentosus/Riehl melanosis remains uncertain and a definite aetiology (e.g. photosensitive drug, lupus erythematosus and contact dermatitis) should be excluded.<sup>85</sup>

### Vitiligo

Vitiligo patients have decreased risk of developing skin cancer, especially melanoma.<sup>86,87</sup> Although sunburn is a provoking factor for vitiligo,<sup>88,89</sup> repigmentation of vitiligo lesions is almost impossible without UV exposure (natural or using phototherapy booths, lamps or lasers).<sup>90,91</sup> Vitiligo patients should be advised to regularly expose their lesional skin to the sun until vitiligo lesions become pink, after which a high-SPF broad-spectrum sunscreen is advised to prevent sunburn.<sup>90,91</sup>

**Table 1** Practical recommendations for clinicians compiled by the expert panel

	Recommendations
<b>Skin phototype</b>	
	All SPT can benefit from using daily sunscreen photoprotection. The type of photoprotection must be adapted to the skin phototype but also latitude and altitude.
	UVA protection is important for all skin types and is even more important than protection against UVB (SPF factor) for dark skin.
	For dark skin, sunscreen with SPF30+ and an SPF/UVA-PF ratio of <1.5 is recommended.
	For light skin, SPF50+ and an SPF/UVA-PF ratio of <3 is recommended.
	Tinted sunscreens containing pigments, particularly iron oxide, have a greater protective effect against VL (blue light) and are, therefore, highly recommended for the prevention and treatment of hyperpigmentation disorders, especially for intermediate and dark skin.
	Transparency is important to reduce white residues, especially for darker SPT, or coloured sunscreens matched to skin colour.
<b>Photoaging</b>	
	Daily use of sunscreen with a balanced UVB/UVA protection is very important to prevent photoaging all year-round in all skin phototypes.
	Generally, an SPF of at least 30 (SPF15 may be adequate in higher latitudes in the winter) with good UVA and UVB protection, and IRA protection. <sup>†</sup>
	IRA protection is recommended (sunscreens and daily photoprotection). <sup>†</sup>
	The need for VL protection for the prevention of photoaging is not yet clear, but should be recommended to avoid actinic lentiginos.
<b>Skin cancer</b>	
Melanoma	Sunscreens with high-SPF and good UVA protection, SPF50+ and an SPF/UVA-PF ratio close to 1, are recommended for melanoma prevention in fair-skinned individuals.
	Photoprotection, including sunscreen with SPF50+ and an SPF/UVA ratio as close to 1 as possible, is especially important in childhood for preventing sunburn as this is a high-risk factor for developing melanoma later in life.
Basal cell carcinoma	Sunscreens with SPF50+ and an SPF/UVA-PF ratio <3 are recommended.
Actinic keratosis and squamous cell carcinoma	For AK and SCC, a well-balanced sunscreen with SPF50+ and with an SPF/UVA-PF ratio <3 with protection is recommended.
<b>Photodermatoses</b>	
Polymorphous light eruption	Recommendations for PMLE include broad-spectrum sunscreen with an SPF/UVA-PF ratio close to 1.
Chronic actinic dermatitis	For chronic actinic dermatitis, high-SPF broad-spectrum sunscreen is essential.
Solar urticaria/solar angioedema	For solar urticaria/solar angioedema, antihistamines and sun avoidance remain the mainstay treatment. Broad-spectrum sunscreens with UVB, UVA and VL photoprotection (tinted sunscreen) are recommended.
Drug-induced phototoxicity	If drug-induced phototoxicity, the causative phototoxic agent should be identified and avoided and broad-spectrum sunscreens with SPF50+ and an SPF/UVA-PF ratio as close to 1 as possible are recommended, in combination with corticosteroids (topical or systemic) for acute phototoxicity.
Cutaneous porphyrias	For cutaneous porphyrias, physical protection and sun avoidance are recommended in severe cases due to the difficulty of protecting against VL. In areas not covered by clothes, a sunscreen with VL photoprotection (tinted sunscreen) is recommended.
Lupus erythematosus and dermatomyositis	For both lupus erythematosus and dermatomyositis, broad-spectrum sunscreen with an SPF/UVA-PF ratio close to 1 is recommended.
	Any lesions should be treated first to repair the skin barrier function before use of sunscreen in order to minimize systemic absorption and irritant reactions.
	SPF50+ sunscreen may not be necessary in the winter for people living in higher latitudes as this can prevent natural photoadaptation/hardening.
<b>Pigmentary disorders</b>	
	Broad-spectrum sunscreen with SPF50+ and a balanced protection against UVA (UVB/UVA protection ratio as close to 1 as possible) is recommended for the prevention or treatment of pigmentary disorders.
	VL/HEV photoprotection with tinted sunscreen is recommended to prevent VL-induced pigmentation in skin type III or higher.
Melasma	Protection against VL/HEV is essential, in addition to broad-spectrum and well-balanced UVB/UVA protection, all year-round for the treatment of melasma and prevention of relapses.



Table 1 *Continued*

	Recommendations
Postinflammatory hyperpigmentation	Photoprotection is recommended for at least 2 weeks before any procedure or inflammatory dermatoses. When possible, opaque dressing is the best option. In other cases, application of broad-spectrum sunscreen with UVB, UVA and VL/HEV protection is recommended on the treated areas for at least 15 days (one month maximum) after inflammation has resolved in order to prevent PIH.
Lichen planus pigmentosus	Broad-spectrum sunscreen is recommended for lichen planus pigmentosus all year-round to prevent further aggravation.
Vitiligo	Vitiligo patients should be advised to regularly expose their lesional skin to UV radiation without sunscreen until their vitiligo lesions start becoming pink. When the vitiligo lesions are pink or repigmented, SPF50+ broad-spectrum sunscreen is recommended to prevent sunburn that could cause Koebnerization.
<b>Skin inflammatory disorders</b>	
Rosacea	For rosacea, broad-spectrum (UVB and UVA) photoprotection of SPF30+ with an SPF/UVA-PF ratio <3, as well as protection against IRA and VL, is recommended.
Acne	Use of an SPF30+ broad-spectrum sunscreen with good UVB and UVA protection, as well as VL protection (sun hats and shade), is strongly recommended for retentional acne with signs of PIH or for patients at high risk of PIH, e.g. Fitzpatrick skin type IV or higher, or if significant occupational, or recreational sun exposure.  For inflammatory or cystic acne, a mist formula of organic SPF30+ broad-spectrum sunscreen is recommended since inorganic sunscreen can cause irritation (pain and burning), especially if being treated with isotretinoin.  Although sunscreen containing zinc oxide may be recommended to decrease risks of phototoxicity of both topical and systemic acne drugs, transparency is important to reduce white residues, especially for darker skins types; teenagers with acne generally prefer a mist formula.
Atopic dermatitis	Generally, sunscreen should not be applied for inflammatory disorders until any lesional skin has been treated and the inflammation has resolved in order to avoid systemic absorption and photosensitization reactions.  For AD, regular use of broad-spectrum sunscreens is recommended for preventing photosensitivity. Some sunscreen compounds, e.g. benzophenones (not commonly found in sunscreens for children) and butyl methoxydibenzoylmethane, may cause allergic reactions and are best avoided.
Psoriasis	Broad-spectrum sunscreens SPF30+ that do not contain organic UV filters but only contain inorganic UV filters are recommended. Generally, sunscreens for babies only contain inorganic filters (titanium dioxide and zinc oxide). Sunscreens are not recommended for infants younger than 6 months old.  Exposure to sun can be beneficial in psoriatic patients, except for erythroderma and pustular types. Sun exposure should however be limited and patients must avoid sunburn that could cause koebnerization.  Broad-spectrum sunscreens SPF50+ combined with a high UVA protection is recommended for photoaggravated forms of psoriasis.

AD, atopic dermatitis; AK actinic keratosis; BCC basal cell carcinoma; HEV high-energy violet light; IR infrared; ITA individual typology angle; KC keratinocyte cancer; PIH postinflammatory hyperpigmentation; PLE polypodium leucotomos extract; PMLE polymorphous light eruption; SCC squamous cell carcinoma; SPF sun protection factor; SPT skin phototype; UV ultraviolet; VL visible light.

†There are currently no available sunscreen filters that protect against IRA. Until new sunscreens are developed, sunscreens with antioxidants as a strategy to protect against IRA are highly recommended.

## Skin inflammatory disorders

### Rosacea

Caucasians with light sun-sensitive skin are at highest risk of rosacea.<sup>92</sup> The daily use of broad-spectrum sunscreens is recommended since both UV radiation and heat are potential triggers of initiation and aggravation of erythema and telangiectasia in rosacea patients by dysregulation of the innate and adaptive immune system.<sup>92,93</sup> Sunscreens containing dimethicone, cyclomethicone, or both to mitigate facial irritation<sup>94</sup> and repair the skin barrier may be advisable.

### Acne

As UV radiation, especially UVA, increases the thickness of the stratum corneum<sup>95</sup> and alters the skin microbiome inducing a dysbiosis,<sup>96</sup> it may worsen the presence of retentional lesions (closed comedones) causing inflammation and flare ups of acne during the autumn.

No studies have shown whether sunscreen use is beneficial for acne lesions, but studies have shown that UVA can induce PIH on acne skin (irritation, excoriations and treatment adverse effects), especially in dark skin types (SPT IV to VI) and severe inflammatory acne grade III to V (GEA grading).<sup>97,98</sup> Inorganic

sunscreens, while they may be non-comedogenic, tend to be chalky in consistency. Therefore, mist formulas of organic sunscreens with a water or light liquid base and non-greasy textures have higher cosmetic acceptability and lead to better adherence for teenagers with acne-prone skin.<sup>99</sup> To minimize phototoxicity induced by acne medications, topical treatments should be applied in the evening and systemic treatments taken during the evening meal.

### Atopic dermatitis

UVA1 phototherapy is usually beneficial for acute atopic dermatitis (AD), while treatment with UVB can reduce *Staphylococcus aureus* colonization of AD lesions.<sup>100,101</sup> High temperatures on the skin surface and sweating, due to the action of IRA, may worsen erythema or itching of eczematous lesions in AD, and UV may affect skin barrier functions. Photoaggravation of AD may occur in some patients.<sup>102</sup> Photosensitive AD, which typically presents with a photodistributed rash and involvement of non-sun-exposed skin, should be suspected if dermatitis worsens despite the use of photoprotection or local treatments.<sup>103</sup> Photobiologic evaluation is necessary for patients with photosensitive AD<sup>102</sup>; this may include phototesting to determine the minimal erythema dose to UVB and UVA, and photopatch testing to exclude photocontact allergies. Sunscreens should not be used on weeping and moist lesions or scalded lesions resulting from severe scratching.<sup>104</sup>

### Psoriasis

Most psoriasis is improved by sun exposure, and phototherapy is a well-demonstrated approach for treating psoriatic lesions. Photoaggravation of psoriasis can occur in around 5 to 24% of cases, particularly in light-skinned individuals.<sup>105</sup> Sunburn can provoke Koebnerization of psoriasis.<sup>105</sup>

### Conclusions

Increasing evidence on the impact of the different wavelengths of sunlight on the skin demonstrates the need for a tailored prescription of sunscreen according to SPT and dermatoses, which has been made possible due to advances in the filters and formulations of sunscreens. The recommendations of the expert panel are summarized in Table 1.

Despite the significant advances that have been made during the past decade, better protection against UVA1, VL and IRA is still required. Active compounds used topically or systemically could provide a good adjunct to filters by enhancing DNA repair, minimizing oxidative stress, decreasing inflammation or restoring skin microbiota.

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