

# UV Radiation: What We Know and Do We Protect Ourselves Adequately?

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## ABSTRACT

*Chronic sun exposure causes degenerative changes in the skin that are recognized as photoaging, immunosuppression and photocarcinogenesis. Sun is necessary for life, so total sun avoidance is impossible. Sun exposure during the first 15 years of life and blistering sunburns before age 20 have been linked to an increased risk of melanoma. Individuals who have outdoor lifestyles, live in sunny climates, and are lightly pigmented will experience the greatest degree of photoaging. In our study, performed four years ago, we have shown the knowledge of more than 4000 people about the effects of UV rays on the skin. The results show us that sun exposure is still exaggerated and uncontrolled due to the lack of knowledge about this topic. Encouraging photoprotection and improving the awareness of the general public about the harmful effects of too much sun exposure must be the leading preventative health strategy.*

**Key words:** photoprotection, photoaging, sunscreens, preventive health strategy

## Introduction

The life is impossible without sun. The sun is vital source of energy for all life on Earth, and as we know, life without sun, could not be sustained. The components of sunlight are visible light and infrared radiation, which are not considered harmful to humans, and ultraviolet radiation. Less than 5% of the sunlight that reaches the earth's surface is ultraviolet radiation which is composed of UVA, UVB, and UVC wavelengths. UVC rays (200–290 nm) are high-energy, short wavelengths, and are almost completely absorbed by the stratospheric ozone layer. UVB rays (290–320 nm) are lower-energy wavelengths, and the amount of rays reaching earth levels varies according to season, time and cloud cover but they are only 2% of the UV radiation on the earth's surface. UVB are mostly absorbed by the epidermis while as much as 70% are blocked by the stratum corneum. Acute effects are sunburn and related inflammation. Chronic effects are photoaging, immunosuppression and photocarcinogenesis. UVB damages mainly the DNA level inducing photolesions which can lead to gene modification and cell transformation. UVB radiation is the major cause of sunburns, which is the leading risk factor for melanoma and non-melanoma skin cancers. Also, it can cause delayed

skin pigmentation. UVA can be divided into UVA I, or far UVA (340–400 nm), and UVA II, or near UVA (320–340 nm). They are longest, lowest-energy wavelengths and comprise 98% of the UV radiation on the earth. UVA radiation is always present, independent of cloud cover or glass. Large amount of the annual UVA dose (52%) is received outside during summer time. The photobiological effects of UVA radiation is cumulative and leads to both epidermal (stratum corneum thickening, lower immune potential) and dermal changes (inflammation, impairment of connective tissue, lysozyme deposit, elastosis, effect on collagen and glycoaminoglycans). Both participate in skin photoaging process and these cellular changes have also been demonstrated in in vitro by using reconstructed skin models<sup>1</sup>. The 80% of UVA rays reach the dermo-epidermal junction and penetrate deeper in the papillary dermis. Acute effects are erythema, photoallergic and phototoxic reactions. Chronic effects are photoaging, immunosuppression<sup>2</sup> and potential photocarcinogenesis<sup>3,4</sup>. Exposure to sun with living in an oxygen-rich atmosphere causes unwanted photodamage. The most severe consequence of photodamage is skin cancer. Approximately 130.000 malignant melanomas oc-

cur globally each year, and an estimated 66.000 death occur annually from melanoma and other skin cancers<sup>5</sup>. Less severe photodamage changes result in photoaging – wrinkling, scaling, dryness, and pigment abnormalities in the form of hyperpigmentation and hypopigmentation<sup>6</sup>. For a photochemical reaction to occur in the skin, ultraviolet radiation from the sun must be absorbed by chromophore, resulting in a series of photochemical reactions. These reactions can cause changes in DNA, including oxidation of nucleic acids and modification of proteins and lipids, changing its function in the end. Their accumulation may result in skin cancer or photoaging changes<sup>7</sup>. DNA may absorb UVB, by directly inducing changes between adjacent pyrimidine bases on one strand of DNA, although UVA can also result in accumulation of thymine dimers<sup>8,9</sup>. DNA changes are constantly being repaired by the process of nucleotide excision. Whenever repair is incomplete and damage to the genome is great, photodamage may result<sup>6</sup>. This premature aging process is cumulative with sun exposure, and preferentially affects individuals with lighter skin color. Sun exposure during the first 15 years of life and blistering sunburns before age 20 have been linked to an increased risk of melanoma<sup>10</sup>. Individuals with outdoor lifestyles, living in sunny climates, and with lightly pigmented skin will experience the greatest degree of photoaging<sup>11</sup>. Many agents affect the transmission of ultraviolet light to human skin. These include naturally occurring photoprotective agents (ozone, pollutants, clouds, and fog), naturally occurring biologic agents (epidermal chromophores), physical photoprotective agents (clothing, hats, make-ups, sunglasses, and window glass), and ultraviolet light filters (sunscreen ingredients and sunless tanning agents)<sup>12</sup>. Sunscreens are the »gold standard« for protecting skin from photodamage<sup>6,13</sup>. Daily photoprotection is highly recommended to people living in areas with blazing sun, patients prone to photoreactions, patients having received organ transplant or with reduced immune potential and with photosensitive genodermatoses. It is also recommended for fair skin individuals, outdoor workers, elderly patients and for all people during summertime. Sunscreens come in two general types: chemical and physical. The active ingredients in chemical sunscreens absorb UV radiation, while physical agents scatter radiation. Because chemical sunscreens are associated with higher incidences of contact and photocontact sensitization, physical sunscreens have become more widely used<sup>14</sup>. The widely accepted *in vivo* method to evaluate a sunscreen is based on the protection against erythema (mainly induced by UVB) which is expressed by sun protection factor (SPF). The SPF is defined as the ratio of the dose of UV radiation required to produce a minimal erythematous dose (MED) on protected skin and the dose of UV radiation that produce a minimal erythema on unprotected skin. There is not yet a standardized assay to assess the level of protection against UVA. Two methods are used: immediate pigment darkening (IPD) and persistent pigment darkening (PPD). PPD is the persistent part of the immediate pigmentation as observed two to four hours after the exposure and is actually the pre-

ferred method<sup>15</sup>. An ideal ratio of SPF/UVA protection factor <3 is actually recommended<sup>16</sup>. The protection provided by sunscreens depends greatly on how they are applied and the person's activities after application. Sunscreen application is not as frequent as it should be, and the amount applied does not meet the recommended quantity of 2 mg/cm<sup>2</sup> of skin, on average, most sunscreen users apply only one third of the recommended amount<sup>14,17</sup>. Most people identify sun exposure to sunbathing at the beach and forget that they can be sun exposed when walking or practicing outdoor sports. In addition, sun reflection can be important by snow (30 to 80%), sand (6 to 25%), sea (20%) or grass (0,5 to 4%). There has been an important change in sun protection over the last 20 years. People have started to use sunscreens to protect their skin not only from sunburn, but also from photodermatoses, such as polymorphous light eruption, and from the long-term adverse effects, such as skin aging and skin cancer<sup>18</sup>. Coastal region of Croatia is characterized by a Mediterranean climate with hot, dry summers and mild winters and, more than 2500 sunny hours per year. Inland has a continental climate with predominantly hot summers and cold winters and, approximately 2000 sunny hours per year<sup>19</sup>. Therefore, Croatia is a country where sun is intense all year round, and daily photoprotection must be recommended. During the four-year period dermatologists and pharmacists educated visitors in the Sun Prevention Center campaign about the harmful effects of the UV radiation and the benefits of proper sun protection.

## Methods

In the four-year period (2002–2005) data was obtained during Sun Prevention Center campaign. Visitors answered the questionnaires with twenty-eight questions regarding skin characteristics, phototype and behavior habits during sun exposure. We collected 4387 questionnaires. The questionnaires were subsequently statistically analyzed with simple percentage analysis, derivation of correlations between answers using the <sup>2</sup>-method.

## Results

The results of statistical analysis of the questionnaires collected during the four-year campaign show that women were more frequent visitors (74%) than men. Most of the visitors were between 18 and 39 years old. Visitors were mainly fair-skinned, dark-haired and one third of them (30%) declared that they sometimes get sunburned. 45% of the visitors spent more than three weeks per year in the sun, but 26% expose themselves to the sun during the whole year. Approximately 25% of them experienced the photoallergic reactions and 30% had hyperpigmentations after sun exposure. About 60% sunbathed during the hottest hours of the day (between 11 am and 4 pm). The majority of the visitors used sunscreens (84%), but 39% of them stopped sunscreen

use the last days of vacations to achieve a more intense tan. 56% of the visitors used sunscreen only during vacation and 14% used it during the whole summer. Very few visitors used sunscreens in other occasions than during summer, eg. in the spring and fall during outdoor activities (5%) and when skiing in the winter (12%). Most of the visitors used sunscreens with SPF's between 10 and 18, which they applied every two hours, and 82% of them recognized the meaning of Sun Protection Factors (SPF). Interestingly, the results also show that the knowledge about the harmful effects of UV rays increased from 87% in 2003 to 93% in 2004 and then decreased again in 88% in 2005. Only 27% of the visitors knew that UV rays cause a decrease in the immune system and only 5% of them knew that they indirectly cause the eruption of acne in the acne prone skin. The results of statistical analysis showed that 90% of visitors knew that UV rays can cause skin cancer and 84% of them that they cause sunburns. Besides using sunscreens, visitors mostly protected themselves with hats and sunglasses (33%) and by hiding in the shade (34%). 36% of the visitors had children and 30% of them protected their children with higher SPF's than themselves. Visitors older than 36 years are statistically more likely to follow sun protection rules. An average of 6% of all the visitors answered positively to the question about the occurrence of skin cancer in the family. Only 9% of the visitors used artificial tanning beds once a week during spring and summer. They are most popular among people aged between 18 to 35 years.

## Discussion

The results in the four-year study conducted in the Sun Prevention Centers show us that sun exposure is

still high and uncontrolled due to the lack of knowledge about this topic. However, a high percentage of people use sun protection products. On the other hand, judging from the results of the statistical analysis of the questionnaires, most of them practice curative instead of preventive sun protection. Younger visitors, who have not yet noticed the consequences of exaggerated sun exposure on their skin, use lower SPF's. They stopped using sunscreen the last days of vacations to achieve a more intense tan, they sunbath during hottest hours of the day, etc. Encouraging photoprotection and intensive education is the leading preventative health strategy used by physicians involved in skin care. It is estimated that 80% of the lifetime sun exposure occurs before the age of 18 and epidermological studies show that the occurrence of skin cancer in adulthood is in strong correlation with the frequency of sunburn occurrences in childhood. Research indicates that regular use of sunscreen with a SPF's 15 or higher during the first 18 years of life can lower the risk of certain skin cancer by 78%. The sunscreens, now available, have much higher sun protection factors than over last 10 years, but the SPF would still have only a relative value, because it would differ depending on the use of particular sunscreen.

In conclusion, education campaigns should be focused on children, adolescents, outdoor professionals and young women. The campaigns should aim to improve behavior in the sun and to decrease the number of UV induced skin damage. Sun protection can be achieved by combining avoidance of sun exposure, appropriate clothing, and regular use of broad spectrum sunscreens. Campaigns resulted in positive changes in the knowledge about sun exposure and sun protection. Education about sun protection is one of the major goals in public health care.

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## ULTRAVIOLETNO ZRAČENJE: ŠTO ZNAMO I ŠTITIMO LI SE DOVOLJNO?

### SAŽETAK

Kronično izlaganje suncu uzrokuje degenerativne promjene kože – fotostarenje kože, imunosupresiju i fotokarcinogenezu. Sunce je neophodno za život i potpuno izbjegavanje izlaganja sunčevim zrakama je nemoguće. Pretjerano izlaganje suncu prvih petnaest godina života i opekotine izazvane suncem nakon dvadesete godine života povećavaju rizik od nastanka malignog melanoma. Osobe koje pretežito rade i borave na otvorenom, ljudi koji žive u područjima sa izraženom insolacijom, te svijetle puti, izloženiji su nastanku aktiničkog oštećenja kože. U našoj studiji, koja je provedena zadnjih četiri godine, predstavili smo znanje o štetnom djelovanju sunčevih zraka više od 4000 ispitanika. Rezultati pokazuju da je izlaganje suncu još uvijek pretjerano i nekontrolirano zbog nedostatnog znanja o štetnom djelovanju sunca. Poticanje na zaštitu od sunca, edukacija i upozoravanje populacije na štetno djelovanje sunca, smjernice su daljnjih preventivnih javno-zdravstvenih nastojanja.