IMPACT OF ULTRAVIOLET RADIATION (UVR) EXPOSURE ON SKIN CANCER: AN EMPHASIS ON PEDIATRIC AND ADOLESCENT YOUNG ADULT (AYA) POPULATION

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Background

Skin cancer is a significant public health problem in the United States. Along with several genetic and environmental factors, Ultraviolet radiation (UVR) remains the measure cause of this deadly disease. To an estimate, about 90% skin cancer can be prevented by managing natural sun exposure and manmade tanning beds. On one hand, the sun emits light and warmth which sustains life on earth by helping plants in photosynthesis and regulating human physical and psychological well-being by producing Vitamin D in their skin, and controlling their biorhythms; but on another hand, it also emits UV radiation, which is toxic for all sort of lives. Both the US Department of Health and Human Services and the World Health Organization, have identified UV as a proven human carcinogen and the main cause of nonmelanoma skin cancers (NMSC), including basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and melanoma.

**UV Radiation:** UVR is electromagnetic radiation found between X-radiation and light in the electromagnetic spectrum. It is emitted by the sun and artificial devices, including sunbeds or sunlamps. UVR can be divided into ultraviolet A (UVA), ultraviolet B (UVB), and ultraviolet C (UVC) radiation components. UVR (“above violet”) waves range from 200 to 400 nm. UVB (290 – 320 nm) and UVA (320 – 400 nm) rays penetrate the atmosphere and have the greatest biological significance. Solar radiation that reaches the earth’s surface comprises approximately 95% UVA and 5% UVB rays. Sand, snow, concrete, and water can reflect up to 85% of sunlight, thus intensifying exposure. UVR can penetrate to a depth of 60 cm in water and result in significant exposure. UVA rays are relatively constant throughout the day and the year. UVB rays have greater intensity in summer than in winter, at midday than in morning or late afternoon, in places closer to the equator, and at high altitudes. UVR can also be produced by man-made lamps (eg, sunlamps) and tools (eg, welding tools).

**UV and Skin Cancer:** The photobiological reactions related to skin cancer risk due to UVR exposure are the reactions with the main chromophores of the skin’s outer layer — urocanic acid, DNA, tryptophan, tyrosine, and the melanins. The products resulting from the reaction of UVR with DNA (DNA photoproducts) include pyrimidine dimers, pyrimidine-pyrimidine (6-4) photoproducts, thymine glycols, and DNA exhibiting cytosine and purine damage and other damage, such as DNA strand breaks and cross-links and DNA-protein cross-links. The various DNA photoproducts differ in their mutagenic potential. UVR-induced DNA photoproducts cause a variety of cellular responses that contribute to skin cancer. Unrepaired DNA photoproducts may result in the release of cytokines that contribute to tumor promotion, tumor progression, immunosuppression, and the induction of latent viruses. UVB is considered to be the major cause of skin cancer, despite the fact that it does not penetrate the skin as deeply as UVA or react with the outer skin layer as vigorously as UVC. Its high reactivity with macromolecules, coupled with the depth to which it penetrates skin, makes UVB the most potent portion of the UV spectrum for both short-term and long-term biological effects. UVA, while possibly not as dangerous, also causes biological damage.

**Prevalence and Impact:** Cutaneous malignant melanoma (CMM) incidence has increased markedly over the past 25 years in Canada, the US, Australia, and Northern Europe, and is a significant public health problem in light skin populations. The major environmental risk factor is solar UV exposure, and the principal modifying factor for the effect of this exposure is individual susceptibility as indicated by pigmentation and sun-sensitivity. Although children are not commonly diagnosed with skin cancer, it is during childhood that much of one’s lifetime sun
exposure occurs and when important protective behaviors can be established. Research has shown that children typically experience significant sun exposure during a school day, often enough to cause sunburn, and even more often, enough to cause DNA damage that increases their risk of skin cancer over the course of their school years. Approximately 65%–90% of skin cancer are caused by UVR, and because a substantial percentage of lifetime sun exposure occurs before age 20, UVR exposure during childhood and adolescence plays an important role in the development of skin cancer later in life. Unfortunately, in absence of proper education, awareness, policy, legislation and lack of implementation of existing laws, this preventable malignancy still causes 3.5 million new diagnosis and 12,000 death each year in US, due to which billions of dollar are lost in economy. One person dies of melanoma every hour (every 57 minutes). Providentially, several studies have shown that a substantial proportion of cancers could be prevented, including skin cancer. According to the recent report of American cancer society, many of the more than 2 million skin cancers, that are diagnosed annually, could be prevented by protecting skin from excessive sun exposure and avoiding indoor tanning.  

**Toxicology and Risk Assessment**

According to the Skin Cancer Foundation (2008), "A person's risk of melanoma doubles if he or she has five or more sunburns." A large body of research indicates that exposure to UVR (quite often from natural sunshine or man-made sources like tanning beds) triggers mutations, or genetic defects, that lead the skin cells to multiply rapidly and form malignant tumors. In 1992, the International Agency for Research on Cancer concluded that “there is sufficient evidence in humans for the carcinogenicity of solar radiation. Since then a large body of evidence established from cellular, biological and epidemiologic studies attributing to the fact that higher sun exposure correlates with UVR induces skin cancer and immune suppression eventually which also increase the risk of development of skin cancer. The major source of UVR is solar radiation or sunlight, although exposure to artificial sources in the workplace and tanning salons is becoming more important in terms of human health effects. Ultraviolet C (UV-C), from the sun, is virtually completely screened out by the Earth’s atmosphere, and is thus a negligible source of adverse human health effects. Ultraviolet B (UV-B) is responsible for erythema (sunburn), skin cancer, and immunosuppression. However, solar UV-B is crucial in the synthesis of vitamin D, which some recent studies suggest may potentially reduce risk of colon, prostate, and breast cancers. Ultraviolet A (UV-A) is responsible for skin aging, and has more recently been implicated, along with UV-B, in the development of skin cancers in animals and in immunosuppression in humans. Although the sun is the main source of UV-A exposure, use of UV-A emitting lamps in sunbeds for recreational tanning has raised concern about artificial sources of human exposure.

**Solar Radiation:** The greatest source of human exposure to broad-spectrum UVR is solar radiation; however, the exposure varies with geographical location. Solar UVR exposure is estimated to account for over 90% of melanomas in North America, and Australia, with similar figures for Northern Europe. According to the International Agency for Research on Cancer (IACR) solar radiation is a proven human carcinogen based on sufficient evidence of carcinogenicity from studies in humans, which indicate that exposure to solar radiation causes
Skin cancer (malignant melanoma and non-melanocytic cancer). Over the past 25 years, a number of case-control and cohort studies have addressed the relationship of CMM with solar UVR, many controlling for the effects of pigmentation and sun-sensitivity. Of the 57 studies noted in the systematic review, 34 evaluated a measure of ‘intermittent’ solar exposure, usually defined as outdoor recreational activities, sunbathing, or vacations in the sun. Most studies showed a positive association between intermittent exposure and melanoma risk, and the relationship was statistically significant in 18 of them. Some studies suggest that solar radiation may also be associated with melanoma of the eye and non-Hodgkin’s lymphoma.

Information on global broad-spectrum UVR levels has been compiled from data gathered for epidemiological studies of skin cancer and other health effects, such as premature aging of the skin, cataracts, and suppression of the immune response. Despite the large number of measurements, estimating human exposure is complex. The UVR wavelengths to which an individual is exposed vary considerably with latitude, altitude, time of day, and season. People also vary in their length of outdoor exposure, the parts of the body they expose, and the shapes of their bodies.

**Sun Lamps and Sunbeds:** Exposure to sunlamps or sunbeds is also known to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in humans. Sunlamps and sunbeds emit broad-spectrum UVR, primarily UVA and UVB radiation. Sunbeds now chiefly emit UVA; however, before the mid 1970’s, they more commonly emitted UVB and UVC. Three different UVA phosphors have been used in sunlamps sold in the United States since the late 1970s, producing emission spectra that peak at 340, 350, or 366 nm. Two modern sunlamps evaluated by the U.S. Food and Drug Administration emitted 99.0% and 95.7% UVA; the remaining radiation was UVB. A new high-pressure UVA sunbed with eighteen 1,600-watt filtered arc lamps emitted 99.9% UVA. An older type of sunlamp, used prior to the late 1970s (UVB/FS type), emitted 48.7% UVA. Epidemiological studies have shown that exposure to sunlamps or sunbeds increases the risk of malignant melanoma. The longer the exposure, the greater the risk, especially in individuals exposed before the age of 30 and individuals who have been sunburned. Malignant melanoma of the eye also is associated with exposure to sunlamps. A recent meta-analysis was conducted in an attempt to summarize current knowledge. Ten studies provided estimates of risk for being ‘ever exposed’ to sunbeds and sunlamps. Where possible, risk ratios selected for inclusion in the analysis were those with adjustment for host susceptibility and sun exposure. Compared to those with no exposure, those ever exposed had a statistically significant increase in risk of CMM. Compared with subjects having no sunlamp or sunbed exposure, those with the ‘longest duration or highest frequency of exposure’ had a relative risk of 1.69. The analysis suggests that the use of sunbeds and sunlamps does increase risk of CMM.

**Adverse Effects of Solar UV Due to Use of Sunscreens:** It has been suggested that the advent of effective UV-B sunscreens in the 1960s, and their adoption for common use shortly thereafter, may have inadvertently fuelled an increase in CMM incidence. These authors propose that light-skinned individuals might expose themselves to the sun for much longer periods than previously possible, because the onset of erythema is delayed by sunscreen use, making possible substantially more UV-A exposure.
Impact

SKIN CANCER PREVALENCE AND IMPACT IN US: The skin is the largest sensory organ of the body providing the anatomical barrier from pathogens and damage between the internal and external environment in bodily defense. The uncontrolled growth of abnormal skin cells however, leads to skin cancer which is the major cause of cancer related death worldwide and the most common of all cancer types. Approximately 65%–90% of melanomas are caused by UVR. Skin cancer rates have been on the rise over the past few decades in United States with more than 3.5 million skin cancers along with nearly 77,000 new cases of melanoma (the most serious form of skin cancer) diagnosed each year, resulting in 12,000 deaths. That’s more than all other cancers combined and suggest that one in five Americans will develop skin cancer in the course of a lifetime. Since 1973, new cases of the most serious form of skin cancer, melanoma, have increased approximately 150%. During the same period, deaths from melanoma have increased approximately 44%. The three most common types of skin cancer are basal cell carcinoma, squamous cell carcinoma, and melanoma. In contrast to malignant melanoma, nonmelanoma skin cancers are not usually fatal. All forms of skin cancer are extremely rare among children, as cancer development may take several decades. However, frequent sun exposure and sunburn during childhood significantly increase the risk of developing skin cancer later in life. According to a study led by Donatus Ekwueme, Ph.D., CDC, deaths caused by melanoma accounted for $3.5 billion in lost productivity each year. Deaths among men accounted for $2.4 billion of lost productivity (an average of $441,903 per man), and deaths among women accounted for $1.2 billion of lost productivity (an average of $401,046 per woman). The study also found that a person who died of melanoma between 2000-2006, died 20 years prematurely compared to 17 years from other cancers.

PREVALENCE AND IMPACT OF SKIN CANCER IN OHIO: In 2011, more than half of the nearly 70,000 cases of melanoma in the United States were concentrated in 10 states and Ohio remains one of them. From 2003 to 2007, 4 percent/100,000, or an annual average of 1,193 new cancer diagnoses, and 2.6 percent/100,000, or an annual average of 324 cancer deaths in Ohio, were melanoma skin cancer. In Ohio approximately 70% of individuals who developed melanoma of the skin were 50 and over. An average of 2,222 new cases of melanoma of the skin were diagnosed annually during this period in Ohio with a corresponding rate of 18.3 per 100,000. The rate among males in Ohio (21.9 per 100,000) was 34% higher than the rate among females (16.3 per 100,000) during this time period. Although the economic impact of skin cancer in Ohio itself has not been systemically studied, we can infer from above mentioned CDC nationwide study led by Dr. Ekwueme that skin cancer cases in Ohio is costing billions of dollars to state.

**Pediatric and AYA population at higher risk of skin cancer due to UVR exposure:** Children are more sensitive to UVR damage than adults, and sunburn during childhood increases the risk of skin cancer later in life, and suppresses the immune system. Intriguingly, in past 40 years the pediatric melanoma cases have increased by an average rate of 2% per annum. Cumulative exposure of sunshine is a risk factor for skin cancers. The link between childhood exposure to high levels of UV radiation in sunlight and elevated risk of skin cancer later in life is well established. More than one half of a person’s lifetime UV exposure occurs during childhood and adolescence because of more opportunities and time for exposure. Exposure to UV radiation during childhood plays a role in the future development of skin cancer. Persons with a history of >1 blistering sunburns during childhood or adolescence are two times as likely to develop melanoma as those who did not have such exposures. Americans receive at least a quarter of their lifetime sun exposure during childhood. Children spend nearly 3 hours per day outdoors including at school, but they are not routinely protected from overexposure to solar radiation. A national survey and individual studies suggest that many American children are sunburned annually. Data suggest that 90% of pediatric melanoma cases occur in patients aged 10-19 and incidence of melanoma are nine times more common between the ages of 10 and 20 than it is between birth and 10 years. This is the age when kids start to spend more time in outdoor environment exposing themselves to sunshine in an uncontrolled manner and teenagers are exposed to tanning beds. Studies indicate that protection from UV exposure during childhood and adolescence reduces the risk for skin cancer.

**Other Occupational UVR exposures impact:** Occupational exposure to artificial broad-spectrum UVR occurs in industrial photo processes, principally UV curing of polymer inks, coatings, and circuit board photoresists; sterilization and disinfection; quality assurance in the food industry; medical and dental practices; and welding. UV lasers, such as those used in cornea shaping and coronary angioplasty, are another potential source of occupational exposure, with relative risks that could be comparable to risks for individuals in outdoor professions. Electric arc welders are the largest occupational group with exposure to artificial broad-spectrum UVR. It is estimated that more than 500,000 welders in the United States have been occupationally exposed to broad-spectrum UVR. Occupational exposure to artificial broad-spectrum UVR depends on both the source of exposure and the protective methods used to decrease exposure. Some artificial broad-spectrum UVR sources (such as germicidal lamps in some uses) are self-contained and present no risk to workers. Other occupational uses, such as use of UVR in laboratories, UV photography, and UV lasers, inevitably lead to broad-spectrum UVR exposure, which may include intense short-term exposures.

**Current efforts to solve the problem**

Recent recommendations from the International Agency for Research on Cancer, a subsidiary of the World Health Organization, state, "Policymakers should consider enacting measures, such as prohibiting minors and discouraging young adults from using indoor tanning facilities, to protect the general population from possible additional risk for melanoma." Measures that have been used to reduce population risk due to overexposure to UVR include mainly education on the health risks associated with UVR exposure and personal protection. As per the guidelines of WHO, in several countries including US education have taken the form of national education campaigns that have directed at various population groups, such as the
workforce, and may be implemented at the level of specific settings, such as schools. School policy and environmental change are proven to important and valued components of sun-safety programs in few states because policies can protect all children, including those who choose not or are unable to protect themselves have legal force, and apply to all schools in a district. Although primary school-based educational strategies are proven interventions to raise children's awareness and knowledge about sun safety, in absence of Ohio state legislation for school sun safety and most of the schools in Ohio lacking a sun safety policy despite of CDC guidelines.

Personal protection are proposed to include reducing the duration of exposure to the sun, depending on the intensity of radiation and skin pigmentation. Suggested policies also includes measures such as clothing (hats, shirts, sunglasses, etc.) and sunscreens. Interventions to increase the protection of a population from UVR also includes tools aimed at raising awareness about the health risks associated with UVR exposure or providing information to assist individuals to understand when personal sun protection is required, such as the Global Solar UV Index. Such indices are broadcasted over television or radio or are part of the weather forecast in daily newspapers.

**W.H.O. SUGGESTIONS TO PROTECT FROM UVR:** Following are a few sun safety measures that are proposed to prevent skin cancers and other UVR-related health outcomes:
- Limit time in the midday sun.
- Use shade wisely: seek shade when UV rays are most intense.
- Know the UV index: when the UV index predicts radiation levels of 3 (moderate) or above, sun safety practices should be implemented.
- Wear protective clothing, including hats and sunglasses.
- Use a broad-spectrum sunscreen with a sun protection factor (SPF) of 15 or higher.
- Avoid sunlamps and tanning parlours; WHO recommends that persons under the age of 18 do not use them at all.
- Be particularly mindful of appropriate sun exposure in children, particularly avoiding overexposure. There are

**REGULATIONS:** In order to protect the most vulnerable population from potential UVR risk hazardous several laws and regulations have been passed by respective organizations in USA:  

*State legislative laws:* Policymakers in some states are regulating minors' use of tanning devices (like tanning beds). Currently California, Illinois, Nevada, Texas and Vermont ban the use of tanning beds for all minors under 18, and at least 33 states and the District of Columbia regulate the use of tanning facilities by minors. Some counties and cities also regulate the use of tanning devices, including Howard County, Maryland, which was the first local jurisdiction to ban indoor tanning for all minors under age 18, as well as Chicago and others. Although Ohio followed the California State Legislation to regulate tanning bed access, Ohio law is not as stringent as California in this case either. Unlike California, Ohio law does not ban tanning under 18, and valid for number of tanning sessions as specified by parent. In Ohio there is no policy exist to regulate sun exposure prevention, school health policy for UV exposure, skin cancer awareness, health education, and screening reimbursement. With all these facts it is not surprising that Ohio remains in the top 10 states in US affected by skin cancer.
Environmental Protection Agency (EPA): Under the Clean Air Act EPA has developed a suite of regulations to protect stratospheric ozone, guarding against increased UVR exposures resulting from its loss.

Food and Drug Administration (FDA): Performance standards for sunlamps and other devices that emit UVR have been developed. User instructions and warning labels must accompany sunlamps and other devices that emit UVR. Specifications for the use of UVR for processing and treating food have been developed. A warning must be included with products containing coal tar for the control of psoriasis that reads “Do not use this product with other forms of psoriasis therapy such as ultraviolet radiation or prescription drugs unless directed to do so by a doctor.”

Occupational Safety and Health Administration (OSHA): Regulations have been enacted to protect welders and other workers from UVR exposure during welding operations.

GUIDELINES/RECOMMENDATIONS: Apart from passing laws and implicating regulations several responsible organizations have also issued some guidelines to follow in schools and workplace to minimize the UVR exposure. These guidelines are also changed time to time based on newly available research data:

Center for Disease Control (CDC): In 2002, the US Centers for Disease Control and Prevention (CDC) issued guidelines to the nation’s schools for programs to prevent skin cancer. These guidelines were intended to reduce children’s exposure to UVR from sunlight however, only few schools embraced these guidelines and many apparently chose to ignore it or remained unaware of it and Ohio is one among them.

American Conference of Governmental Industrial Hygienists (ACGIH): Threshold limit values (TLVs) have been developed for 56 different wavelengths (ranging from 180 to 400 nm) in the UV spectrum. In addition to these TLVs, specific protections for the eye from exposure to UVR in the 315- to 400-nm spectral range have been developed.

National Institute for Occupational Safety and Health (NIOSH): NIOSH has established technical guidance for using ultraviolet germicidal irradiation (UVGI) systems to help protect health-care workers who may have an occupational risk of tuberculosis infection.

Occupational Safety and Health Administration (OSHA): It has been recommended that employers reduce worker exposure to UVR through work scheduling, providing shade, and providing information on UVR exposure risks.

American Cancer Society (ACS): ACS recommends avoiding sunlight between 10 am and 4 pm (daylight time) when the sun’s rays are strongest, avoiding indoor tanning devices and sun lamps, using and re-applying sunscreen when exposed to UV rays, covering skin with clothing, and wearing hats and sunglasses.

Future research/policy needs and suggestions

RESEARCH GAPs AND NEEDS: Our current research understanding indicates that the total or cumulative exposure of UVR appears to be weakly related to risk, although this result must be treated with some caution. In most of the research studies meta-analyses were conducted in highly developed Western countries where indoor work effectively limits the degree of cumulative exposure many people can accrue. Thus, a greater effect for cumulative exposure might have been missed in many studies due to limited range of exposure. Future
epidemiological studies need to keep this factor in account in order to develop more valuable data.

Furthermore, the data interpretation from sunbed exposure also need to be evaluated with caution. It is quite possible that individuals who use sunbeds to tan may spend more time in the sun or engage in more concomitant sunbathing. If this exposure is not adequately controlled for in the analyses, it is possible that the increased risk attributed to sunbed use might be a result of solar exposure. Finally, ‘recreational’ exposure to artificial UV for tanning purposes prior to the early 1980s entailed substantial UV-B exposure, whereas later (largely commercial) exposure was predominantly to UV-A. Thus, an analysis combining these exposures could conceivably be aggregating qualitatively different exposures. More research is necessary in this field to fully investigate the relationship between artificial UV and melanoma.

The epidemiologic picture for the relationship between sunscreen use and skin cancer development is much less clear. As counterintuitive as this may appear, several studies have demonstrated a correlation of skin cancer with sunscreen use. More research in skin photobiology will lead to better sunscreen products. It also appears that educational campaigns to make individuals aware of skin cancer-inducing practices and safe sun exposure practices and protection methods are having an impact on skin cancer incidence and detection. In the future, sunscreen product labels need to provide the consumer with more information, ranging from clear factual statements about the amount that needs to be applied to what sunscreens can and cannot do. As labeled now, most sunscreens products are confusing to the average user. Statements such as "apply liberally and frequently" are too vague to be informative. Others such as "do not use to extend time spent in the sun" are counterintuitive. Finally, the meaning of the acronym SPF should be changed from sun protection factor to sunburn protection factor to avoid giving the consumer an impression of solar invincibility and a false sense of security. SPF defined as sun protection factor connotes an impervious armor protecting against all assaults on skin biology.

Sun exposure and vitamin D status are intertwined. Adequate vitamin D is needed for bone health in children and adults. In addition, there is accumulating information suggesting a beneficial influence of vitamin D on various health conditions. Cutaneous vitamin D production requires sunlight, and many factors complicate the efficiency of vitamin D production that results from sunlight exposure. Ensuring vitamin D adequacy while promoting sun-protection strategies, therefore, requires renewed attention to evaluating the adequacy of dietary and supplemental vitamin D.

Public interventions and education: Various skin cancer task forces have proposed several important guidelines to decrease the rising skin cancer incidence. These briefly include the following: (1) the establishment of policies that reduce exposure to UVR; (2) providing and maintaining physical and social environments, which support sun safety and are consistent with the development of other healthful habits; (3) professional pre-service and in-service skin cancer education for school administrators, teachers, physical education teachers and coaches, nurses, and others working in healthcare; (4) health services and organizations to increase skin cancer prevention education, sun-safety environments and making these policies readily available to the public; (5) lastly, the promotion of free skin cancer screening programs are also highly encouraged.
Suggested efforts for UVR policy implementation in schools: Recently it has been suggested that even in states where sun safety policy exist, partnerships and program advocates are important for successfully implementing and sustaining sun-safety programs. Just having right policy doesn’t help till it is not implemented effectively. Moreover, innovative strategies for reaching school administrators are likely needed to effectively implement sun-safety programs and policies. 62

- All the stakeholders (such as schools, parents, students. Local health department, recreational authorities, and other nonprofit organization working for kid’s health and cancer in particular) have different organizational structures, resources, and sometimes languages. Without taking time to recognizing and understanding these differences it will become hard to engage them in the process.
- State board of education have limited authority to influence these stakeholders therefore, an open communication, development of goals, and setting timelines will be the key to establish successful partnership.
- In order to execute an effective policy development as well as its execution it is imperative to develop strong relationship with education and health agencies at the local level who are connected with the target population and understand better what might and might not work with at grass root level. These relationships will also help engage key school personnel who may serve as advocates or potential gatekeepers.
- An active involvement of all stakeholders during policy development is imperative to ensure its success. Approaching partners once a plan has been developed, may result in their disengagement.
- Since the primary goal of all stakeholders is not directly focused on UVR safety, therefore extra effort need to be made by state board of education to articulate the policy in a manner so that it aligns with each organization set of goals. There will also be a requirement to educate them patiently and improve their awareness about the issue to ensure their engagement in activities.
- Plan for sustainability of the policy implication is key for the long term success of this program. Sustainability need to be ensured from the beginning therefore local authorities and organizations need to plan the activities and partnerships in a manner so that it can help ensure financial and programmatic longevity.

Conclusion

In summary, UVR, in solar or artificial form, is responsible for a substantial burden of human skin and results in skin cancer. Substantial protective measures should be taken against all types of solar radiation (recreational, occupational, intermittent and continuous) to minimize the risk of developing any form of skin cancer. Pediatric and AYA population is more vulnerable to UVR induced skin cancer due to their age and behavioral exposure. Despite of legislative laws, policy and guidelines, implementation limited UVR protection of our population warrants public education and supportive social environment. There is also a greater need to perform more precise epidemiological studies to conclude the impact of UVR dose, time, latitude, ethnicity, genetics and its correlation to other health outcomes. Adequate UVA protection and an appropriate testing method of UVA efficacy are the most pressing unmet needs. Although some in vivo biologic method would appear desirable, at present there is scarce biologic data for such an assessment.
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