

Systematic Review of Pediatric Photoprotection in Children of Color

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ABSTRACT

Background: Early childhood sun exposure contributes to lifetime risk of skin cancer. Many individuals from diverse ethnic backgrounds believe their skin tone confers immunity to sun damage; however, evidence of negative outcomes exists. Best practice in photoprotection for children of color is unclear.

Objective: We sought to address the risks, benefits, and needs for sun protection and education in children of color.

Methods: An English-language systematic literature review was conducted. Inclusion criteria were data on children of color and content relevant to photodamage and photoprotection.

Results: Photoprotection is needed for children of all skin tones with photosensitivity. Individuals with darker skin tones have more innate photoprotection compared with lighter skin tone individuals, but both have incomplete photoprotection. Risk of nevus formation, skin cancer, and dyspigmentation are universal with varying degrees. Hispanic and Black communities are less likely to practice sun protection. Studies demonstrate need for early, culturally appropriate education about sun exposure in all communities.

Limitations: Studies reviewed were of varied design and populations.

Conclusion: This review determined that photoprotection has benefits for all patients, and the benefits of photoprotection should be taught early to children, caregivers, and parents of all skin tones using culturally appropriate approaches.

Key words: Asian, Black, Hispanic, modeling, Native American, photoprotection, skin of color, sun education

Introduction

Damage to the skin caused by sun exposure has been shown to increase the risk of developing multiple skin conditions including photodistributed pigmentary alterations, photodamage, nevi, and skin malignancies.^{1,2} This damage is caused by light in the ultraviolet spectrum, mainly ultraviolet A (UVA) and ultraviolet B (UVB).³ Ultraviolet C rays are almost fully absorbed by the ozone layer.⁴ UVB can create pyrimidine dimers which then leads to an increased risk of nonmelanoma skin cancer.^{3,5}

UVA is associated with other genetic changes, pigmentation changes in the skin as well as penetrating the skin to increase the creation of reactive oxygen species.⁶ Available protection labeled with sun protection factor (SPF) blocks UVB rays, while “broad-spectrum” protects against UVA rays, which, in combination with protective clothing and judicious outdoor exposures, can help prevent skin cancer and photoaging, according to the Food and Drug Administration, at SPF levels 15 and 30, respectively.⁷

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What is known about this subject with regard to women and their families?

- Photoprotection is an important part of women's skin-care regimens and their family routines.
- Women of color are thought to be less likely to use photoprotection due to a misconception that their pigmentation provides adequate photoprotection.

What is new from this article as messages for women and their families?

- The photoprotection from melanin is not adequate to provide complete photoprotection.
- Photoprotection is needed in individuals of all colors starting in early childhood.
- Photoprotection skills are modeled in family environments based on parental usage; therefore, it is essential for women and their children to use sunscreen as a family unit.
- Early interventions with clear information that is culturally appropriate could increase the use of photoprotection in populations of color starting in childhood.

The purpose of this article is to systematically review the available literature on sun protection in children of color to identify risks of sun exposure, photosensitizing conditions, or states that require enhanced sun protection, sun protection attitudes and behaviors, and educational efforts in this population that have demonstrable benefits. Through this systematic review, we hope to elucidate best practices in pediatric skin-of-color photoprotection and education. The need for sun protection is becoming increasingly important given the constant increases in skin cancers and the increased environmental risks that accompany global warming. In addition, this review aims to identify gaps in current research and provide directions for future studies in pediatric photoprotection for children of color.

Materials and Methods

A systematic review of PubMed, Embase, MEDLINE, and CINAHL was performed for the following search terms ["sun protection" or "sunscreen"] and ["skin of color" or "native American" or "black" or "African American" or "Asian" or "Hispanic"] and pediatric. Inclusion criteria included the following: (1) discusses sun protection or sunscreen; (2) mentions Black/African American, Asian, Hispanic, or Native Americans; (3) has primary data on sun protection or sunscreen or is a consensus statement or reports on photosensitivity in children; and (4) 6 patients or more. Exclusion criteria included the following: (1) not English language; (2) review article (can only be used for reference); (3) does not mention children; (4) does not mention patients of color; and (5) case reports with 5 or fewer patients. The initial search was posted into Covidence, and subsequent rounds were generated based on review by 2 reviewers for each paper on the Covidence website (www.covidence.org). In each round of review, 2 of the listed authors reviewed each paper identified. Two or more individuals reviewed each of the articles included for extraction separately, tabulated into excel spreadsheets, and then compared content. The study was designed through the Pediatric Dermatology Research Alliance Skin of Color and Pigmentary Disorders Workgroup.

Results

Eight hundred twenty-two studies were found through searches in PubMed, Embase, MEDLINE, and CINAHL. One paper was removed due to being a duplicate that was identified manually. A total of 46 duplicate papers were removed by Covidence; 775 articles were then screened, with 316 articles identified for full-text review; and 71 papers were included in the extraction component. Screening and inclusion-specific data are presented in Figure 1: PRISMA Table of Articles Reviewed for Pediatric SKIN of Color Photoprotection Study, Supplemental Material, <http://links.lww.com/IJWD/A67>.

Skin cancer risk

A total of 9 studies from the literature search yielded information concerning skin cancer risk.⁸⁻¹⁶ The study populations ranged from 189 to 3604 patients from the United States ($n = 6$),⁸⁻¹² Canada ($n = 2$),^{13,14} Germany ($n = 1$),¹⁵ and Australia ($n = 1$).¹⁶ Some of these studies addressed how skin tone affected the risk of various skin cancers.^{9,10,13-16} The studies concluded that individual skin tone and genetics have a major effect on the risk of skin cancer development.^{9,10,13-16} While most studies focused on natural sun exposure, one study examined the impact of artificial radiation on skin cancer risk in different skin tones. A study on skin cancer risk after X-ray therapy for scalp ringworm assessed children 3.9 to 12.1 years old. This study found a relative risk of 3.6 (95% confidence interval [2.3-5.9]) for basal cell carcinoma among irradiated Whites. While 25% of both the irradiated and control groups were Black, only 3 skin cancers

were observed in Black participants, all in the irradiated group. This suggests that sun damage played a role in X-ray-induced basal cell carcinomas, but that Black patients are not immune to DNA damage.⁹

Three of these papers assessed trends in childhood skin cancer rates.^{8,10,11} A paper in 2005 found that pediatric melanoma incidence was increasing specifically in older children and young adults. This paper found that White race and UV radiation (UVR) exposure were 2 significant risk factors.¹⁰ Two papers published in 2015 and 2020 found that the incidence of melanoma was decreasing significantly from 2001 to 2015 in the United States.^{8,11} They both agreed that a major factor in this decrease was public health initiatives, increased sunscreen use, and decreased outdoor time.^{8,11}

Efforts to reduce UVR exposure are found to be beneficial in children for skin cancer prevention.⁸ A study of California Hispanic children found that sun-protective knowledge and family discussions about sunscreen were inversely associated with time spent outside.¹² The majority of the students' daily UVR exposure was during school hours, where they were often unable to have autonomy in their sun exposure.¹² Future interventions in these populations could address school-time exposure through increased shade, school-distributed sunscreen, and advocacy for sun-protective clothing.

Prevalence of nevi was assessed in 3 different studies.¹⁴⁻¹⁶ Two studies found that the number of nevi was associated with lighter skin tones and UVR exposure. These studies found nevi in all skin tones, with a greater number with increasingly lighter tones.^{15,16} The third study assessed white, Asian, and Indo-Pakistani children and their prevalence of different nevi. All 3 of these ethnicities had similar prevalence rates of pigmented lesions.¹⁴ They found that lighter skin was associated with increased sunburn and freckles. All 3 studies found that UVR exposure as well as a susceptibility to UVR exposure was associated with an increase in nevi counts.¹⁴⁻¹⁶ Importantly, despite pigmentation, darker skin-toned children remained at risk of nevus formation, a risk factor for skin cancer.¹⁴⁻¹⁶

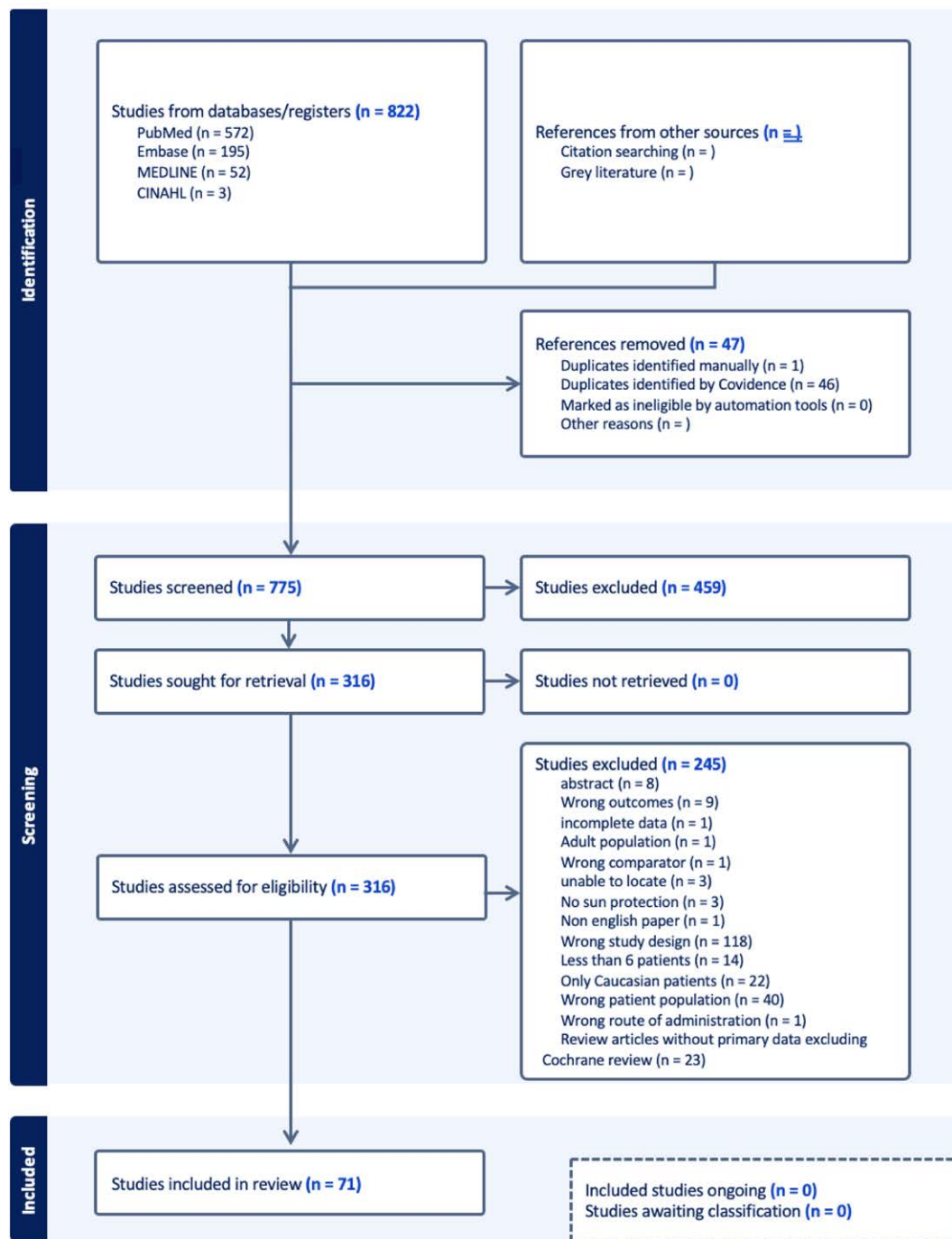
Photosensitivity

Photosensitivity can be triggered by a genetic inability to process skin damaged by UVR, by taking medications, or by having circulating antibodies that promote photosensitivity. Table 1 highlights medical settings in which photosensitivity is a given despite skin tone. These conditions require enhanced sun protection; however, the level of sun protection has to be guided by the illness and is beyond the scope of this review. While photosensitivity can affect individuals of all skin tones, its presentation and management in children of color require special consideration. It is important to note that the diagnosis of photosensitivity disorders may be challenging in children with darker skin tones due to the masking effect of increased pigmentation. This underscores the need for heightened awareness and specialized diagnostic approaches in this population. Ultimately, disorders and medicines that photosensitize require strict sun protection in all skin tones, races, and ethnicities.

Attitudes toward sun protection and sun protection practices

Twenty-six articles were included in the review for sun protection attitudes and practices in children of color. These studies encompassed a diverse range of sample sizes (50-10,000 participants) and geographical locations, including North America ($n = 21$), Thailand ($n = 2$), Brazil ($n = 1$), Saudi Arabia ($n = 1$), and Turkey ($n = 1$). Methodologies employed included surveys, questionnaires, focus groups, and randomized control trials. The study populations comprised Asian, Black, Hispanic, and White children and adolescents.

Sun Protection in Children of Color



28th September 2024



Fig. 1. PRISMA flow chart for the systematic review. PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

A pertinent theme emerging from 8 studies was the importance of familial factors affecting the use of sun protection in children.^{45–50} Children were less likely to report sun protection habits such as sunscreen use and wearing of long sleeves if their parents did not model these behaviors.⁵⁰ Notably, despite parental awareness of sun exposure risks, overall sun-protective practices remained low.^{48,51}

Seven studies investigated the impact of sociocultural factors on sun protection behavior and attitudes, particularly in

Hispanic and Black children.^{52–58} A predominant theme across these studies is that Black and Hispanic children are less likely to display sun-protective behaviors. This trend may be attributed to limited education within these communities regarding the need for sun protection and the subsequent risk of skin malignancies regardless of melanin production. One study highlighted the importance of early intervention, reporting that of 70 respondents who were parents of Black or Hispanic infants less than half of parents consistently covered their infants adequately

Table 1
Medical settings with increased photosensitivity

Collagen vascular diseases including systemic lupus erythematosus and cutaneous lupus ^{17–28}
Xeroderma pigmentosum ^{29–32}
Kindler syndrome ³³
Cockayne syndrome ^{34,35}
Medication-induced pseudoporphyria (eg, Naproxen) ³⁶
Medication-induced photosensitivity (eg, Vemurafenib, ³⁷ Doxycycline, ³⁸ Methotrexate, and Voriconazole)
Disorders of DNA repair (eg, bloom syndrome) ³⁹
Dravet syndrome ⁴⁰
Porphyrias ⁴¹
Polymorphic light eruption ⁴²
Photoaggravated dermatoses (eg, atopic dermatitis) ⁴³
Immunosuppression, genetic and acquired (eg, posttransplantation) ⁴⁴

with clothing and hats (40% [28/70] and 43% [30/70], respectively).⁵⁹ One-third of these parents reported intentionally increasing their infant's level of sun exposure to develop his/her tolerance to the sun.⁵⁹ These actions and beliefs could cause damage to these children in the future and highlight the importance of educating parents on proper sun protection methods as early as possible.

Two studies explored differences in sun protection attitudes between lighter and darker skin types. Children with lighter skin types reported a higher belief in the need for sun protection and subsequently higher use of sun protection.^{60,61} Conversely, children with darker skin types demonstrated lower sun protection knowledge, poorer sun safety attitudes, and were less likely to consider sun protection important.^{60,61}

A consistent theme throughout 3 studies was the decline in baseline sun protection habits as children age, regardless of skin tone.^{62–64} Although adolescents are aware of the need for sun protection, they are less likely to use it. Gender and peer influence play a major role, with females being more likely to practice sun protection behaviors. Tanning practices and pressures to tan were also found to increase as children age. One study assessed Thai adolescents and found that sunscreen was used by 71.5% of students yet only 27.4% regularly applied sunscreen. Adolescent females and high school adolescents demonstrated significantly more accurate knowledge and practice in cleansing and photoprotection ($P < .001$) compared with adolescent males and junior high school adolescents.⁶⁵ The Healthy Passages study assessed 5119 5th graders and found that only 23.4% of them used sunscreen SPF 15 or greater almost always. The individuals included in this study were least likely to engage in sun-protective behavior if they were boys, Blacks, Hispanics, did not perform other preventive health behaviors such as using a seatbelt, or were from a low socioeconomic household.⁶⁶

Surveys of youth aged 11 to 18 years old in 1998 and 2004 were conducted and compared to assess changes in sun exposure habits. This study found that there was a significant increase in always/often use of sunscreen from 31 to 39%.⁶⁷ Non-White individuals who can sunburn had a significant increase in sunscreen application before most severe sunburn, when comparing 1998 with 2004. In 2004, 22.4% more children used sunscreen before their most severe sunburn (56%) when compared with those in 1998 (33.6%). During this period, sun protection campaigns were conducted, which seemed to have a positive effect on this group of non-White participants who have experienced sunburns.⁶⁷

Multiple studies address recognizing the need to increase child and adolescent sun protection behaviors, and specifically the problem of early childhood sunburn affecting at least half of fifth-graders.^{68–70} Three of these studies examined sun protection policies in schools.^{69,70} These studies found school

administrators and parents supportive of the idea of implementing sun-protective policies in schools.^{69,70}

Interventions for sun protection education

A total of 7 studies were analyzed to assess the effects of interventions for sun protection education on children of color.^{71–77} All studies took place in North America and utilized various methodologies including randomized control trials,^{71,72,75,77} education interventional studies,⁷⁴ and baseline observational studies,^{73,76} with sample sizes ranging from 300 to 2000 participants.^{71–77} At baseline, sun protection practices in children and adolescents were generally low.

Four studies emphasized the significance of implementing sun protection education into school curricula.^{72,74,75,77} These studies showed how diverse children and adolescents can benefit from education regarding the hazards of excessive UV exposure as evidenced by increased sun protection knowledge and behaviors, such as increased sunscreen use.⁷⁷ Results were not uniformly positive, as one study implementing a sun safety curriculum in aquatic classes did not observe a significant improvement in sun-protective behaviors among children.⁷⁵

One study focused on implementing sun protection interventions with children and their caregivers.⁷¹ This study demonstrated a notable increase in sun-protective behaviors following the intervention in all skin types, reinforcing the critical impact of familial involvement on sun protection care in children and adolescents.^{45–50} The Sun Sense Study further supports this approach, showing that a multicomponent intervention including parent education and child-focused elements significantly improved sun protection practices and parental knowledge.⁷⁸ All of these studies included children of color, demonstrating that education in children of color is effective and may be best accomplished in a familial setting.

Discussion

It is a common misconception that photoprotection is only relevant in those with lighter skin tones. Skin of color has more melanin, increasing the direct protection it provides. It was found by Kaidbey et al.⁷⁹ that individuals with a Fitzpatrick skin scale of V to VI had an average SPF of 13.4, whereas individuals of lighter skin scale types have an SPF of 3.3. Given that dermatologists recommend a minimum SPF of 30, the partial protection afforded by skin tone is inadequate. This increased natural SPF in darker skin tones, however, still does not adequately protect those individuals from the damaging effects of the sun. Indirect DNA damage can be caused by the excitation of endogenous molecules such as melanin.⁸⁰ When these molecules return to the nonexcited state, this energy is released into the surrounding tissue causing DNA damage or the creation of reactive oxygen species.⁸⁰ Although many individuals with darker skin may feel protected from the sun, DNA damage is still able to occur with cumulative skin cancer risk over a lifetime, as well as many undesirable effects such as depigmentation, aging, aggravation of atopic dermatitis, all forms of lupus erythematosus, and photodermatoses. This systematic review highlights the importance of addressing these misconceptions and promoting appropriate photoprotection practices across all skin tones.

Specifically, children are known to be a high-risk population for sun exposure due to their thinner stratum corneum as well as decreased melanin as compared to the skin of adults.^{81,82} The thinner stratum corneum and mutations that can occur in the basal layer of the skin due to early childhood UV exposure are believed to provide the basis for the lifetime risk of skin malignancies.^{81,83} Children also have a larger exposure to sunlight than many adults. It is estimated on average, that children receive 3 times the UV exposure of adults.⁸⁴ This increased exposure, combined with their more vulnerable skin, underscores the

critical importance of early and consistent photoprotection in children of all skin tones.

When addressing the risk of skin cancer later in life, factors such as the frequency of sunburns, particularly during childhood, have been positively correlated with skin malignancy rates.^{85,86} In some families, the nevus count can be linked to melanoma predisposition. The fact that sun-induced nevi are present in lighter and darker skin-toned children highlights the potential contribution to melanoma risk. Addressing photoprotection in children early in their lives can help reduce the sun damage they accumulate early, which could, in turn, reduce the risk of skin malignancies later in their lives.⁸⁷ Furthermore, it is estimated that Hispanic children experience melanomas at a younger age, often on the leg, and a Spitzoid variant.⁸⁸ Some regions of the country are experiencing a faster rise in melanoma in Hispanic adolescents. Melanomas in Hispanic individuals are more likely to be thicker and late-stage, with less recognition by the affected patient.^{89,90} Location is more common on the lower extremities and acral lentiginous lesions are more common. Prevention and surveillance in youth are required to prevent and identify cases early. Therefore, interventions to reduce skin cancer risk have a demonstrated need in US children of color.

The effects of ultraviolet light on vitamin D production in children of color may be impacted by sun protection. Therefore, vitamin D supplementation may be worthwhile for all photoprotected children.

These findings underscore the complexity of sun protection attitudes and behaviors in children, emphasizing the significant roles of parental influence and sociocultural factors. This suggests a need to develop and implement comprehensive strategies that incorporate these factors to address and improve sun protection behaviors in children of color and adolescents. Future interventions should focus on culturally appropriate education and involvement of both children and their caregivers, leveraging the strong influence of family on sun protection behaviors.

Limitations of this review include the heterogeneity of the studied populations and interventions, which made direct comparisons challenging. Furthermore, photoprotection must also be paired with vigilance in skin cancer surveillance. Future research should aim to use more objective measures of sun protection behaviors and focus on long-term outcomes to enhance the assessment of interventional effectiveness including larger prospective cohorts, for example, registries.

In conclusion, while the natural photoprotection provided by melanin in darker skin tones offers some defense against UV damage, pigmentation cannot fully protect against the harmful effects of sun exposure. This underscores the critical need for improved photoprotection practices across all skin tones. To protect future generations of children of color, universal sun protection with SPF 30, broad-spectrum or stronger, and photoprotective clothing and lifestyles are needed to promote complete photoprotection. By implementing targeted, culturally sensitive interventions that address the unique needs and challenges of children of color, we can work toward reducing the long-term risks associated with cumulative sun exposure and improving overall skin health in these populations.

Conflicts of interest

The authors made the following disclosures: W.F., J.H., A.K., F.Z.D., and A.F. have no conflicts of interest to declare. N.S. has been an advisor or investigator for Avita, Dermavant, Incyte, Pelthos, Pfizer, Regeneron, Sanofi, and Verrica.

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Study approval

This study was IRB exempt.

Author contributions

WF: Participated in research design, writing the paper, data analysis, and systematic literature review. JH and FZD: Participated in research design, writing the paper, and systematic literature review. AK: Participated in research design and systematic review. NS: Participated in research design, writing the paper, and systematic literature review, and data analysis.

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