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IS UV GOOD OR BAD?

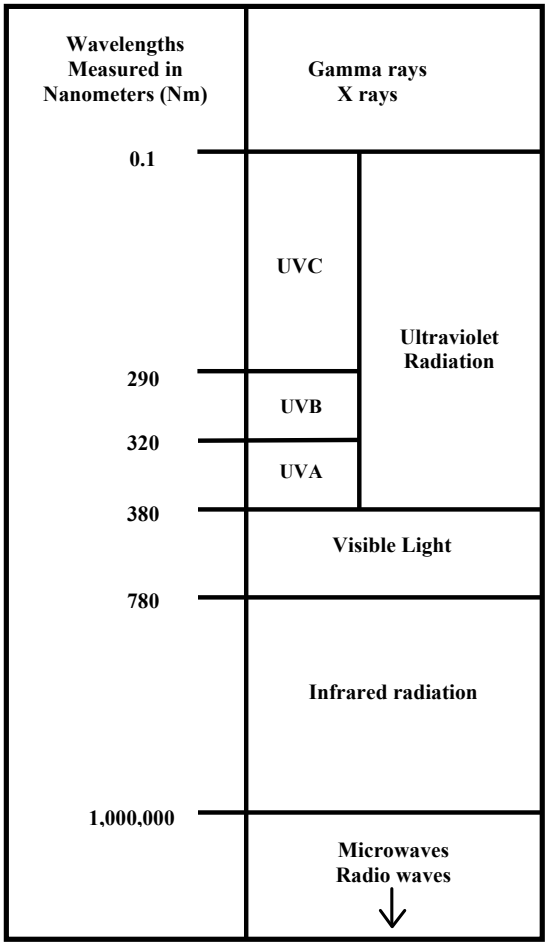
Health Benefits and Risks Involving Ultraviolet Light

CE@Home

Patients ask their doctors every day about protection from the sun. They ask their optometrists, ophthalmologists, dermatologists, general practitioners, and other health care professionals if and how much they should protect themselves from harmful rays. As optometrists, we are at the entry point for many patients into the health care system. The media inundates us with information almost daily about harmful rays of the sun and its effects on our skin and our eyes. But sunlight is absolutely necessary for life. It helps our physiology, mental balance, and is necessary to grow food. So what is all this fuss about sunlight and especially ultraviolet radiation (UVR)?

Ultraviolet radiation has been divided into UVA, UVB and UVC. UVA is also called near ultraviolet and is in the range of 320 to 380 nanometers (nm). UVB is called mid-range ultraviolet and extends from 290 to 320 nm. UVC is far range ultraviolet and extends from 0.1 nm to 290 nm. So, the range of all UV is from 0.1 nm to 380 nm. Energy (or radiation) from the sun contains all UVR visible light, and IR (infrared radiation) that reaches the earth. About 8% of the sun's radiation is UVR. All man-made lamps emit less than the full spectrum from the sun. Some of the newer "full spectrum" lamps are a close approximation of sunlight. Researchers have proven that UVR is the most biologically active part of the spectrum related to human physiology affecting health.

The Spectrum of Electromagnetic Energy



Ultraviolet and the Eye

Our eyes use visible light and UVR for visual and non-visual aspects of functioning. As optometrists, we study extensively the visual aspects, but not much on the non-visual portion, or our reaction to UVR. But let's start with the anterior portion of the eye beginning with the tears, progress through the various ocular tissues and the effects of UVR upon them, and finish with the retina and the non-visual aspects of our response to UVR mediated through the eyes.

Tears have negligible effect on UVR entering the eye, but when the tear film is compromised, the conjunctiva and cornea can be more acutely affected. Normally, the conjunctiva, when overexposed with UVR, can develop pingueculae and/or pterygia, the conjunctival tumors. The cornea is a filter to all wavelengths below 295 nm. Overexposure to UVR can result in actinic keratitis, band-shaped keratopathy, and recurrent erosions. It can also trigger Herpes Simplex Keratitis.

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The lens, aqueous humor, iris, trabecular meshwork, vitreous, and fundus are the intraocular tissues that are continuously exposed to UVR longer than 295 nm throughout life. Continuous exposure to UVR over 295 nm photochemically generates chromophores (pigments) in the crystalline lens, which are responsible for the yellow and brown coloration (brunescence) due to aging.

This alters the perception of color and some of the effects of UVR/blue light on the intrinsically photosensitive retinal ganglion cells (ipRGCs) and resultant systemic effects. The aqueous contains tryptophan, which absorbs UVR in the 295-315 nm range. But because of the aqueous composition and its rapid replacement, UV damage to the aqueous is thought to be insignificant. The iris and trabecular meshwork appear to be protected from UVR damage between 295-400 nm due to its absorption by the cornea and aqueous.

The vitreous is protected from deleterious effect of UVR between 295-400 nm by the filtering effects of the cornea and the lens. Below age 10, the lens transmits most UVR longer than 295 nm to the vitreous and retina, but after that lens changes occur to increase absorption in the 300-400 nm region and later in the visible region. Aphakic patients risk shrinkage of the vitreous gel and denaturation of the collegen network from UVR up to 420 nm. Intraocular lens design and inherent UVR filtration properties protect the vitreous after cataract surgery.

The retina is very sensitive to UV radiation between 295-400 nm, but is largely protected by the cornea, lens and vitreous. Cystoid macular edema was a problem with aphakic eyes due to loss of the UVR-absorbing crystalline lens. Current IOLs have the ability to filter UVR and protect delicate retinal cells. However, the non-visual receptors in the ganglion cells need stimulation for their systemic effects and should be remembered when selecting IOL lenses. Excessive UVR exposure can also be limited with wavelength-selective eyeglass lenses and contact lenses.

In the retina, ipRGCs respond to the blue end of the visible light spectrum that peaks at 460 nm and influence brain function through the retinal hypothalamic tract. They do not terminate in the visual cortex for sight recognition. The ipRGCs are located in the ganglion cell layer of the retina, whereas the rods and cones are in the outer plexiform layer. The ipRGCs innervate directly with the suprachiasmatic nucleus (SCN) in the hypothalamus and influence photostimulation for entrainment of our circadian rhythms. These ipRGCs have a very large dendritic arbor and have the largest receptive field of all ganglion cells in the retina. They contain melanopsin which is photosensitive to short wave blue light. When ipRGCs are photostimulated, a polysynaptic circuit from the SCN suppresses melatonin release from the pineal gland and regulates circadian entrainment. Stimulation (via ipRGCs) also induces pupillary dilation, increases heart rate, and alertness as measured by changes in frequency of EEG brain waves.

With UVR exposure, the hypothalamic pituitary axis provides stimulation that releases various other hormones. Corticotrophin Releasing Hormone (CRH), ProOpio Melano Cortin (POMC), AdrenoCorticotrophic Hormone (ACTH), Thyroid Stimulating Hormone (TSH), and Gonadotropic Releasing Hormone (GnRH) are produced by the pituitary. As production of these hormones is increased, the production of melatonin in the pineal gland is suppressed. So, the pituitary and the pineal gland are antagonistic organs in the brain, via energy entering the eye through photoendrocrinology, and other physical and emotional systems.

Visible light closest to UVR is violet in color. It is the highest energy of all visible light. The blue appearance of the sky is due to the scattering of the UVR in the atmosphere called the Rayleigh phenomenon. Blue light awareness is decreased due to the yellowing of the crystalline lens in the eye and is evident in the paintings of aging artists. The UVR and shorter wavelengths of the visible spectrum are filtered by the crystalline lens and shift our perception toward the reddish end of the spectrum. The subjective sensation of color is only slightly altered by wearing clear UVR absorbing spectacle lenses, especially when viewing pearlescent paint colors of automobiles. The visual centers of the occipital lobe seem to adapt and survive with the diminished violet-blue perception.

Health Benefits from Ultraviolet

1. UV radiation on the skin (dermal phototransduction) starts a multiphasic process of nutrient production. Cholesterol concentration in skin is converted to pre-vitamin D. Pre-vitamin D is changed to vitamin D by the normal heat of the body. Blood carries vitamin D to the liver for conversion to 25-HCC vitamin D then to the kidney that changes it to its more active form, 1, 25-DHCC vitamin D that is its most active form. Vitamin D is necessary for absorption of calcium in the intestines. The 1, 25-DHCC form enhances intestinal calcium binding proteins that are essential for calcium absorption, transportation, and collagen formation in the bones. Calcium is necessary for nerve function and helps prevent osteoporosis.

2. UV radiation lowers blood pressure. Normal blood pressures were lowered (in a study in the *Am. Journal of Physiology*) on an average of 6 mm Hg systolic and 8 mm Hg diastolic after exposure to light. The patients with high blood pressure had a drop 2.5 times greater than the normal BP patients that lasted up to five to six days. Before pharmaceutical agents were developed, (hypertensive) patients were treated with UV light very successfully by physicians.

3. UVR increases cardiac output from the heart. Research at Tulane School of Medicine indicates cardiac output was increased 39% in 18 of 20 subjects exposed to UVR.

4. UV radiation reduces cholesterol. Cholesterol concentration in the skin is higher than in most other organs. When the cholesterol in the skin is converted to pre-vitamin D, then the cholesterol lost is replaced by cholesterol in the blood stream. This cholesterol moves back and forth between the skin and bloodstream. Two hours after UV exposure, 97% of the subjects tested had almost a 13% decrease in blood cholesterol levels in a study of ultraviolet irradiation and cholesterol metabolism published in the journal *Circulation*.

5. UV radiation therapy is an accepted treatment for people with psoriasis and for neonatal jaundice in newborn babies.

6. UV radiation resulted in improved EKG readings in patients with cerebral atherosclerosis. A study with 169 patients with cerebral atherosclerosis received UVR treatments, and at one year follow-up evaluations better EKG readings were present than initially.

7. UV radiation increases hormone levels. The production of various hormones, including CRH, POMC, ACTH, TSH, and GRH, is influenced through the hypothalamic pituitary axis. Melatonin production of the pineal gland is decreased with UVR stimulation and increased in darkness.

8. Seasonal Affected Disorder (SAD), or winter depression, is affected by a lack of UVR entering the eyes. UVR affects the balance of melatonin from the pineal gland and serotonin, a hypothalamic neurotransmitter. The amount of UVR entering the eyes affects both hormones related to SAD.

9. The immune system is influenced by UVR. The white blood cell count is lowered by lack of UVR stimulation. The lymphocytes are increased with UVR, which helps produce interferon that help our immune function.

Consequently, the health benefits from UVR (and sunlight) are related to our daily exposure. So, minimum daily requirements (MDRs) would be from half an hour to two hours of exposure on 40% of our body each day. Very lightly pigmented people would require at least half an hour per day, and very heavy pigmented skin would require about two hours to absorb the UV necessary for optimum health. Inadequate illumination may result in decreased energy levels; craving for carbohydrates and caffeine; tiredness and need for more sleep; lower sex drive; decreased attention and concentration; and mood disturbances.

Health Risks of Ultraviolet

Many health risks are obvious with too little UVR exposure as indicated by the health benefits list. But too much exposure will have deleterious effects on humans. So, moderation with UV exposure is recommended just like for food, water, and other nutrients for health. For example, too much oxygen given a baby can cause retinopathy of prematurity and blindness. This is what happened to Stevie Wonder! So, what happens with over (or under) exposure to UV?

1. Skin cancer and sunburn are associated with overexposure to UVR. Too much time in the sun will damage the skin. UVA can contribute to cutaneous malignant melanoma through DNA damaging molecules such as hydroxyl and oxygen radicals. Sunburn is caused by too much UVB radiation, which also leads to DNA damage and various skin cancers such as basal and squamous cell carcinomas. UVA and UVB over exposure can damage collagen fibers and accelerate aging of the skin. Unfortunately, some of the earlier sunscreen lotions with PABA were found to be cancer-causing when exposed to UVR while being used during sunlight exposures. The new lotions are more protective.

2. Overexposing to tanning beds also causes skin changes—not related to tanning but due to DNA and collagen changes if the time of exposure is too much or protection is not used. Eye cups are very important to prevent actinic keratitis and cataracts due to over-exposure.

3. Snow blindness can occur from too much UVR exposure while skiing or in the snow for extended periods when the sun is out if the person is not using eye protection. Overexposure results in actinic keratitis, conjunctivitis, and cataracts.

4. Welders, people working with photo flood lamps in the TV and movie industry, and people working around carbon arc lamps risk UV induced eye changes from keratitis, conjunctivitis, cataracts, and retinal damage. Eye protection is a must for prevention.

5. "Mal-illumination" due to artificial lighting affects human physiology. Circadian rhythm disruption and SAD are the most obvious physical changes due to lack of UV light caused by imbalanced illumination. Full spectrum lighting is recommended in sufficient intensity to prevent these problems. Exposure to sunlight and its UV qualities will help restore health.

6. Viewing Eclipse and Sungazing. Direct sun viewing will cause UV-induced retinal damage and corneal and lens changes.

7. Certain medications cause systemic photosensitization. There are several commonly prescribed medications that when taken cause exaggerated sunburn through phototoxic and photoallergic reactions. Some of them are:
   a. Sulfonamides for chemotherapy and antibacterial Tx
   b. Sulfonylurea for diabetes
   c. Chlorothiazides for hypertension
   d. Phenothiazines as tranquilizer and antihistamines
   e. Broad-spectrum antibiotics used for infection
   f. Tetracyclines used for infections and rosacea
   g. Griseofulvin for antimycotic Tx

8. Some medications cause intraocular photosensitization. Phenothiazines, psoralens, and the tetracyclines are capable of causing enhanced photochemical damage to the choroid, retina and the lens.

9. Cosmetics and soaps may cause increased skin sensitivity and exaggerated sunburn. Halogenated antiseptic compounds used in soaps, cosmetics, and other consumer products applied to the skin may result in increased photosensitivity and photoallergic reaction to UVR.

The health risks can be minimized with awareness of the effects of over or under exposure to UVR. We can counsel our patients about the medications they are using and that these medications may create increased sensitivity and reaction to UVR. The ocular and cutaneous responses can be prevented or minimized with sensible actions.

Macular degeneration is accelerated with over exposure to UVR. As optometrists, we should counsel our patients about the different absorption lenses available to decrease the rate of macular degeneration respective to their medications, eye, and systemic health.

Using the logical method based upon research in vision, health and medicine, the conclusion is that we need UVR to help promote optimal health. The balance of physiology and our psychological health is enhanced with UVR. We all need differing amounts of UVR due to our general health, age, skin color, medications, life style, culture, and the geographic zone we live in. High in the mountains or below sea level (where I live, minus 150 ft), or northern Alaska with months of darkness, or near the equator with 12 hour days and nights will determine what is available to us naturally. Artificial light exposes us to limited wavelengths of light that alters our health.

No one should go outside and overdo it in sunlight. Don't overcook your food or yourself! Sunlight and the UV effects on the body should be received with short exposures, increasing slowly relative to skin pigmentation and medications. Mid-day sun exposure in Southern California should be limited to only 10 minutes of exposure on 40% of skin and eyes without protection. The UV index is published in many newspapers daily and gives the amount of time to stay in the sun at various times of the day. So, UVR in moderation is necessary for optimum mind-body health. Figure out your personal level of exposure necessary, and make it your goals. Your patients and family will appreciate you more with your knowledge and advice about UVR.

The ophthalmic industry has provided us with absorption curves for all lenses manufactured. We prescribe them everyday. Make yourself knowledgeable about the various lenses so you can make the best recommendations for your patients' optimum health and preventative care.

For questions and references, contact Dr. Barniske at visioncarecenterbrawley@yahoo.com.

CE Questions

1. Ultraviolet radiation is divided into UVA, UVB, and UVC. Near wave UVA is at what wave length on the electromagnetic spectrum?
   a. 1 nm to 290 nm
   b. 290 nm to 320 nm
   c. 320 nm to 380 nm

2. What percent of sunlight is ultraviolet radiation?
   a. 80%
   b. 8%
   c. 40%

3. Researchers have proven that UV is the most biologically active part of sunlight reaching the earth for humans.
   a. True
   b. False

4. The cornea filters out what portion of the electromagnetic spectrum?
   a. 380 nm to 700 nm
   b. 295 nm and below
   c. 295 nm to 380 nm

5. The transparency of the ocular crystalline lens loses some of its clarity due to what wave length of UVR?
   a. All UVR
   b. Less than 295 nm
   c. Greater than 295 nm

6. What retinal change was most prevalent after cataract surgery resulting from overexposure to UV?
   a. Dry macular edema
   b. Cystoid macular edema
   c. Optic nerve atrophy

7. Intrinsically photosensitive retinal ganglion cells (ip RGCs) function through which nerve pathway?
   a. Retinal hypothalamic tract
   b. Rod-cone-optic tract-visual cortex tract
   c. Image forming photoreception

8. Health benefits from UVR exposure on the skin include:
   a. Vitamin D production
   b. Reduces cholesterol
   c. Jaundiced babies and psoriasis treatment
   d. All the above
   e. None of the above

9. Health benefits from UVR exposure through the eyes include:
   a. Winter depression therapy
   b. Hormone level changes
   c. Circadian rhythm balance
   d. All the above
   e. None of the above

10. Health risks from excessive UVR exposure include:
    a. Skin cancer and sunburn
    b. Keratitis, cataracts, retina damage
    c. Premature aging of the skin
    d. A and B above
    e. All of the above

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