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Review



Sunscreen: An Updated Review on UV Protection, Efficacy and Safety

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	Abstract
Published on: 20.03.2026	<p>Sunscreen is used to protect against ultraviolet rays from the sun. Sunscreen works by using ultraviolet light. When applied to the skin, the first type of mechanism reflects UV rays, while the second type absorbs UV rays and transforms them into heat energy for the human body. The medication is more effective against UV rays when it is infused into sunscreen. The SPF is greater when medications are used in sunscreen than when standard sunscreens are sold on the market (1, 2). Frequent use of sunscreen will leave the skin smooth and hydrated, preserving its natural color and shielding it from UV-induced color damage. The possibility that a sunscreen product will succeed after development is confirmed by the four fundamental criteria of effectiveness, safety, registration, and patent freedom. Sunblock formulae must be created to prevent sunburn, sun tanning, skin melanoma, and early fine lines and wrinkles in addition to increasing the degree of sun protection factor (SPF) (4, 5). Sunscreens are frequently used to protect the skin from the sun's harmful rays and reduce the risk of sun-induced skin disorders. Broad-spectrum sunscreens are now being researched in an effort to mitigate the long-term effects of excessive UV exposure. Vitamin E is a fat-soluble antioxidant with photoprotective qualities that is vital to human health (3, 4).</p>
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	<p>Keywords: Sunscreen, UV Radiation, SPF, Photoprotection, Skin Cancer, UVA/UVB</p>

1. INTRODUCTION

Sunscreen shields the skin from UV rays from the sun. The UV rays that the sun emits constitute the basis for sunscreen. UV A, UV B, and UV C are the three distinct wavelengths of UV light that the sun emits (3, 5). 200–300 is the wavelength of UV A, 300–350 is

the wavelength of UV B, and 100–290 is the wavelength of UV C. UVA and UVB are the only two forms of ultraviolet light that may enter the Earth's atmosphere and reach the skin layer. UVB radiation causes the most harm to human skin. This sort of radiation causes sunburn, an inflammatory response, and skin redness (2, 4). When sunscreen is applied to

the skin, it protects it from the sun, maintains the skin moisturised and smooth, and prevents it from drying out.

The ingredients in sunscreen include red algae, zinc oxide, carrot seed oil, shea butter, lavender oil, and coconut oil, among others. Zinc oxide powder plays an important part in sunscreen, which is used to protect against the sun (5, 6).

1.1. Ultra Violet- Ray from Helious

The sun's non-ionizing electromagnetic radiation (EMR) consists of UV (100-400 nm), visible (400-780 nm), and infrared light (780-5000 nm). UVR is the most essential and crucial sort of EMR for human health. As previously noted, the sun is the principal source of UVB and UVA radiation, and exposure is often regarded as inevitable (5, 7). The quantity of UVR that reaches a specific area on Earth varies by season, geography, and time of day. UVR intensity, for example, is strongest around the equator and at high altitudes, then declines as latitude increases. UVB intensity is regarded maximum during the summer months and on a daily basis between 1100 and 1500 h (6, 7). Importantly, UVA intensity is more stable throughout the day and from season to season than UVB. The rationale supporting sunlight exposure as a risk factor for the development of malignant melanoma is more nuanced than that of NMSC. Nonetheless, epidemiological research supports the importance of UV exposure, namely severe sunburn in childhood, as a risk factor for melanoma. Sun sensitivity, or pigmentation features such as eye, hair, and skin color, as well as skin reactivity to sun exposure, (for example, failure to tan and intermittent exposure to bright sunlight), are major predictors of melanoma

susceptibility. Interestingly, unlike NMSC, UVB-mediated p53 mutations are practically absent in melanomas, indicating distinct pathways responsible for the genesis of these malignancies (7, 8).

1.2. Effect of Helious Rays on Skin

UV radiation exposure can be acute, chronic, or delayed. Affects on the skin. UVR-induced skin consequences manifest as rapid responses such as inflammation, sunburn, immunosuppression, hyperplasia, and pigmentation. Regarding vitamin D production and long-term implications, particularly photoaging and photocarcinogenesis. These immediate and long-term repercussions are determined by the spectrum and total UVR dosage, although the whole action spectrum for the majority of UVR-induced symptoms in human skin has yet to be found. Using different criteria to prevent UVR-induced changes may not provide equal security for all endpoints (8, 9).

1.3. Sunscreen Efficacy

Sunscreens are unique products since their efficacy is guaranteed when used properly. This promise is based on their ability to prevent sunburn, which has been the benchmark against which these products have been rated thus far. However, as indicated in this study, this single criterion does not appear to be enough for future sunscreen product reviews. The need for broad-spectrum UVB and UVA photoprotection solutions is the cornerstone of this position. However, unlike any other over-the-counter drug, the completed sunscreen product is tested for efficacy before being distributed to consumers. We'll take a short look at the methods used to evaluate sunscreen efficacy.

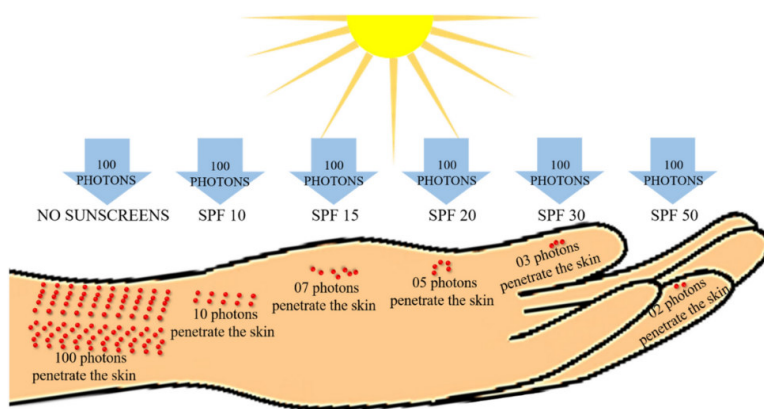


Figure: 01

2. EVIDENCE FOR A ROLE OF UV RADIATION IN SKIN CANCERS

The, sunscreen that cause protection to the skin

- The prevalence of NMSC is inversely associated to latitude in populations of largely European

descent and is greater in outdoor compared to indoor workers.

- The body parts that get the highest doses of UVR include the head, neck, arms, and hands, where NMSC is most prevalent.

- Persons that readily sunburn, i.e. Fitzpatrick skin types I and II, are more vulnerable to the formation of NMSC.
- 50% of basal cell carcinomas and 90% of squamous carcinomas have p53 tumor suppressor gene mutations, the majority of which are UVR hallmark mutations.
- Exposure to UVR induces dose-, time- and wavelength- dependent skin cancers in animals

2.1. Sunscreen Safety

In addition to traditional every day and recreational photoprotection products, sunscreens are increasingly being employed in a range of consumer items. As a result, questions have been raised concerning their long-term safety, particularly in the case of UVR exposure. The purpose of this section is to address some current concerns about sunscreen safety. This is not a comprehensive review of published studies on sunscreen safety, but rather an attempt to compare and contrast results from in vitro studies with those gained in vivo. Sunscreens are used to protect against UV radiation from the sun. SPF (Sun Protective Factor)-based sunscreens are being marketed.

2.2. Sunscreen Studies in Humans

Sunscreens were tested on human skin to see how they affected the acute effects of UV radiation. For example, Freeman et al. found that sunscreen combining OMC and benzophenone-3 protected human skin from UVR-induced DNA damage, as measured by the creation of pyrimidindimers. Van Praag et al. (100) discovered that a sunscreen combining the UVA filter, avobenzone, and the UVB filters, 3-(4'-methylbenzylidene)-camphor and 2-phenyl-benzimidazole-5-sulfonic acid, reduced UVB-induced cyclobutene dimer production in human skin. Finally, PABA substantially decreased unscheduled DNA synthesis caused by high dosage, 2 minimum erythema dose (MED), UVR exposure in human skin. Collectively, these findings that sunscreens reduce acute UVR-induced DNA damage in vivo corroborate their protective value in people. Furthermore, despite the many approaches and outcomes, a consistent positive outcome was achieved.

2.3. The Human Safety of Current Sunscreens

In vitro studies employing bare DNA or grown cells have fueled heated debates about sunscreen safety. These research discovered that after irradiation, sunscreens can assault DNA either directly or indirectly via free radicals, causing damage in the form of adducts or cell death. These findings imply that sunscreens may lead to long-term skin damage. It has been proposed that the DNA damage found in these in vitro investigations may be carcinogenic and arise from the use of sunscreens as prescribed. If the in vitro processes are cause for worry, then acute and, more importantly, chronic application should mirror these events, and sunscreens should speed up the emergence of UVR-induced DNA damage or tumor growth in vivo. However, the in vivo data show that

sunscreens protect against acute, chronic, and delayed UVR-induced skin injury. In all photocarcinogenicity investigations using sunscreens alone or in combination, there was a tendency toward delaying UV-induced tumor growth and reducing the number of tumors per mouse.

Despite variations in methodology across all of these research, a single result was obtained. The sunscreens' level of protection varied from totally preventing UV-induced tumor development to postponing tumor development by two to three weeks. Therefore, safety concerns based on current in vitro outcomes with sunscreens have little influence on how people use them and may even be detrimental if they deter people from using them.

2.4. Protected Versus Unprotected Skin

When applying sunscreen, the UVR spectrum that the skin's underlying cells are exposed to is defined by the sunscreen's attenuation spectrum. Sunscreens change the light spectrum that the skin is exposed to in this way. Longer UVA wavelengths will undoubtedly make up this sunscreen-protected spectrum (SPS), which will vary depending on the kind of sunscreen employed. This is true for most sunscreen products now on the market. The whole action spectrum, threshold, and dose-response for any physiological, biological, or molecular events that take place in the skin should thus ideally be known. For instance, the discovery of skin immunology twenty years ago raised concerns that sunscreens would not be able to stop the immune-suppressive consequences of UVR, while blocking the acute inflammation it causes. This topic has been the subject of several research with differing opinions (123,124). Many of the discrepancies can be explained by various experimental settings, such as light sources and the absence of UVC filters, and since a full action spectrum for immune suppression has not been identified, the whole picture is still unknown. In order to completely comprehend the relevance of UVR-sunscreen interactions, it is imperative that UVR-mediated biological processes be thoroughly described.

3. DISCUSSION

Preventing sunburn from UVR exposure is the most obvious immediate advantage of sunscreens now on the market. Both advantages and possible drawbacks have been proposed for this phenomenon. The apparent advantage is avoiding sunburn, which may lower the risk of nonmelanoma and perhaps melanoma skin cancers because NMSC production has been linked to the severity and frequency of sunburns.

Concerns have been raised about the current sunscreens' insufficient protection and, more significantly, the possibility of prolonged exposure to UVR without immediate symptoms (such as sunburn), which might eventually result in higher UVA dosages. Even though there is no evidence to support the notion that using sunscreen stimulates or promotes extended

sun exposure, it is nevertheless a widely held belief that is somewhat rational and alluring. In any case, it should be mentioned that for a certain acute UVR exposure, the skin damage caused without sunscreen photoprotection is more than that acquired with it.

4. CONCLUSIONS

UVR exposure may contribute to melanoma and is causally associated with NMSC. Sunscreens unquestionably and consistently reduce the UVR exposure of the skin. Sunscreens from the past and now offer good UVB protection but lack UVA, particularly UVA1, attenuating components. Recently developed long UVA blocking chemicals are being included into newer sunscreens to cover almost the whole UV spectrum. Existing *in vivo* animal and human studies are very similar in concluding that sunscreens are safe and effective, however further research will undoubtedly be beneficial.

The fact that sunscreens only block a fraction of the UVR spectrum has been criticized once more. This shouldn't be a problem now that genuine broad-spectrum protection is achievable. However, the potential for sunscreens to alter our behavior and make us "mad dogs and Englishmen" who venture out into the midday heat is where they may be dangerous. Therefore, sunscreens are just one component of a reasonable sun protection approach that also has to include appropriate attire, hats, sunglasses, avoiding the sun during peak hours, and—above all education. We think the present skin cancer pandemic will continue until the idea of a good tan is eradicated from Western culture.

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