

Sun Exposure and Skin Health : A Comprehensive Review of Photoprotection and Sunscreen Efficacy In Preventing Skin Diseases

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Abstract: *Skin is a thin layer of tissue forming the natural integumentary system of the body that acts as a barrier to protect it from exogenous and endogenous factors that induce undesirable biological responses in body. Among these risk factors skin damage triggered by solar ultraviolet radiation [UVR] is an escalating problem in dermatology with an increased incidence of acute and chronic cutaneous reactions. Sunburn is described as the erythematic acute cutaneous response in addition to increased melanin and apoptosis of keratinocytes to prevent skin carcinoma, solar UV damage leads to immunosuppressive skin diseases. Sunscreen is the most protective behaviour, these are products that are placed in contact with human skin with intention of absorbing, scattering, reflecting solar UV radiations. The frequency of use has increased remarkably due to greater awareness of skin damaging effects of skin exposure to sunlight. Sunscreen chemicals [UV Filters] are used not only to protect skin but also to prevent it from photo-degradation.*

Keywords: Sunscreen chemicals [UV filters], skin, photoprotection, sun exposure

I. INTRODUCTION

Skin is the integumentary system of the body and it plays a very important role in body functions. It acts as a barrier toward harmful exogenous agents and produces responses. Stressors such as viral or bacterial infections, heat or cold exposure, solar ultraviolet radiation (UVR) and exogenous chemicals to biological tissues can affect skin health.[1] An insight into the WHO report provides the incidence of 300 000 NMSCs due to chronic Sunburn history and sun exposure. Data studies indicate that skin diseases make up, on an average, 18 percent of all general practice consultation. Global burden of disease study has estimated that slightly more than 50 per cent female preponderance of skin disease is common during the time of adolescent when most harmful exposure of UV is experienced. Boundaries and geographical limits exist not. [2] However cutaneous infestations are more common in developing countries whereas skin malignancies are more prevalent in developed countries. This review presents the different skin diseases caused by solar UVR and a brief look at the implementation of preventive measures for solar UV-induced dermatological diseases.

RISK OF SOLAR UV EXPOSURE

Human skin is always exposed to ultraviolet radiation, and the effects of such exposure can be divided into two: acute UVR damage, which includes sunburn, erythema, pain, oedema, and photodermatoses; and more severe chronic UVR damage, which includes photoaging and premalignant skin lesions, such as actinic keratosis and skin cancers, such as basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and malignant melanoma (MM). Because solar UVR reaches the earth's surface every day, outdoor workers are particularly at risk of acquiring occupational skin cancer because of their high exposure to the sun[3]. According to a person's skin color and how it reacts to sunlight in terms of burning and tanning, Fitzpatrick's skin phototypes are determined. Fitzpatrick's type I–III skin is termed fair white skin, and type IV–VI skin is described as skin of color. The easiest characteristics to differentiate between races are skin color and hair texture, and these are strongly related to sun UVR and geographic location. The biological responses linked to skin photoaging, which involve skin drooping and elastosis, could be four times higher than noon solar irradiation during summer mid-latitudes. These responses also may play an important role in unprotected UVA

exposure from sun beds[4]. The final common risk factor for melanoma among young and adult women is indoor tanning that has been linked with a rise in skin cancer incidence in the general US population. Other common risk factors in the case of young and adult women are indoor tanning that has increased the incidence of skin cancer among the US population as a whole. There is a correlation that can be seen between indoor tanning and a higher risk for acute as well as chronic dermatological diseases.[5]

SUN EXPOSURE & SUN BURN

Exposure of the skin to more UV radiation of the sun causes its sunburning. It is associated with erythema, a well-known acute cutaneous response to UV radiation. Erythema results from an inflammatory response within the skin, and the severity of UV radiation-induced DNA damage is associated with the severity of erythema.[6] At any age, sunburns seem to cause similar levels of damage. Those people having lighter skin tones who get sunburned most readily are most likely to suffer from it. Older people and younger children are more photo-sensitive. Exercise was the most common risk factor, while sunbathing was the least common risky activity at the time of the most recent sunburn.[7] Other symptoms that should be included are pain, general weakness, and mild dizziness. Erythema is caused mainly by UVB radiation; the wavelength of which is short and likely to penetrate through the epidermal layer of the skin than UVA. Melanin, which is a pigment increasing rapidly against UVR-induced erythema, is the human natural defense. The effect on cells has a direct result of the effect on DNA and killed keratinocytes. Sunburn is a surrogate for cancer-causing radiation. Sunburn cells are keratinocytes that have been induced to undergo apoptosis to prevent further transformation into malignant cells.

Autoantigens are released from dying keratinocytes and are engulfed by the skin's Langerhans cells.[8]

SUN EXPOSURE & SKIN CANCER

Sunburns and prolonged sun exposure increase the risk of SCCs, as documented by Kennedy et al. [9]. Nowadays, skin cancer is becoming a serious health threat that degrades the quality of life in patients. According to the Brazilian National Cancer Institute, the most common kind of cancer in Brazil can be triggered by sun exposure and attacks any individual with any skin type regardless of age.[9] If an individual exposes their skin for long periods of time to solar UVR, changes in the molecular, pigmentary, and morphological structure of the skin lead the progression of skin cancers more quickly. There are speculations that with the aging population and continuous depletion of the ozone layer, skin cancer—especially noncancerous squamous cell carcinoma—will only increase in the future.[10]. Those who had sunburns doubled the risk of melanoma; nonburning sun Exposure was reported to lower melanoma. Too much sun exposure If a child is exposed to high levels of damaging UVR, there is a significant association between that child's exposure and the development of skin cancer over time.[11] Patients with alopecia areata have a reduced risk of skin cancer, especially SCC.[12] Gender differences in the prognosis of melanoma have been documented in several studies; survival rates are higher in females than in males.[13] Sun exposure, irrespective of skin color, leads to an increased risk of obtaining cancer. That is why sunburns and sunbathing are as near as things come to smoking. For all those patients with HIV infections and other patients who have already received an organ transplant especially kidney transplantation, their bodies are also susceptible to a higher skin cancer incidence than the normal.[14] Other drugs, besides their heart and over-the counter antibiotics medication, tend to make a person's skin more susceptible to the sun while burning the skin faster than normal which may, therefore, enhance the possibility of skin cancer.[15]

SUN EXPOSURE & SKIN DISEASES

All organ systems are affected by the complex and time-dependent biological process of aging, which is characterized by a decline in function and a weakened body's ability to respond to physical, biological, and chemical stressors.[16] There is a perfect organ in the field of ageing research to identify the ageing process by a significant social influence. Human skin is visible because of this.[17] Since UV radiation from the sun increases. As it induces inflammation and also accelerates the degradation of extracellular matrix, most researchers feel that this is the primary reason that explains apparent aging of human skin.[18] Besides being carcinogenic, ultraviolet light also causes collagen to change, and that leads to wrinkles on the skin's surface. Granzyme B is a serine proteinase with substrate specificity like that of the apoptotic cysteine proteinase family. It can cleave and activate multiple death proteins in

target cells and mediate contributions to the degradation of the extracellular matrix (ECM) of the skin after UV exposure by direct and indirect cleavage of ECM proteins by proteinases induction for their own cleavage.[19]

PHYTOPHOTODERMATITIS

The skin becomes sensitized to UV radiation by a chemical mechanism that results upon exposure. The most common photosensitizing agents are the naturally occurring psoralens, which include fura-lens and have led to a variety of manifestations ranging from burning, itching, and large blisters which evolve slowly.[20]

SUN EXPOSURE & SKIN PIGMENTATION CHANGES

LLP is a phenomenon by which color caused by UV lingers in a person for months or several years. LLP may be an indicator of a "genuine" risk in terms of the development of skin cancer. It does appear that LLP acts similarly in many ways to other types of hyperpigmentation, as observed in age spots and solar lentigines: all these are recognized to serve as precursors to lesional and clinical manifestations of photocarcinogenesis. The skin biopsy specimens from clinical studies that caused sunburn were employed to determine any possible long-term changes in the epidermis pigmentation.[21] Comparing the long-term LLP-positive individuals with their unexposed control and LLP-negative counterparts, they showed a hyperpigmented basal layer and increased pigmentation. It is well established that even slight differences in melanin concentration can cause significant differences in skin color. These features, including enhanced interdigitation, enhanced visual pigmentation, and histological markers of a hyperpigmented basal Layer, suggest the similarities of this long-term effect with other forms of UV-induced hyperpigmentations. These subtle changes in the basement membrane yield long-term elevations in pigmentation, which could result from feedbacks from parts of the membrane that are signaling to the nucleus that affect gene expression. Indeed, there have been several hundred genes that have been implicated in skin pigmentation and are known to have faced strong selective pressures during the history of humankind; for example, there is great variation in the population frequencies of genomic variants. However, within the same community, responses to sun exposure vary, indicating a variation beyond high-population differences in skin color [22].

SUNSCREEN

Protection against exposure to the sun has been preached since ancient times. It is well known that long exposure to the sun results in skin damage, skin cancer, sunburns, and premature aging. It has been established that sunscreen application reduces the risk of photodamage and skin cancer. In reality, how effective sunscreen is can only be measured by the level of sun protection factor it offers. The minimal erythema dose, therefore, refers to the low quantity of UV radiation able to cause the minimum extent of skin redness. Put simply, SPF 15 means that a person can spend time in the sun 15 times compared to a person who hadn't applied sunscreen before coming up with the first sunburn. longer before any redness occurs than without any sunscreen at all. The AAD recommends Sunscreens with [24]:

1. SPF of at least 30, which blocks 97% of UV rays.
2. "Broad-spectrum" coverage, which protects against both UVA and UVB rays. UVA contributes to early aging and skin damage; UVB is responsible for sunburn. Both cause skin cancers.
3. "Water-resistant" on the label, which allows for maintenance of SPF after 40 to 80 minutes in water.

Reapply sunscreen every two hours. It is necessary especially when outside in direct contact with water, snow, or sand as the materials reflect UV light. Up to 80% of the sun's rays pass through even on a cloudy day. Reapply sunscreen every two hours, after swimming, or if sweating [23]. These can be overcome by the application of two layers of sunscreen or by using a sunscreen with twice the amount of SPF necessary. The two types of sunscreens are chemical and physical blockers. Physical blockers consisting of titanium dioxide or zinc oxide work to scatter or reflect UV radiation off the skin. They generally provide more photoprotection and are better suited for people who have sensitive skins [25]. Chemical sunscreens absorb UV photons and convert them into lower-energy, safer wavelengths. Although they are seemingly more attractive, they contain more chemicals: oxybenzone, avobenzone, octocrylene, and PABA, which cause irritation or contact dermatitis [26].

Questions in recent times that have been brought to the fore regarding the safety of certain chemical components of sunscreens. Four ingredients of systemic absorption potential have been identified to include oxybenzone, avobenzone,

octocrylene, and escamsule, reported in a 2019 report by the FDA [27]. Some aerosolized sunscreen brands were recalled last year after benzene, associated with lymphomas, was found in them [27].

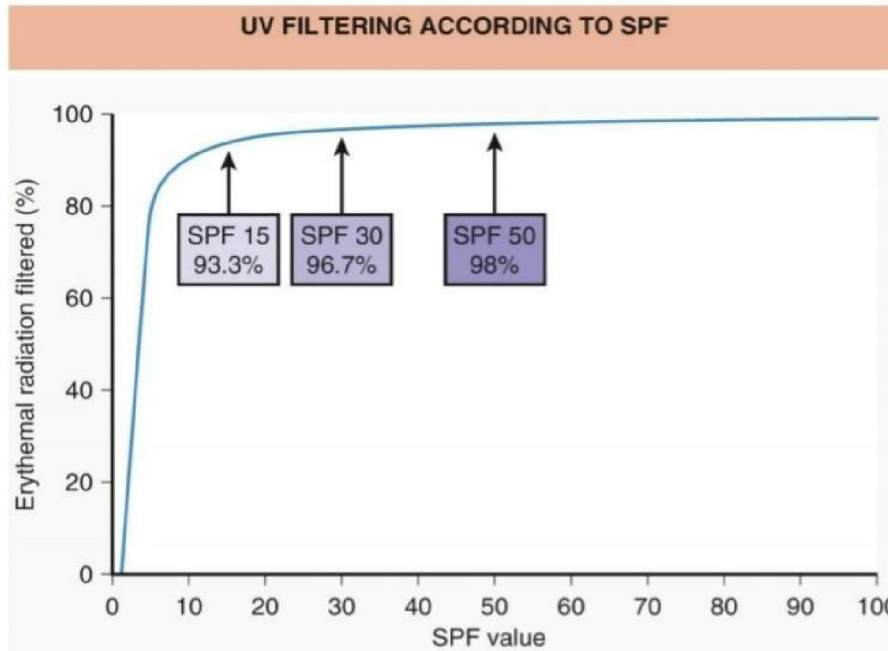


Figure 1: Instructions for monthly skin self-exams, as recommended by the Skin Cancer Foundation.

Nonetheless, one must note here that a study conducted on chemical sunscreens in the year 2020 which had six chemical ingredients which have proven to have incredibly little amounts of absorption within blood-stream, but however had proven to show how a systematically absorbed substance, raises further questions about their safety into the human organism in view of the side-effects for health [28]. Just because a material has absorbed into the systematic form it is not detrimental in all respects. Additional studies in oxybenzone and octinoxate found no effect on developmental, reproductive, or hormonal changes [29]. The few studies that linked the exposure of oxybenzone with pregnancy and reduced birth weights or gestation for a male infant were associated with high heterogeneity and confounding variables [29, 30]. In summary, 1) without further research, there can be no concrete evidence that applying sunscreen causes damage, and 2) experiments and clinicals have proven that the protective use of sunscreen far outweigh any potential risk. Patients must talk with their dermatologist. A person should visit a dermatologist if they have issues so that a sunscreen can be applied to that individual's specifications. Interestingly, this is not a problem with physical sunscreens. As "generally recognized as safe and effective," they carry the FDA's label GRASE. However, based on the color of the skin, they leave a chalky white or gray residue. For a more even application, the darker the skin of a person, the sooner one should test micronized sunblock preparations [31]. They also appreciate tinted sunblocks as giving protection not only by UVA and UVB rays but by visible light too, bringing it even closer to a natural hue than their own skin tone. This might help eliminate that annoying problem of hyperpigmentation around the sun using the Fitzpatrick scale are more susceptible to burnings or tanned after exposure to UV radiation. Sunburns, especially during childhood and adolescents, enhance the risks of melanoma [23]. Darker skinned people have an average SPF of 13.4 because their higher amount of melanin is a UV filter [23].

They should also be sun protective, although because skin cancer can affect anyone, regardless of skin shade. In reality, people of darker skin are at a higher risk for certain types of melanomas, and also often tend to be diagnosed later when the cancers have become advanced. There is a wide range of sunscreen formulations from which to choose in accordance with personal preference. For the face and other dry skin, creams are recommended. Gels work really well on hairy areas, such as the scalp and chest of men. Sticks work well around the lips and eyes. Sprays are a good option for parents who want to put sunscreen on their kids. Getting enough coverage can be tricky. It is recommended that the

skin be misted until it shimmers and then rubbed in evenly. A convenient fact is that most lip balms, cosmetics, and moisturizers already have SPF. "The best sunscreen is the one that the patient will actually wear," says the paper's senior author.



Figure 2: The Fitzpatrick scale, which categorizes individuals on the basis of how easily they tan or burn.

PROTECTIVE CLOTHING

Particularly between the hours of 10 am to 4 pm, wide brimmed hats with the recommendations of three inches and long sleeves and protective eyeglasses with ultraviolet filtering are recommended Figure 4. Thicker cloth provides a greater amount of protection especially those made of the dense weave of textiles: Denim, canvas, wool, synthetic fibers (Spandex), polyester/cotton, and nylon/elastane [32, 33]. The looser fit and darker tones provide higher levels of protection. Moisture or stretched clothing reduces photoprotection capabilities. Sun gloves that provide forearms and wrists may offer protection as you are driving.

Washing additive by SunGuard creates UPF 30 within 20 washes

SYSTEMICS

Many foods, especially green tea, are rich in antioxidants (Vitamin C, Vitamin E, selenium, and polyphenols), which have been established to have photo-protective effects. Kapoor et al. in a meta-analysis conducted in 2021 reported that habitual consumption of green tea catechins increased the minimal Erythema dose and suppressed redness and sunburns by inhibiting the formation of reactive oxygen species [34]. These derivatives also inhibited leucocyte Elastase and metalloproteinases, and hence, possessed anti-carcinogenic properties. Resveratrol derived from red wine and skin of grapes is an antioxidant shown to have anticarcinogenic activity primarily as a result of anti-UVB protection [35]. Other nutritional factors thought to possess photoprotective activity include flavonoids, carotenoids (carrots, tomatoes), turmeric, pomegranate juice, astaxanthin, Coenzyme Q10 (fatty fish, organ meats), and vital Omega-3 fatty acids (fish, flaxseed, chia seeds).[36]

What to Wear to Protect Your Skin from the Sun

Skin cancer is the most common cancer in the U.S., and nearly 20 Americans die from melanoma — the deadliest form of skin cancer — every day.

That's why it's important to dress to protect yourself from the sun. In addition to **seeking shade** and **applying sunscreen**, **wearing sun-protective clothing** can go a long way in protecting you from the sun's harmful UV rays, which can increase your risk for skin cancer. However, not all clothes are created equal when it comes to sun protection. Some clothes provide better UV protection than others.

The right sun-protective outfit:



Provides long-lasting sun protection.



Works great for all skin types and colors.

To help protect your skin from the sun, wear these clothes and accessories outdoors whenever possible:



A wide-brimmed hat with no holes in the fabric



Sunglasses with UV protection





Pants



Tightly woven fabrics (ones you can't see through)





Dark or bright colors



A lightweight, long-sleeved shirt



For more effective sun protection, select clothing with an ultraviolet protection factor (UPF) number on the label.



Make sure to apply a **broad-spectrum, water-resistant sunscreen** with an **SPF of 30** or higher to all skin not covered by clothing.



Reapply sunscreen every two hours when outdoors, or after swimming or sweating.



Don't forget your feet! When wearing sandals, flip-flops, or going barefoot, apply sunscreen to all exposed skin.

(Figure 3.AAD recommendations for protective clothing)

MECHANISM OF ACTION OF PHOTOPROTECTION

UV radiation greatly damages the skin by causing immunosuppression, sunburns, precancerous and cancerous lesions, and skin aging. There is a high risk of skin cancer by UV radiation and it has immunosuppressive action on the antigen-

presenting cells in the epidermis. There are three types of UV Radiation: UVC, UVB, and UVA. A minimal amount of UVA, 90 percent of UVB, and completely UVC is absorbed by the ozone layer. Hence, the depletion of it enhances UV transmission. It has a relation with UVA and aging. It builds free radical oxygen species with deep penetration into the epidermal layer and indirectly, causes harm to DNA. UVA diminishes antigen-presenting cells and enhances inflammatory cells in the dermis.[39] UVB causes damage to DNA strands and sunburn. It leads to mutations of pyrimidine dimers, which are associated with skin cancers except melanoma.[40] Main and secondary protective factors participate in photoprotection. The main factor is sunscreen, which includes chemical barriers that absorb light and physical barriers that scatter and reflect light. Some limiting secondary factors include antioxidants, osmolytes, and DNA repair enzymes. This class of compounds interferes with the photochemical cascade provoked by UV exposure.[38]

Organic sunscreens are chemical sunscreens. The chemical structure that comes in the form of an aromatic molecule conjugated to a carbonyl group is the basis of this class of sunscreen mechanism. By this structure, the molecule is capable of absorbing high energy UV Radiation is absorbed, and the molecule is excited. On returning to the ground state, the molecule emits the lower energy of the longer wavelengths. Sunscreen is specific for wavelengths, absorption range differs.

Chemicals used to make sunscreens include filters of UVA and UVB. The entire spectrum of UVB light is absorbed by UVB filters. Unlike this, UVA filters do not absorb the total spectrum of UVA radiations. There are two classifications of uranium radiations as well. These are as follows: UVA I for 340–400 nm and UVA II from 320–340 nm. Broad-spectrum sunscreens absorb UV & radiation. Both in the UVA and in the UVB portions.[41]

UVB BLOCKERS

Aminobenzoates, Cinnamates, Salicylates, Octocrylene, Ensulizole, Camphor derivative The most powerful UVB absorber is aminobenzoate, although it does not absorb UVA. Because of the sensitivity to para-aminobenzoic acid (PABA), their use has decreased. Although PABA is a very effective UVB filter, it was once thought to be the most frequent contact and photoallergen. Because of this, its application in sunscreen is restricted. The most widely used PABA derivative is Padimate O, which is also an efficient UVB filter and has a favorable safety profile.[37]

Cinnamates, that are cinoxate and octinoxate (OMC), have replaced PABA as the next most effective UVB absorber. [38] In the US, the most common UVB filter used is octinoxate. Due to the fact that padimate O is a stronger UVB absorber, other UVB absorbers are combined with it to achieve the SPF. Octinoxate is not very photostable and degrades in sunlight very quickly. Cinoxate is not as big of an option.[37] Because salicylates are poor UVB absorbers, they are used in high concentrations. They are also used to enhance the potency of other UVB filters.

Octisalate and homosalate are two salicylates that are FDA-approved. They function to inhibit the photodegradation of other UV filters, such as oxybenzone and avobenzone. Trolamine salicylate is a water-soluble salicylate. It has a photoallergic risk very much low as with the chemical of octocrylene and phototoxicity is highly low. It has little irritation risk. With the other UV absorbers its SPF formula can be made to increase, and act just above the skin's surface only upon UVB rays, while in the case of UVA ray no interference occurs. It's water-Soluble ingredient that gives a softer, less greasy feel to makeup. Although not FDA-listed, camphor derivatives are reasonably good UVB filters. Terephthalidene dicamphor sulfonic acid is a camphor derivative used as a broad ultraviolet A filter. [37]

UVA BLOCKERS

Benzophenones, Anthranilates, Avobenzone, Ecamsule. While oxybenzone is a broad spectrum absorber as it absorbs UVA II as well, typical benzophenones absorb mainly UVB light. It is the most commonly used benzophenone [38]. Oxybenzone has the highest risk of contact or photocontact dermatitis among all sunscreens. Not only is oxybenzone not thought to be photostable, but there are also carcinogenic and endocrine adverse effects that have not been proven scientifically.[38] Among the other Dioxybenzone and sulisobenzene are the benzophenones on the FDA's list.[37] Anthranilates are not as effective as UVB and UVA filters compared to benzophenones. Clinicians therefore hardly ever use them.[37] Avobenzone is very potent against UVA I (>380 nm) but photo-unstable, losing 50% to 90% of their particle content after only one hour of UV exposure. They have also been complained to be weakening the octinoxate UV filter. To make them more photostable, a combination of UV absorbers is used such as octocrylene,

salicylates, benzophenones, camphor derivatives, and micronized zinc oxide or titanium dioxide.[37] Ecamsule includes Terephthalidene dicamphor sulfonic acid, a photochemically very stable, water-insensitive chemical with a minimal systemic absorption. It inhibited UVA-induced photoaging in animal studies.[37]

Similar to clothing, the mechanism by which a physical sunscreen works is through reflection and scattering of UV rays. What proportion of sunscreens can reflect determines their effectiveness. Some of the qualities are the reflection index, the size of particles, coating thickness, and the suspension base; the more excellent the UV filter will be the higher the reflecting index is. Even though this formulation is cosmetically preferable, when particle sizes are diminished to a micronized suspension (10-50nm), there's the enhanced risk of systemic absorption, thus the shielding of short wavelength too. However, with even less cosmetically favorable, the amount of reflection becomes greater with an increase in the coating thickness.

An alternative in enhancing UVA protection along with better absorption is given in iron oxide. Physical sunscreen mainly contains titanium dioxide along with zinc oxide. Aqueous photoprotection primarily includes antioxidants, osmolytes, and DNA repair enzymes, which actually do inhibit skin damage by counter reacting on the photochemical cascade initiated by UV light following the irradiation. Of them, vitamin C and E, silymarin, and green tea polyphenols are many an antioxidants present in many types of sunscreens. The causative agent of sunburn and erythema is damage caused by UV, prevented through the action of vitamin C. Vitamin E has additional protective effects, including minimizing immunosuppression, erythema, photoaging, and photocarcinogenesis. Silymarin, which originates from milk thistle, prevents reactive oxygen species scavenging and inhibits oxidation of lipids and lipoproteins. Externally applied, decreases the number of UVB-induced sunburn cells as well as UVB-induced pyrimidine dimers. It has been established to decrease the amount of UVB-induced tumors in mice.[42] The antioxidants of green tea polyphenols are more powerful than those in vitamins C and E. They have anti- carcinogenic and anti-inflammatory properties. They can scavenge hydrogen peroxide, superoxide radicals, hydroxyl radicals, and single oxygen.[43] Osmolytes are small molecules that regulate hydration to stabilize the cell in stressful situations. Many sunscreens provide protection against various UV rays through osmotically active substances like taurine and ectoine.[38][44][45].

ADMINISTRATION

It is best applied topically. The proper application of medication is what will make it effective. Fifteen minutes before exposure to the sun, a generous and even layer of sunscreen should be applied. A body application of 30 mL or 2 mg/cm² is the proper dose. Reapplication of sunscreen is recommended every two hours and after swimming or sweating. The Photoprotective property of clothing can also be measured in terms of a UV protection factor. UPF or Ultraviolet protection factor meters measure the penetration rate of UVB and UVA that a particular textile allows. Animal studies reported efficacy against pre-malignant lesions as well as erythema for UPFs greater than 30. UPF is therefore higher or lower when the fabric is wet or dry. Compared to dark-colored fabrics, light-colored ones possess a lower UPF. Generally, clothing offers reasonable protection against UVA and UVB rays. The loose-fitting, colored kind is the best photoprotection. Hats also come in different levels of photoprotection based on the material, weave, and brim width. It has SPF for the nose at 7, neck at 5, cheeks at 3, and chin at 2, while in a hat whose brim exceeds 7.5 cm, a brim from 2.5 to 7.5 cm brim width gives 3 SPF for the nose, 2 SPF for the cheeks and neck, and 0 SPF for the chin. A hat with a brim less than 2.5 cm has a minimum SPF of 0.75 for the neck and chin and a maximum of 1.5 for the nose.[37] Without any sunscreen, the pigment content of cosmetics provides an SPF of 3 to 4; however, it dissipates four hours after application. UV filters are more and more used in foundations for photoprotection.[37] Sunglasses can protect your eyes from UV rays. Many eye diseases, cataracts being one of them are caused directly by sunlight especially ultraviolet B radiation. Progressive exposure results in cataract formation and development of ocular cancer. All ranges of ultraviolet must be 99% to 100% absorbed by the sunglasses. Contact lenses protect the front side of the eye. They do, however, offer photoprotection for the intraocular lens. [37]

SIDE EFFECTS

Four of the side effects of sunscreen use are types of contact dermatitis-irritant, allergic, phototoxic, and photoallergic. Because it is more cosmetically elegant, physical sunscreen contains nanoparticles, which implies negative effects.

Nanoparticles could be more catalytically active because they provide more free radicals and increase protein and DNA damage. These tiny particles can bind to proteins and form complexes that act like haptens, thus triggering autoimmunity. [38,47] There are so many potential negative impacts on the reproductive and developmental system. These disruption effects have been shown in in vitro and in vivo studies. The alterations in the uterine and prostate level of proteins which express the estrogen, androgen, progesterone, insulin-like growth factor I, complement proteins, nuclear receptor co-repressor, and steroid receptor coactivator could be mechanisms of action by which these agents induce reproductive toxicity.[46]

CONTRAINDICATIONS

The 1999 FDA Sunscreen Final Monograph suggests that mothers of babies below six months should get the doctor's advice regarding using sunscreen on their infants though photoprotection for each age group is recommended. The reasons are that, as babies' metabolisms don't develop and also the chemicals absorbed in sunscreens don't get excreted out of their bodies. If using sunscreens, apply them only in small amounts and only to parts of the body exposed to the sun.[37]

MONITORING

Sunscreen is an over-the-counter drug, which falls under the jurisdiction of FDA. The measure of a sunscreen's efficacy is the ability to protect from UVB; it can also be expressed as the sun protection factor (SPF) and substantivity. SPF: Ratio of the minimum amount of UVB irradiation causing minimal redness on the protected skin, as compared with the same degree of redness that can be achieved by unprotected skin from a given dose of UVB radiation. Since SPF is 1000 times more erythematous than UVA, it can provide better protection against UVB rays. For example, the amount of UVB light it blocks is as follows: 97% in the case of SPF-30, and only 94% in the case of an SPF-15. [37] Substantivity refers to the capability of a sunscreen to tolerate a hard environment, such as water and perspiration. FDA has established vocabulary for labeling substantivity. The term "water-resistant" refers to a 40- minute period in which moderate exercise and immersion in water are used together to maintain photoprotection. Highly water-resistant refers to an 80-minute effectiveness period. Both terms can be sweat-resistant.[38]

TOXICITY

The first line of treatment for contact dermatitis is to avoid the offending agent. Patch testing can help identify the offending agent. The American Contact

The website of Dermatitis Society lists the results of patch tests and also lets the patients view a list of non-allergenic products that can be used. Topical steroids are incorporated in the treatment of localized reactions. Oral steroids should be prescribed when there is a severe reaction. When oral steroids are not effective, mycophenolate mofetil, methotrexate, or oral cyclosporine should be used. Mild to moderate dermatitis may be prescribed with pimecrolimus, tacrolimus, and calcineurin inhibitors. Photoallergy and phototoxicity normally require UVA radiation for the reaction to take place. The patient should strive to avoid the offending agent, but if not, they should use protective garments, avoid tanning beds, and use non- allergic sunscreen. Irritant contact dermatitis can be prevented and is treated with barrier creams as well as high-lipid moisturizers.[41]

REGULATORY OVERVIEW

When sunbathing became popular in the 1930s, the first "sunscreen creams" were introduced to the market in the USA and Europe [48]. Para-aminobenzoic acid (PABA) was later patented in Germany and France and widely used as a component in sunscreens in 1943 [49]. All developed nations have regulations regarding sunscreen use. Every country, including the USA, Australia, Canada, ASEAN, India, and the European Union (EU), has defined the maximum permissible concentration and list

of compounds classed as UV filters. Table I shows a summary of UV filters approved in India and other countries. UV filters used in sunscreens are considered cosmetics in the EU and, therefore, appear on the positive list [50, 51]. The European Cosmetics Association collaborates with the European Commission in updating the lists, which is done through scientific research. Sun products come under over-the-counter drugs in the US: active ingredients for these products must be declared as safe and effective. Their production and marketing are governed by US FDA monographs

published in the Federal Register. The monographs were first introduced and have since been constantly updated since 1978. In the USA, zinc oxide, trolamine salicylate, menthyl anthranilate, cinoxate, and dioxybenzone are permitted, but not in India [52, 53]. Sunscreen products are also classified as prescription pharmaceuticals in Canada and not legally allowed to be imported there, advertised, or sold unless they meet the specifications of the Food and pharmaceuticals Act. Those natural health products (NHPs) that contain para amino benzoic acid, zinc oxide, or titanium oxide will be classified as falling under the category of sunscreens. Drugs will be deemed so if these drugs have any of the following elements: avobenzone, Ensulizole, Homosalate, Meradimate, Octinoxate, Octisalate, Octocrylene, Oxybenzone, Sulisobenzene, Drometrizole trisiloxane, Encacamene, Padimate-O, Terephthalylidene dicamphor sulfonic acid, Cinoxate, Diethanolamine-methoxycinnamate, Dioxybenzone, and Triethanolamine salicylate. This document represents the revised version of Sunburn Protectants Monograph, announced by Health Canada recently. As is true for other medication classes within this group in Canada, the name of the publication has been changed to "Guidance Document Sunscreen Monograph". It is the product of a careful examination of the current regulations, policies, guidelines, and practices within Health Canada and other pioneering regulatory agencies. This draft monograph supersedes the Sunburn Protectants Monograph dated October 12, 2006 [54]. The additional sunscreen agents accepted in Canada are menthyl anthranilate, diethanolamine methoxycinnamate, cinoxate, and dioxybenzone. In India, zinc oxide, trolamine salicylate, glyceryl PABA and ethyl dihydroxy propyl PABA have not been used in any UV filter. Australia being one of the countries where the rate of skin cancer is very high, application of sunscreen forms an essential part of any sun protection program for the Australians. A big section of the Australian population applies sunscreen to their body every day of their lives. Some sunscreens in Australia are regulated by TGA as therapeutic goods in terms of safety, efficacy, and quality of the sunscreen products. The TGA reformulated sun-screening agents which were registered as active ingredients in listed products in 2006. To lead sponsors and manufacturers on the regulatory requirements for sunscreens in Australia, the Australian Regulatory Guidelines for Sunscreens (ARGS) were formulated [55]. Some skin cancers may be prevented or at least less likely with an SPF rating of 30 or above. The SPF value of sunscreens determines their classification, which includes "listable," "registrable," and "exempt" sunscreens. Listable sunscreens have an SPF of 4 or higher and can only make claims about suncreening. Sunscreens with medicinal claims are subject to registration. Sunscreens may contain only accepted ingredients, all of which are screened for safety. The SPF rating that appears on the label must be tested to ensure each sunscreen product protects the skin according to the requirements of the TGA regulations. UV filters include such compounds as bemotrizinol (tinosorb S), 2,2'-Methylene-bis-6-(2-Hbenzotriazol-2yl)-4-(tetramethylbutyl), alpha-(2-oxoborn-3-ylidene), toluene-4-sulphonic acid and its salts, salicylic acid salts (potassium, sodium, and triethanolamine), triethanolamine salicylate, zinc oxide, and so on. Australia has approved -1,1,3,3-phenol (tinosorb M), while India does not mention it. [56] The 2009 ASEAN Cosmetic Document's Annex VII has a list of UV filters that cosmetic goods may contain. The usage guidelines and warnings such as "do not stay too long in the sun, even while using a sunscreen product," according to the document must be placed on the label. Zinc oxide and methyl anthranilate are not mentioned in the UV filters by India [57]. The Bureau of Indian Standards (BIS) in India has documented permitted UV filters to be present with cosmetic products. There is no top limitation of SPF rating. For the purpose of directive, UV filters are compounds, which contained in cosmetic sunscreen products, are especially intended to filter certain UV rays in order to protect skin from certain damaging effects of rays. Not in the list are additional UV filters used in cosmetic products only for protection against the UV rays. [58]

II. DISCUSSION

According to India, any article intended to be rubbed, poured, sprinkled, sprayed, applied to, introduced into or otherwise applied to the human body or any part of it for cleaning, beautifying, promoting attractiveness or altering the appearance shall be called a cosmetic. This also covers any article which is meant to be used as an ingredient in a cosmetic [59]. According to the EU, cosmetics refer to any material or preparation that will be intended to be in contact with the mucous membranes of the oral cavity and the various external parts of the human body, for example, epidermis, hair system, nails, lips, and. External genital organs-the body's major or sole function is to clean, perfume, change the appearance of the body, remove body smells, protect or maintain its appearance. [60] Any preparation or substance with an intended or future purpose to touch and get in contact with human beings, various oral mucous

membranes in conjunction with teeth and numerous exterior components such as hair systems, nails, external parts, the epidermis and human beings' various oral and vaginal membranes, along with an overall purpose or sole application, cleaning, perfuming or change of outlook in making corrections to various unpleasant odor problems, offering protective covers and keeping everything healthy - are defined in the use by ASEAN to give these products meaning as explained below . Definitions of ASEAN and EU are the same. According to the US FDA, cosmetics refer to articles intended to be applied to, introduced into, rubbed, poured, sprinkled, or sprayed on, to accomplish any cleaning, beautifying, promoting attractiveness, or altering appearance of the human body [61]. The Canadian Food & Drugs Act defines a cosmetic as any material or any combination of materials produced, marketed, or used for cleaning, enhancing, or otherwise changing the appearance of human skin, hair, or teeth. This definition even includes deodorants and perfumes [62]. Besides, the US FDA and Health Canada maintain that cosmetics should not have claims concerning physiological effects. UV filters are pharmaceutical in the United States, Canada, and Australia. India, the ASEAN, and the EU list UV filters for cosmetics. Because of this consideration, the percent requirements of some compounds are different. The US, Canada, and Australia demand proof regarding their efficacy and safety besides agency approval .India's The definition of cosmetics is very much alike that of the US but uses the EU model for the list of UV filters instead of the US model. The sale of cosmetics is governed by the Drugs and Cosmetics Act 1940 and Rules 1945 in India. The BIS lays standards for cosmetics for the goods covered under Schedule 'S' of The Drugs and Cosmetics Rules 1945. UV filters or its products are not covered under Schedule S i.e. the Drugs and Cosmetic Rules do not provide any standard quality of UV filter chemicals or its products in India. Standards for good manufacturing procedures and facilities, machinery, and equipment for manufacture of creams, ointments, emulsions, lotions, etc., all other products falling under medication category (Schedule M) are more stringent than the requirements for cosmetics (Schedule M II). That is the reason why sunscreen Products that fall under the drugs category need to be approved much slower than sunscreen products that fall under the category of cosmetics. The active ingredients of sunscreens are UV filters. Sun Protection Factor measures the effectiveness of sunscreens in terms of concentration and combination of UV filters. There are differences in labeling, requirements, permissible claims and SPF testing techniques. Any UK sun-screen would need proof of performance in relation to its SPF value as well as any claim about it having UVA or UVB protection [63]. SPF rating is also required in Australia, Japan, Canada and USA. In Australia, an SPF value above four means such products are drugs. However, in India, a maximum SPF value limit is yet to be set. Increased SPF natural, ayurvedic, and herbal products are available now.

No directives for claims and no need of declaration of the composition of the ingredients in cosmetic items currently applied [64]. Water resistance as well as broad spectrum are two claims that need to be evaluated appropriately. Cosmetic manufacturers make inflated claims and issue an SPF rating because of such flaws. The same sunscreen lotions, with a sun protection factor of up to 40, are marketed as cosmetics in India. In India, the same sunscreen products are also manufactured and sold as drugs or cosmetics. In India, a new sunscreen lotion with titanium dioxide, octinoxate, avobenzone, and oxybenzone has also been approved as a new drug.[64]

III. CONCLUSION

By contemplating on the aforementioned studies and data we can conclude that the lack of knowledge about solar UV-induced dermatological diseases and the necessity to stay away from chronic solar exposure may cause more undesirable skin problems. So numerous health promotion programmes should be encouraged, as well as easier access to the adoption of preventive measures based on studies conducted be provided. Very high UVI requires that prevention when considering solar protection be part of the daily care of the public. Avoiding exposure between 10 a.m. and 3 p.m., or when UV levels are at their peak, is not viable for the general public and is therefore probably ineffective. In addition to other effective skin protection techniques like wearing long sleeves, hats and sunglasses, sunscreen is the skin protective habit that is most frequently mentioned and is the most actively promoted as part of the Sunrise campaign. When counselling patients with a history of NMSC, physicians should encourage sunburn prevention, especially in younger adults, emphasising shade and sun avoidance over sunscreen. Considering the increasing attention to sun screen products and globalization of their market, international harmonization of product regulation would be useful. Two major international organizations have been working in this sense, the International Organization for Standardization and the International Cooperation on Cosmetics Regulation (ICCR). The ICCR is composed of experts

from the USA (FDA), Canada (Health Canada), Europe (European Commission, DG Enterprise) and Japan (Ministry of Health, Labour and Welfare). It is important to have stringent safety assessment of their potential to produce local toxicity, such as irritation, sensitization, photo-toxicity, acute toxicity, dermal absorption/penetration, sub-chronic toxicity, genetic toxicity, carcinogenicity and photo-carcinogenicity etc. for the sunscreen chemicals in this country. SPF rating for cosmetic products and drugs needs to be fixed and guidelines for label claims on these products should be developed. SPF labelling should be made mandatory. Standard for sunscreen products should be fixed and made statutory. There is need to redefine “cosmetic” in global perspective.

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