Ultraviolet (UV) Radiation and Cancer Risk

What is UV radiation?

Radiation is the emission (sending out) of energy from any source. There are many types of radiation.

Ultraviolet (UV) radiation is a form of electromagnetic radiation. The main source of UV radiation (rays) is the sun, although it can also come from man-made sources such as tanning beds and welding torches.

Radiation exists across a spectrum from very high-energy (high-frequency) radiation – like x-rays and gamma rays – to very low-energy (low-frequency) radiation – like radio waves. UV rays have more energy than visible light, but not as much as x-rays.

Higher energy UV rays often have enough energy to remove an electron from (ionize) an atom or molecule, making them a form of *ionizing radiation*. Ionizing radiation can damage DNA in the cells in our body, which in turn may lead to cancer. But because UV rays don't have enough energy to penetrate deeply into the body, their main effect is on the skin.

Scientists often divide UV radiation into 3 wavelength ranges:

- UVA rays are the weakest of the UV rays. They can cause skin cells to age and can cause some indirect damage to cells' DNA. UVA rays are mainly linked to long-term skin damage such as wrinkles, but are also thought to play a role in some skin cancers.
- UVB rays have slightly more energy than UVA rays. They can damage the DNA in skin cells directly, and are the main rays that cause sunburns. They are also thought to cause most skin cancers.
- UVC rays have more energy than the other types of UV rays. Fortunately, because of this, they react with ozone high in our atmosphere and do not reach the ground. Therefore UVC rays are not normally a risk factor for skin cancer. But they can also come from some man-made sources, such as arc welding torches, mercury lamps, and

UV sanitizing bulbs that kill bacteria and other germs (such as in water, air, food, or on surfaces).

How are people exposed to UV radiation?

Sunlight

Sunlight is the main source of UV radiation, even though UV rays make up only a small portion of the sun's rays. About 95% of the UV rays from the sun that reach the earth are UVA rays, with the remaining 5% being UVB rays. The strength of the UV rays reaching the ground depends on a number of factors, such as:

- **Time of day:** UV rays are strongest between 10 am and 4 pm.
- **Season of the year:** UV rays are stronger during spring and summer months. This is less of a factor near the equator.
- **Distance from the equator (latitude):** UV exposure goes down as you get farther from the equator.
- **Altitude:** More UV rays reach the ground at higher elevations.
- **Clouds:** The effect of clouds can vary. Sometimes cloud cover blocks some UV from the sun and lowers UV exposure, while some types of clouds can reflect UV and can increase UV exposure. What's important to know is that UV rays can get through, even on a cloudy day.
- **Reflection off surfaces:** UV rays can bounce off surfaces like water, sand, snow, pavement, or grass, leading to an increase in UV exposure.
- **Contents of the air:** Ozone in the upper atmosphere, for example, filters out some UV radiation.

The amount of UV exposure a person gets depends on the strength of the rays, the length of time the skin is exposed, and whether the skin is protected with clothing or sunscreen.

Man-made sources of UV rays

Man-made sources of UV rays can also be important. These include:

- **Sunlamps and sunbeds (tanning beds and booths):** The amount and type of UV radiation someone is exposed to from a tanning bed (or booth) depends on the specific lamps used in the bed, how long a person stays in the bed, and how many times the person uses it. Most modern UV tanning beds emit mostly UVA rays, with the rest being UVB.
- **Phototherapy (UV therapy):** Some skin problems (such as psoriasis) are helped by treatment with UV light. For a treatment known as PUVA, a drug called a psoralen is

given first. The drug collects in the skin and makes it more sensitive to UV. Then the patient is treated with UVA radiation. Another treatment option is the use of UVB alone (without a drug).

- **Black-light lamps:** These lamps use bulbs that give off UV rays (mostly UVA). The bulb also gives off some visible light, but it has a filter that blocks most of that out while letting the UV rays through. These bulbs have a purple glow and are used to view fluorescent material. Bug-zapping insect traps also use "black light" that gives off some UV rays, but the bulbs use a different filter that causes them to glow blue.
- **Mercury-vapor lamps:** Mercury-vapor lamps can be used to light large public areas such as streets or gyms. They do not expose people to UV rays if they are working properly. They are actually made up of 2 bulbs: an inner bulb that emits light and UV rays, and an outer bulb that filters out the UV. UV exposure can only occur if the outer bulb is broken. Some mercury-vapor lamps are designed to turn themselves off when the outer bulb breaks. The ones that don't have this feature are only supposed to be installed behind a protective layer or in areas where people wouldn't be exposed if part of the bulb breaks.
- **High-pressure xenon and xenon-mercury arc lamps, plasma torches, and welding arcs:** Xenon and xenon-mercury arc lamps are used as sources of light and UV rays for many things, such as UV "curing" (of inks, coatings, etc.), video projection, fiber optics, disinfection, to simulate sunlight (to test solar panels, for example), and even in some car headlights. Most of these, along with plasma torches and welding arcs, are mainly of concern in terms of workplace UV exposure.

Does UV radiation cause cancer?

Yes. In fact, most skin cancers are a direct result of exposure to the UV rays in sunlight. Both basal cell and squamous cell cancers (the most common types of skin cancer) tend to be found on sun-exposed parts of the body, and their occurrence is typically related to lifetime sun exposure. The risk of melanoma, a more serious but less common type of skin cancer, is also related to sun exposure, although perhaps not as strongly. Skin cancer has also been linked to exposure to some artificial sources of UV rays.

Studies in people

Sun exposure

Basal and squamous cell skin cancer: Many observational studies have found that basal and squamous cell skin cancers are linked to certain behaviors that put people in the sun, as well as a number of markers of sun exposure, such as:

- Spending time in the sun for recreation (including going to the beach)
- Spending a lot of time in the sun in a swimsuit

- Living in an area with a high amount of sun
- Having had serious sunburns in the past (with more sunburns linked to a higher risk)
- Having signs of sun damage to the skin, such as liver spots, actinic keratoses (rough skin patches that can be precancerous), and solar elastosis (thickened, dry, wrinkled skin caused by sun exposure) on the neck

Melanoma: Observational studies have also found links between certain behaviors and markers of sun exposure and melanoma of the skin, including:

- Activities that lead to "intermittent sun exposure," like sunbathing, water sports, and taking vacations in sunny places
- Previous sunburns
- Signs of sun damage to the skin, such as liver spots, actinic keratoses, and solar elastosis

Other cancers: Because UV radiation does not penetrate deeply into the body, it would not be expected to cause cancer in internal organs, and most research has not found such links. However, some studies have shown possible links to some other cancers, including:

- Merkel cell carcinoma (a less common type of skin cancer)
- Cancer of the lip
- Some types of eye cancer, such as melanoma of the eye and squamous cell carcinoma of the conjunctiva

Artificial sources of UV rays

Indoor tanning: Studies have found that people who use tanning beds (or booths) have a higher risk of skin cancer, including melanoma and squamous and basal cell skin cancers. The risk of melanoma is higher if the person started indoor tanning before age 30 or 35, and the risk of basal and squamous cell skin cancer is higher if indoor tanning started before age 20 or 25.

Welding and metal work: Some studies have suggested that welders and sheet metal workers might have a higher risk of melanoma of the eye.

Phototherapy: People exposed to UVA as a treatment for skin conditions such as psoriasis (as a part of PUVA therapy) have an increased risk of squamous cell skin cancers.

Treatment of skin conditions with UVB alone (not combined with PUVA) has not been linked to an increased risk of cancer.

Studies in the lab

Studies of cells

Studies of cells in lab dishes and test tubes have shown that sunlight and simulated sunlight (for example, from xenon or xenon-mercury arc lamps) can cause DNA damage (mutations).

Studies in animals

Exposure of mice, rats, and some other lab animals to sunlight and artificial sources of UV rays has been shown to lead to skin cancers. Most of these cancers have been squamous cell carcinomas. Some exposed animals have also developed cancers of the eye (affecting the cornea and conjunctiva).

No type of UV radiation has been shown to be safe – cancers have developed after exposure to UVA (alone), UVB (alone), and UVC (alone).

What expert agencies say

Several national and international agencies study different substances in the environment to determine if they can cause cancer. (A substance that causes cancer or helps cancer grow is called a *carcinogen*.) The American Cancer Society looks to these organizations to evaluate the risks based on evidence from laboratory, animal, and human research studies.

Based on animal and human evidence like the examples above, several expert agencies have evaluated the cancer-causing nature of UV radiation.

The **International Agency for Research on Cancer (IARC)** is part of the World Health Organization (WHO). Its major goal is to identify causes of cancer. Based on the data available, IARC classifies UV radiation as “carcinogenic to humans.”

The **National Toxicology Program (NTP)** is formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). The NTP has classified UV radiation as “known to be a human carcinogen.”

(For more information on the classification systems used by these agencies, see *Known and Probable Human Carcinogens*.)

What about tanning beds?

Some people think that getting UV rays from tanning beds is a safe way to get a tan, but this isn’t true.

IARC classifies the use of UV-emitting tanning devices as “carcinogenic to humans.” This includes sunlamps and sunbeds (tanning beds).

The **NTP** has stated that exposure to sunlamps or sunbeds is “known to be a human carcinogen.”

The **US Food and Drug Administration (FDA),** which now refers to all UV lamps used for tanning as “sunlamps,” requires them to carry a label that states, “Attention: This sunlamp product should not be used on persons under the age of 18 years.” The FDA also requires that user instructions and sales materials directed at consumers (including catalogs, specification sheets, descriptive brochures, and webpages) carry the following statements:

- Contraindication: This product is contraindicated for use on persons under the age of 18 years.
- Contraindication: This product must not be used if skin lesions or open wounds are present.
- Warning: This product should not be used on individuals who have had skin cancer or have a family history of skin cancer.
- Warning: Persons repeatedly exposed to UV radiation should be regularly evaluated for skin cancer.

Are there any other health issues related to UV radiation?

In addition to cancer, exposure to UV rays can cause other health problems. UV rays, either from the sun or from artificial sources like tanning beds, can cause sunburn. In some people, exposure to UV rays can cause a rash or a type of allergic reaction. Exposure to UV rays can also cause premature aging of the skin and signs of sun damage such as liver spots, actinic keratosis, and solar elastosis.

UV rays can also cause eye problems. They can cause the cornea (on the front of the eye) to become inflamed or burned. They can also lead to the formation of cataracts (clouding of the lens of the eye) and pterygium (tissue growth on the surface of the eye), both of which can impair vision.

Exposure to UV rays can also weaken the immune system, so that the body has a harder time fending off infections. This can lead to problems such as reactivation of herpes triggered by exposure to the sun or other sources of UV rays. It can also cause vaccines to be less effective.

Some medications can make you more sensitive to UV radiation, making you more likely to get sunburned. Certain medical conditions can be made worse by UV radiation.

About UV rays and vitamin D

Doctors are learning that vitamin D has many health benefits. It might even help lower the risk for some cancers. Your skin makes vitamin D naturally when it is exposed to UV rays from the sun. How much vitamin D you make depends on many things, including how old you are, how dark your skin is, and how strong the sunlight is where you live.

At this time, doctors aren't sure what the optimal level of vitamin D is. A lot of research is being done in this area. Whenever possible, it's better to get vitamin D from your diet or vitamin supplements rather than from exposure to UV rays because dietary sources and vitamin supplements do not increase skin cancer risk, and are typically more reliable ways to get the amount you need.

Can I avoid exposure to UV radiation?

UV rays in sunlight

It's not possible (or healthy) to avoid sunlight completely, but there are ways to help ensure you're not getting too much sun. If you are going to be outside, simply staying in the shade, especially during midday hours, is one of the best ways to limit your UV exposure from sunlight. Protect your skin with clothing and wear a hat to protect your head, face, and neck. Wear sunglasses that block UV to protect your eyes and the skin around them. Use sunscreen to help protect skin that isn't covered with clothing.

For more information, see *Skin Cancer Prevention and Early Detection*.

Artificial sources of UV rays

Many people believe the UV rays of tanning beds are harmless. This is not true. The best thing to do is not use tanning beds (or booths).

People who may be exposed to artificial sources of UV at their job should follow appropriate safety precautions, including using protective clothing and UV shields and filters.

Additional resources

The following information may also be helpful to you. These materials may be ordered through our toll-free number, 1-800-227-2345.

Known and Probable Human Carcinogens

Skin Cancer Prevention and Early Detection

Melanoma Skin Cancer

Basal and Squamous Cell Skin Cancer

National organizations and websites*

Along with the American Cancer Society, other sources of information include:

American Academy of Dermatology
Toll-free number: 1-888-462-3376 (1-888-462-DERM)
Website: www.aad.org

Environmental Protection Agency
Website: www.epa.gov/sunwise

National Cancer Institute
Toll-free number: 1-800-422-6237 (1-800-4-CANCER); TYY: 1-800-332-8615
Website: www.cancer.gov

Skin Cancer Foundation
Toll-free number: 1-800-754-6490 (1-800-SKIN-490)
Website: www.skincancer.org

**Inclusion on this list does not imply endorsement by the American Cancer Society.*

No matter who you are, we can help. Contact us anytime, day or night, for information and support. Call us at **1-800-227-2345** or visit www.cancer.org.

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