The role of sunscreen in the prevention of cutaneous melanoma and nonmelanoma skin cancer

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Sunscreen is a multibillion-dollar industry, and its efficacy in the prevention of skin cancer is often taken as fact.[1] Despite this, there are only 4 prospective studies that examine sunscreen's role in preventing skin cancer, and none of these studies examine the efficacy of sunscreen in preventing skin cancer in otherwise healthy individuals (Supplemental Fig 1; available at http://www.jaad.org). Could it be that the nearly universal recommendation of dermatologists and professional societies (eg, American Academy of Dermatology, World Health Organization) to use sunscreen to prevent skin cancer is unfounded? This article attempts to answer this question by analyzing the prospective studies that evaluate the effectiveness of sunscreen for prevention of melanoma and nonmelanoma skin cancers.

Table I summarizes the results of these studies. The majority of prospective studies indicate that sunscreen is effective in preventing actinic keratosis and squamous cell carcinoma development and may be effective for basal cell carcinoma (BCC) and melanoma.[2-7] Additionally, it appears that sunscreen is highly effective in preventing actinic keratoses and squamous cell carcinomas even when used for only a brief period of time and after significant photodamage has already occurred.[2-6] For BCCs, the relationship is less clear. Although neither of the prospective studies undertaken demonstrated a strong preventive effect of sunscreen on development of BCC, this may be an artifact of the long promotion phase common to BCCs.[4,6,7] Therefore, longer studies are needed to detect the true impact of sunscreens on the development of BCCs. The effect of sunscreen on melanoma prevention is also unclear. The failure of the Nambour Skin Cancer Trial to provide conclusive evidence that sunscreen prevents the development of melanoma may reflect difficulty in powering such an outcome rather than a true lack of efficacy in melanoma prevention, as the incidence of melanoma is much lower than that of nonmelanoma skin cancer.[4,6-8]

Table II summarizes the design characteristics of the aforementioned studies. The generalizability of these studies is limited by several factors: (1) they evaluated the relationship between sunscreen and skin cancer in persons with an elevated baseline risk of developing these lesions (eg, transplant recipients, persons living in subtropical climates, and individuals with a personal history of actinic keratosis) (it should be noted that selection for populations at elevated risk for controlled trials is an accepted methodology for decreasing the sample size and length of study needed to power the outcome of interest); (2) they all provided participants with counseling on the proper use of sunscreen whereas the average sunscreen user applies only a quarter of the recommended amount of sunscreen, resulting in a marked reduction to only a 16th the stated sun protection factor (SPF); and (3) the types of sunscreens studied do not necessarily approximate the types of sunscreens commonly used by consumers (eg, all the products studied were organic sunscreens characterized by variability in broad-spectrum coverage and variability in SPF).[7]

Additionally, all of these studies had 2 important limitations that may have resulted in underestimation of the effect of sunscreen on skin cancer prevention: (1) they did not all prevent participants assigned to a control group from using sunscreen (which is significant, as 1 study reported that 26% of the control group participants reported using sunscreen at least twice a week) and (2) the longest of these studies lasted only 4 years, which likely does not capture the

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Table I. Summary of findings from prospective studies evaluating the role of sunscreen

	Study findings		
Study title/author	**AKs and SCCs**	**BCCs**	**Melanoma**
Thompson et al[2]	Decrease in AK development (RR, 0.62; 95% CI, 0.54-0.71) Increase in AK remission (OR 1.53; 95% CI 1.29-1.80)	Not studied	Not studied
Naylor et al[3]	Decrease in AK development ($P < .05$)	Not studied	Not studied
The Nambour Skin Cancer Prevention Trial (Green et al,[4] Green et al,[5] and Van Der Pols et al[6]	Decrease in SCC development after 4.5 y (OR, 0.61; 95% CI, 0.46-0.81) Decrease in total number of SCCs developed at 8-y follow-up (RR, 0.62; 95% CI, 0.38-0.99) Decrease in number of persons who developed SCCs at 8-y follow-up (RR, 0.65; 95% CI, 0.43-0.98)	No significant difference in number of new first BCCs or total number of BCCs after 4.5 y Statistically nonsignificant 25% decrease in BCC development rate at 8-y follow-up	Borderline statistically significant decrease in melanoma development at 10-y follow-up (HR, 0.5; 95% CI, 0.24-1.02) Decrease in invasive melanoma development at 10-y follow-up (HR, 0.27; 95% CI, 0.08-0.97)
Uhrlich et al[7]	Decrease in AK development (RR, 3.07, 99% CI 1.76-4.36) No invasive SCC in sunscreen group (nonsignificant)	Nonsignificant difference in the rate of BCC formation (2 vs 9)	Not studied

AK, Actinic keratosis; *BCC*, basal cell carcinoma; *CI*, confidence interval; *HR*, hazard ratio; *OR*, odds ratio; *RR*, relative risk; *SCC*, squamous cell carcinoma.

Table II. Summary of study design characteristics

	Study design characteristics				
Study title/author	**No. of participants**	**Unique inclusion criteria**	**Study location**	**Study length**	**Study groups**
Thompson et al[2]	588 enrolled, 431 completed	Personal history of ≥1 AK Age >40 y	Victoria, Australia, 37° south latitude	September 1991-March 1992	Daily broad-spectrum SPF 17 sunscreen Daily base cream
Naylor et al[3]	53 enrolled, 35 completed	Personal history of ≥1 AK or NMSC Continued sun exposure Not regularly using sunscreen	Lubbock, Texas, 33.5667° north latitude	December 1987-December 1990	Daily UV B—blocking SPF 29 sunscreen Base vehicle minus active ingredients
The Nambour Skin Cancer Prevention Trial (Green et al,[4] Green et al,[5] and Van Der Pols et al[6])	1621 enrolled, 1383 completed	Resident of Nambour, Australia Age, 20-69 y	Nambour, Australia, 26.6269° south latitude	Initial Trial from January 1, 1993-August 31, 1996 Follow-up assessment 8 y later in December 2004 Additional 10-y follow-up assessment in December 2006	Daily SPF 16 broad-spectrum sunscreen and 30 mg of β-carotene Daily sunscreen and placebo tablets β-Carotene only Placebo only
Uhrlich et al[7]	120 enrolled	Solid organ transplant recipients Age >40 y	Berlin, Germany, 50.5200° north latitude	24 mo	Broad-spectrum daily SPF 60+ sunscreen No intervention

AK, Actinic keratosis; *NMSC*, nonmelanoma skin cancer; *SPF*, sun protection factor; *UV*, ultraviolet.

long-term magnitude of sunscreen's impact, especially on cancers with longer periods of evolution.[4]

Specific issues with individual studies are as follows: (1) Thompson et al[2] followed patients for only 1 summer and utilized low-SPF sunscreen (SPF 17); (2) Naylor et al[3] had an attrition rate approaching 33%, despite having a low sample size to begin with, and they studied only ultraviolet B—only sunscreen; (3) the Nambour Skin Cancer Prevention Trial was retrospective in nature only after the initial 4.5 years, and its analysis was based on the number of melanomas occurring anywhere on the body even though sunscreen was applied only to the face and upper extremities; and (4) Uhrlich et al[7] did not provide the control group with placebo cream, and their study was designed to study only actinic keratoses and squamous cell carcinomas even though post hoc analysis for other lesions was also performed.

Concern surrounding sunscreen safety also exists. Some studies associate sunscreen use with increased intentional sun exposure and a resultant increased risk of sunburn and skin cancers. Other safety concerns include fear that use causes vitamin D deficiency and that nanoparticles utilized in the current formulations allow for systemic absorption of sunscreen's active ingredients, which could cause systemic toxicity. In-depth discussion of these concerns is beyond the scope of this article.

In conclusion, should the use of sunscreen be encouraged in counseling on skin cancer prevention? The answer appears to be yes. Nonetheless, available prospective studies have serious limitations and additional studies are necessary. Specifically, studies that evaluate sunscreens' role in lower-risk patients, evaluate the efficacy of sunscreen over longer durations, and better elucidate current safety concerns are needed.

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Study Type: Systematic Review
Database Utilized: PubMed
Search Terms: "sunscreen", "photo-protection", "skin cancer", "actinic keratosis", "squamous cell carcinoma", "basal cell carcinoma", and "melanoma."
Dates Queried: 1/01/1990 – 10/01/2017
Study Designs Included: Clinical Trials
Interventions Assessed: Organic and Inorganic Sunscreen
Outcomes of Interest: Number of Actinic Keratoses, Basal Cell Carcinomas, Squamous Cell Carcinomas, and Melanomas at initiation and termination of the study
Other Modes of Study Identification: Article citations were reviewed to identify additional studies.

Supplemental Fig 1. Systematic review methodology.