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Attitudes on, Practices, and Recommendations for Visible Light Protection Amongst Dermatology Practitioners

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ABSTRACT

Background: Iron oxides, antioxidants, and pigmentary titanium dioxide are sunscreen additive ingredients that enhance visible light protection, reduce associated hyperpigmentation, and protect against certain photosensitive dermatoses There are currently no standardized recommendations for visible light protection with these additive ingredients, leading to varied clinical recommendations.
Objectives: This study aimed to evaluate dermatology practitioners' counseling practices for visible light protection.
Methods: An electronic survey was distributed to dermatology practitioners. Survey responses were compiled for analysis, and statistical significance was calculated using a standard 95% confidence interval.
Results: 91.68% of 974 respondents actively counsel patients about visible light protection, primarily emphasizing its role in exacerbating pigmentation in patients with melanin-rich skin (70.92%). Of these, 10.34% recommended sunscreens with visible light protective additive ingredients specifically for patients with melanin-rich skin, and 48.89% recommended them for managing melasma or post-inflammatory hyperpigmentation. Iron oxide additive ingredients were most frequently recommended (90.92%), followed by antioxidants (69.08%) and pigmentary TiO2, (58.85%). 8.32% of respondents reported not counseling patients about visible light protection, with major reasons encompassing the lack of standardized guidelines (50.62%), challenges in recommending suitably tinted sunscreens (27.16%), limited availability of sunscreen options (23.46%), and insufficient supportive data (18.52%).
Conclusion: There is a need for increased education and awareness regarding visible light protection strategies and the identification of patients who may benefit the most from a targeted photoprotective strategy. Establishing standardized guidelines and broadening the availability of sunscreen options conferring visible light protection may help address these gaps.

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INTRODUCTION

Exposure to solar radiation (SR) is associated with a range of adverse effects on the skin, including photocarcinogenesis, sunburn, photoaging, and pigmentation. While the primary focus of SR-induced pathologies has historically centered on the consequences of ultraviolet (UV) radiation, humans are exposed to visible light (VL, 400-700 nm), 12 to 14 orders of magnitude greater than UV.[1]

Wavelengths within the VL spectrum penetrate the full thickness of the epidermis and dermis, extending into the subcutaneous adipose layer;[2] whereas UVA penetration does not extend beyond the dermis, and UVB only penetrates the epidermis.[3] In addition to exposure from SR, VL is transmitted from flash lamps, computers, televisions, and cell phones.[2] Given its pervasive presence and profound penetrative properties, the impact of VL on the skin cannot be disregarded.

Over the past decade, a growing body of literature has strengthened our understanding of the harmful effects of VL on the skin. VL exposure is associated with erythema, post-inflammatory hyperpigmentation (PIH), melasma, and exacerbation of photodermatoses. VL has been shown to induce immediate erythema in skin phototype (SPT) I to III and immediate and prolonged erythema in SPT IV to VI.[2] Exposure to VL triggers inflammation and stimulates melanocytes through the generation of reactive oxygen species (ROS), exacerbating hyperpigmentation. In SPT IV to VI, VL has been shown to induce more severe and prolonged pigmentation as compared with UVA1-induced pigmentation,[4] underscoring its role in pigmentary disorders in individuals with melanin-rich (MR) skin. VL also plays a role in exacerbating solar urticaria, chronic actinic dermatitis, polymorphous light eruption, and cutaneous porphyrias.[2]

Accordingly, the importance of sunscreen with VL protection is gaining recognition, especially in the prevention and treatment of pigmentary disorders in individuals with MR skin, who constitute nearly 40% of the United States (U.S.) population.[5] Recent studies have demonstrated that additive sunscreen ingredients, including iron oxides, antioxidants, and

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pigmentary titanium dioxide (TiO2) enhance VL protection and improve outcomes in patients with hyperpigmentation.[2,6-11] Iron oxides and pigmentary TiO2 scatter and reflect VL photons, imparting VL photoprotection. Antioxidants, including vitamin E (atocopherol), vitamin C, licochalcone A, and diethylhexyl syringylidene malonatecombate, combat oxidative stress mediated by UV and VL.[2]

In the US, the sunscreen active ingredients approved by the Food and Drug Administration (FDA) largely protect against UVA and UVB, offering no protection from VL. Guidelines for clinicians outline recommendations for UV protection; however, there are currently no standardized guidelines for VL protection, leading to varied clinical recommendations, if any at all. Whether sunscreens containing VL-protective compounds are routinely recommended to patients in practice remains unknown. This study aims to better understand how dermatologists are currently advising patients regarding VL protection, understand where gaps in counseling may exist, and make recommendations to improve protection against VL.

MATERIALS AND METHODS

A 15-question, Institutional Review Board (IRB)-approved (No. NCR235167) survey was created using SurveyMonkey, a third-party cloud-based survey tool. The survey was electronically distributed to dermatology practitioners registered to the Orlando Dermatology Aesthetic and Clinical Conference (ODAC) e-mail list, and responses were collected anonymously. The ODAC listserv encompasses a heterogeneous population of dermatology practitioners from a variety of demographic backgrounds, subspecialties, and practice settings and locations, exemplifying a representative study population of dermatology practitioners.

Dermatology practitioners included board-certified dermatologists (BCDs), residents, fellows, physician assistants, and nurses practicing clinical dermatology. Eligibility criteria included dermatology practitioners over the age of 18 practicing in the US. Surveys completed by dermatology practitioners practicing outside of the U.S. were excluded.

Survey questions evaluated 1) counseling practices for VL protection; 2) the circumstances under which recommendations for VL protection were made; and 3) sunscreen additive ingredient preferences. The survey included questions with multiple choice, checkbox, and free response answer choices. Survey responses were compiled for analysis, and statistical significance was calculated using a standard 95% confidence interval.

RESULTS

Demographics

There were 1,311 respondents who were examined for eligibility. 974 respondents met the eligibility criteria and were included in the study. The response rate was 20.19% (974/4823). Demographic information is summarized in Table 1.

Counseling Practices

91.68% (893/974) of respondents reported that they counsel patients about protecting their skin from VL. Those who counseled primarily discussed the role of VL in inducing more prominent and long-lasting pigmentation in patients with MR skin (70.92%, 617/870, Figure 1). Other topics discussed included the exposure to VL from light bulbs, computers, and cell phones (59.31%, 516/870), the synergistic effects of VL with UV radiation (48.39%, 421/870), and the role of VL in inducing immediate erythema in all patients (23.22%, 202/870).

Among the respondents, 8.32% (81/974) reported that they did not offer counseling to patients concerning VL protection. The primary reasons for this included the absence of standardized guidelines (50.62%), difficulties in recommending appropriately tinted sunscreens (27.16%), limited availability of VL-protective sunscreens (23.46%), insufficient data supporting the efficacy of VL protection (18.52%), and a relatively small patient population susceptible to pathologies mitigated by VL (19.75%, Figure 2).

FIGURE 1. Topics addressed when counseling about visible light protection.

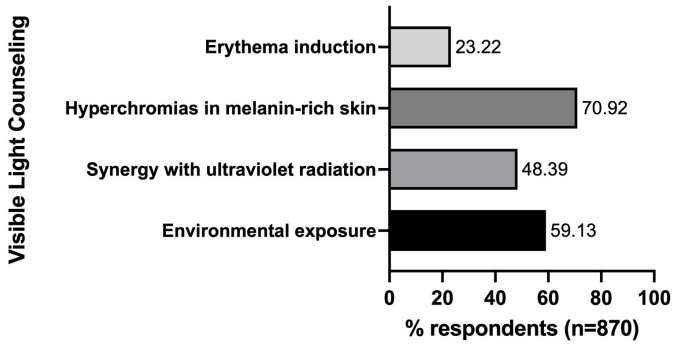

FIGURE 2. Factors influencing the decision to not counsel on visible light protection.

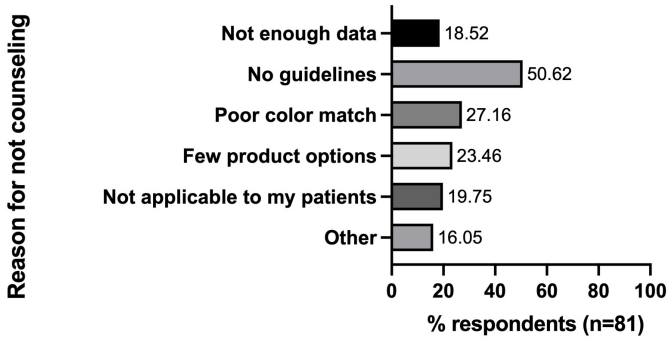

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TABLE 1.

Study Respondent Self-Reported Demographic Data		
		No. (%)[a]
Gender (N=968)	Male	263 (27.17)
	Female	691 (71.49)
	Non-binary	3 (0.31)
	Prefer not to answer	10 (1.03)
Age (N=970)	25-34	511 (52.68)
	35-44	230 (23.71)
	45-54	129 (13.40)
	55-64	61 (6.29)
	65+	38 (3.92)
Race[b] (N=973)	American Indian or Alaskan Native	9 (0.92)
	Asian	224 (23.02)
	Black	51 (5.24)
	African American	33 (3.39)
	African Caribbean	9 (0.92)
	Latinx	56 (5.86)
	Middle Eastern or North African	34 (3.49)
	Native Hawaiian or other Pacific Islander	8 (0.82)
	White/Caucasian	563 (57.86)
	Prefer to self-describe	4 (0.41)
	Prefer not to answer	44 (4.52)
Level of Training (N=974)	Board certified dermatologist	312 (32.03)
	Resident	334 (34.29)
	Fellowship year	38 (3.90)
	Nurse practitioner	98 (10.06)
	Physician assistant	192 (19.71)
Practice Setting (N=974)	Academic or university	361 (37.06)
	Private solo practice	156 (16.02)
	Private group practice	315 (32.24)
	Combined academic and private practice	48 (4.93)
	Community hospital	57 (5.85)
	Military	15 (1.54)
	Other	22 (2.36)
Practice Location (N=974)	Northeast US	294 (30.18)
	Southeast US	221 (22.69)
	Midwest US	169 (17.35)
	North Central US	24 (2.46)
	South Central US	76 (7.91)
	Northwest US	66 (6.78)
	Southwest US	123 (12.63)

[a]Percentages may not sum to 100 due to rounding.
[b]Self-identified racial categories, respondents allowed to choose all that apply; 62 (N=973, 6.37%) respondents chose more than one answer.

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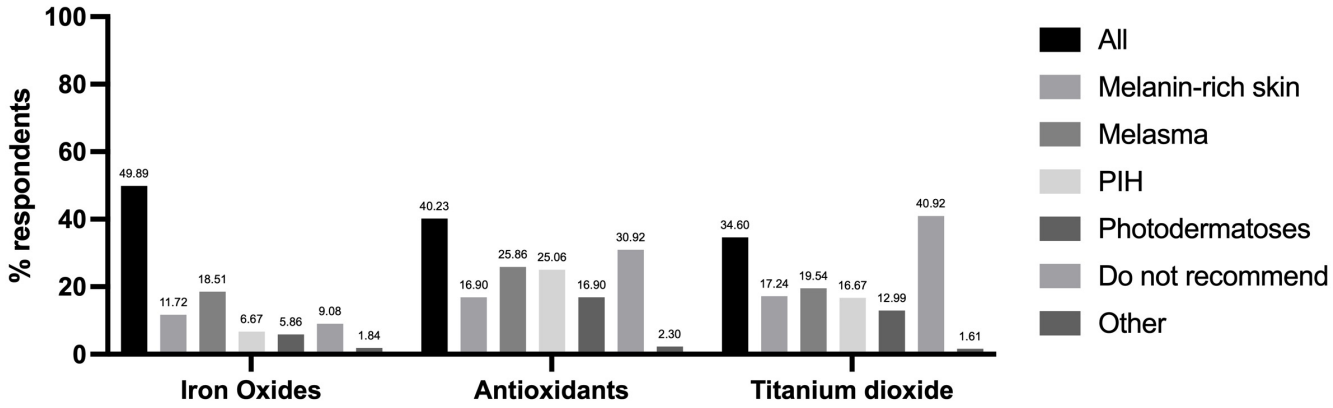
FIGURE 3. Sunscreen additive ingredient recommendations for treatment of visible light-mediated cutaneous pathologies.



Other reasons indicated in the free response text included a lack of knowledge of VL protective strategies, limited clinic time, and the high costs associated with tinted sunscreens.

Those self-identifying as African American or Black treated a patient population consisting of over 75% of patients with MR skin more frequently than all other groups. They were also significantly more likely to counsel on VL protection than their White counterparts (P<0.05). General counseling about VL protection did not significantly vary based on the proportion of MR patients in one's practice, though practitioners treating patients comprising 25% to 50% and 50% to 75% of MR skin patients were significantly more likely to counsel on VL's role in inducing more prominent and long-lasting pigmentation than practitioners with less than 25% (P<0.05).

Respondents from the South-Central region of the US counseled about VL protection significantly more than those from the Northeast, Midwest, and Southwest regions (P<0.05); however, topics discussed during counseling did not vary significantly with location. Additionally, those between the ages of 45 and 54 counseled significantly more than those over the age of 55 (P<0.05). BCDs counseled patients about VL exposure from the environment, synergy with UV radiation, hyperpigmentation in patients with MR skin, and induction of erythema significantly more than dermatology residents (P<0.05).

Preferred Additive Ingredients

Of the surveyed respondents who counsel on VL protection, sunscreens containing iron oxide additive ingredients were most frequently recommended (90.92%, 791/870), followed by antioxidants (69.08%, 601/870) and pigmentary TiO2, (58.85%, 512/870); though the circumstances under which they were recommended differed (summarized in Figure 3). Overall, 49.88% (434/870) of respondents recommended tinted sunscreens containing an additive ingredient conferring VL protection to treat all patients, 10.34% (90/870) recommended them as a treatment specifically for MR patients, 46.89% (408/870) recommended them for patients with melasma or PIH, and 5.05% (44/870) recommended them for photodermatoses induced by VL. 9.08% (79/870) of the respondents who counsel patients on VL protection did not recommend a tinted sunscreen containing any of the surveyed additive ingredients. Free text response answers indicated that some practitioners were unaware of pigmentaryTiO2 as an additive sunscreen ingredient, and others recommended the application of antioxidants via a non-sunscreen product.

Prevention

Survey respondents most frequently recommended a sunscreen conferring VL protection to prevent melasma (84.48%) and PIH in patients with MR skin (83.45%). Sunscreen conferring VL protection was also recommended to patients for the prevention of photoaging (73.22%), photodermatoses exacerbations (58.51%), and erythema (47.59%). Additionally, some respondents indicated recommending these sunscreens to prevent skin cancer, PIH secondary to acne, and rosacea exacerbations. Recommendations to use VL-protective sunscreen to prevent certain skin conditions did not significantly vary between the proportion of patients with MR-skin treated or practice location in the US, although respondents between the ages of 25 and 34 recommended VL-protective sunscreens to prevent melasma and PIH in patients with MR skin significantly more than those aged 45 to 54 (P<0.05).

Patient Preferences

Survey respondents predominantly recommended sunscreens with VL protection to patients seeking the highest level of photoprotection (77.24%) and those aiming for improved skin tone uniformity (65.63%). Additionally, they suggested such sunscreens to patients interested in color-based coverage (48.62%), those concerned about photoaging (61.15%), and those comfortable with or indifferent to a potential white cast (28.28%).

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DISCUSSION

To the best of the authors' knowledge, this is the first study to characterize the state of VL counseling and recommendations practiced by US dermatology practitioners. Emerging research continues to strengthen our understanding of the role that VL plays in dermatologic disease and conditions, so these results present a timely cross-sectional account of counseling and recommendation patterns while standardized guidelines remain absent on this topic.

The topics discussed during counseling on VL-protection as well as recommendations for VL-protective sunscreens for preventing specific skin conditions varied among respondents based on certain demographic factors. These results are likely due to several variables, including differences in education regarding the photobiology of VL, expertise in treating and managing certain VL-related skin conditions, patient population composition and concerns, and the provider's personal experience and familiarity with VL-protective sunscreens. Practitioners residing in South-Central US, the region of the US with the largest self-identified Black population,[12] provided VL counseling more frequently than practitioners in other regions. Similarly, practitioners treating a self-reported patient population with a relatively higher percentage of patients with MR skin showed trends towards providing more comprehensive VL counseling, highlighting VL's perceived and understood relevance to those with MR skin, and making more targeted recommendations to patients with MR skin, melasma, and PIH. Such practitioners also tended to make more appropriate recommendations regarding the use of iron oxides or antioxidants to said patients, and for melasma and/or PIH. Altogether, this suggests that practitioners with more experience treating patients with MR skin may be more comfortable and informed in providing comprehensive photoprotective strategies to patients most susceptible to or actively with VL-mitigated conditions.

Of notable concern is that only 10.34% of all respondents recommended sunscreens with additive ingredients, with evidence supporting VL protection specifically to patients with MR skin. Approximately half of the respondents suggested such sunscreens for the management of melasma or PIH, while most respondents recommended them more generally to all patients, highlighting a gap in the provision of tailored and targeted photoprotective strategies amongst dermatology practitioners. The apparent mismatch between the proportion of practitioners counseling on VL-induced hyperpigmentation and the proportion of practitioners making clinical treatment recommendations with sunscreens for hyperpigmentation suggests the need for increased recognition of sunscreens as an effective treatment option for hyperchromias. Guidelines regarding VL-protective sunscreens as a treatment strategy and increased education surrounding the appropriate sunscreen options may increase the degree of their implementation into photoprotective routines, particularly in patients most susceptible and affected. Additionally, data characterizing the threshold for sufficient VL protection in sunscreen products are lacking, and this likely further hinders clinical guidance. Further studies are necessary to establish efficacy criteria for the formulation of sunscreens that adequately protect against VL.

The increased counseling about VL protection observed amongst middle-aged practitioners, as opposed to their older counterparts, may be attributed to the first evidence of skin damage associated with VL being published 17 years ago;[13,14] this age cohort was possibly still in or recently graduated from medical education programs when this research was becoming integrated into their curriculum and counseling practices. Similarly, practitioners in younger age groups are benefitting from more recent knowledge regarding the role VL plays in hyperpigmentation, particularly in darker skin tones. This likely contributes to our study findings, which show that younger cohorts are more likely to recommend VL-protective sunscreens for preventing melasma and PIH in patients with MR skin. Our finding that BCDs counseled on a variety of VL-related topics more than dermatology residents is most likely explained by greater expertise and experience on the photobiology of VL and clinical relevance.

Tinted sunscreens are relatively novel products that use iron oxides (available in yellow, red, and black pigments) and pigmentary TiO2 (ie, non-nanoscaled) to provide VL protection, reducing transmission by over 90% (Table 2).[6] A variety of tints are created by combining different proportions of iron oxides and pigmentary TiO2, so these products can be formulated to blend

TABLE 2.

Additive Sunscreen Ingredients Protective Against Visible Light

Additive Ingredient	Compounds	Mechanism of Action	Limitations
Iron Oxides	Black, yellow, and red Fe_2O_3	Scatter and reflect VL[c] photons	Limited shade ranges, high cost of formulated products
Antioxidants	Vitamin E, vitamin C, licochalcone A, diethylhexyl syringylidene malonate	Scavenge free radicals	Difficult to maintain stability in sunscreen formulations
Physical UVR[a] filters	Pigmentary TiO_2[b] (non-nanosized TiO_2)	Scatter and reflect VL photons	May leave white cast after application

[a]UVR, ultraviolet radiation
[b]TiO2, titanium dioxide
[c]VL, visible light

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into a range of natural skin tones.[9] Tinted sunscreens reduce the appearance of cutaneous hyperchromias after 60 days of application,[15] and provide better protection against VL-induced pigmentation than non-tinted sunscreens.[16] They may be the product of choice for patients who are diagnosed with melasma as studies have found that they are superior in managing and preventing relapses of melasma compared with sunscreens with only UV-protective properties.[7,8] Herein approximately 20% of respondents recommended sunscreens containing either iron oxides or pigmentary TiO2 specifically for patients with melasma, highlighting a potential knowledge gap regarding the use of these ingredients for VL protection. Furthermore, a higher percentage of respondents did not recommend pigmentary TiO2 compared with other ingredients, which may be due to its noticeable, opaque white cast.[9] Some respondents recommended a mineral sunscreen for VL protection; however, it is important to note that only non-nanoscaled TiO2 contains particles conferring VL protection. Many mineral sunscreens are formulated with nanoscaled physical filters, and this discrepancy is also indicative of a knowledge gap regarding appropriate VL-protective additive ingredients.

Systemic and topical antioxidants neutralize ROS and other free radicals generated by VL exposure, thereby protecting against melanogenesis, inflammation, and DNA damage.[2,17] Sunscreens with added antioxidants and free radical scavengers show promise in mitigating the effects of VL + UV-A1 exposure in patients with SPT IV to VI.[18] The production of antioxidant-enriched sunscreens is a meaningful advancement of our photoprotection armamentarium as these non-tinted options may be more cosmetically suitable for a diverse array of skin tones. This in turn may increase the use of sunscreen with VL protection in those with darker skin tones who are additionally more prone to hyperchromias. Our study found that respondents were divided in their recommendation of sunscreens with added antioxidants, such that approximately 40% recommended them for all patients while approximately 30% did not specifically recommend them. It seems likely that this may be due to the variability in access and stability of sunscreen products with antioxidant additives, although more research is needed to explore these results further.

While broad-spectrum SPF 30+ sunscreen is generally recommended for all patients, individuals with MR skin are more susceptible to hyperchromias induced and exacerbated by VL. For these patients, a particular emphasis on shielding against VL using tinted sunscreens and antioxidants is an important part of a comprehensive photoprotective strategy.[19] Mounting evidence underscores the necessity for tailored sunscreen recommendations that factor in SPTs and photosensitive dermatoses, enabled by advancements in sunscreen additive ingredients and formulations.[20] The practice of personalized photoprotection aims to provide precise guidance concerning sunlight exposure and its impact on skin health, tailored to individuals across a spectrum of skin types.[19]

Limitations

Limitations of our study include possible selection bias such that dermatology practitioners who are interested in and well-practiced in counseling on VL protection were more likely to complete the survey. Additionally, we did not ask about respondents' counseling on VL protection through wearing photoprotective clothing and accessories and seeking shade; further studies should examine these recommendation patterns. Finally, although our study was completed by a large and diverse group of respondents, its cross-sectional nature limits the generalizability of our findings.

CONCLUSION

Overall, while some significant patterns were revealed in our results, the variety in recommendation practices highlights the need for uniform education and guidelines for dermatology practitioners to follow. There is a need for increased education and awareness regarding VL protection strategies and the identification of patients who may benefit the most from a tailored photoprotective strategy. Establishing standardized guidelines to provide unified recommendations and broadening the availability of sunscreens conferring VL protection can collectively address these gaps, ensuring comprehensive, consistent, and effective photoprotection.

DISCLOSURES

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Ethics Approval: The questionnaire and methodology for this study were approved by the George Washington University Committee on Human Research, Institutional Review Board (FWA00005945).

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