

Ultraviolet Radiation

What is ultraviolet radiation?

Ultraviolet radiation (UV radiation) is electromagnetic wave radiation just like visible light and infrared radiation. The electromagnetic wave spectrum also includes electromagnetic fields as well as X-ray and gamma ray radiation. Visible light accounts for only a small portion of the electromagnetic radiation spectrum, which lies between 380nm and 780nm in wavelength (1nm = 1 nanometre, or 1 millionth of a millimetre). The Infrared range spans the wavelengths between 780nm and 1mm. The invisible UV rays are within the electromagnetic spectrum between wavelengths of 100nm and 380nm. This spectrum is further subdivided into three ranges: UVA (315nm to 380nm), UVB (280nm to 315nm), and UVC (100nm to 280nm). UV radiation with wavelengths of between 100nm and 200nm are largely absorbed by the air (so-called vacuum UV) and are thus of little meaning for everyday life. The UVB and UVC rays, on the other hand, are particularly hazardous. But also UVA radiation can be harmful to humans in excessive amounts.

Where can UV radiation be found?

The most important source of UV radiation is the sun. Aside from this natural source, there are various artificial sources of UV radiation, such as welding arcs, special gas discharge lamps, halogen incandescent lights, and others.

Sunshine, or solar radiation, is the form of UV radiation that most commonly affects people. Some leisure-time activities, such as visiting a solarium, can also expose people to UV radiation. At work, exposure to UV rays can result from arc welding, work in printing (exposing printing plates to UV rays, UV lamps, for colour drying), testing materials (inspection for cracks or flaws using UV rays), and de-germing (sterilizing the air in buildings or using UV radiation while packaging foods).

What effects does UV radiation have on people?

Exposure to UV rays can have both positive and negative effects. The ultimate effects depend primarily on the level of exposure to UV rays an individual receives.

Positive effects

The formation of vitamin D3 is the most significant of the positive effects, which is used above all to prevent rickets. Light and UV rays are also considered to have positive effects for therapeutic purposes, such as in treating skin disease. Many people expose their skin to UV rays for the subjective purpose of getting a suntan (to improve self-esteem or to be fashion-conscious).



Negative effects

The negative effects arise above all from too much exposure to UV radiation. These can impact both the skin and the eyes.

Among the damage caused to the **skin**:

- Sunburn (erythema)*: Inflammation of the skin that disappears after several days. This results in pigmentation (the tan) and a thickening of the top-most epidermal (stratum corneum) skin layers which in turn increases the body's resistance against a renewed burn.
- Aging of the skin*: Frequently repeated or long-term exposure to UV radiation can make the skin dry, leathery, rough and slack, and cause wrinkling.
- Skin cancer*: Excessive and long-term UV ray exposure can lead to skin cancer. Three types of skin cancer have been identified that affect different skin layers, each having a different manifestation as an illness.
- Phototoxic reactions, photo allergy*: The combination of UV radiation and certain chemicals (eg: particular medications and cosmetics) can cause toxic reactions and trigger allergic reaction.

Among the damage caused to the **eyes**:

- Inflammation of the cornea (keratitis), (photo) conjunctivitis*: UV rays destroy the outermost cells of the cornea and/or the conjunctiva. This phenomenon is known to mountain climbers as "snow blindness" and to welders as "flashing". The damage is felt for six to eight hours after the exposure as a pain in the eyes. The condition heals completely after one or two days.
- Clouding of the lens (cataracts)*: Among other causes, long-term exposure of the eyes to UV radiation can lead to an irreversible clouding of the lens tissue. This is particularly true for people who are often outdoors (farmers, seamen). The condition primarily affects the elderly. These may develop age-related cataracts after decades of exposure to sunlight. Age-related cataracts are widespread. Although modern medicine often makes it possible to use artificial lenses to help avoid blindness, the disease still results in considerable disability.

What causes sunburn?

Whether or not there is sunburn depends on the one hand on the amount of UV exposure and on the other on the skin's sensitivity to UV radiation. Skin sensitivity to UV radiation is largely dependent on the skin's ability to tan, and its resulting amount of pigmentation. Europeans are generally categorised as having one of four different skin types.



- Skin type I:* Markedly light skin; a large number of freckles; reddish hair; blue or, very rarely, brown eyes; skin always burns easily in the sun.
- Skin type II:* Slightly darker skin than for skin type I; few freckles; blond to brown hair colour; blue, green, or grey eyes; almost always gets a sunburn.
- Skin type III:* Light to light brown skin; no freckles; dark blonde to brown hair; grey or brown eyes; occasionally gets mild sunburns.
- Skin type IV:* Light brown to olive skin colour; no freckles; dark brown hair; dark eyes; very rarely gets a sunburn.

Aside from the skin type, it is the skin's adaptation to sunlight that determines the chances of getting sunburn. The skin of babies and children is particularly sensitive to UV rays and must thus be protected against too much exposure to the sun.

What is the UV Index ?

To estimate the risk of sunburn from the sun's radiation, the German *Bundesamt für Strahlenschutz* [the federal office for protection against radiation] regularly publishes an UV Index (www.bfs.de/uvi/index.htm). The basis for devising the UV Index are the measured levels of the sun's UV radiation intensity, as determined by a UV measurement network at several locations in Germany. The results of these measurements determine the so-called "sunburn-causing radiation intensity". This is then used to define the UV Index, which is a guideline for the sunburn risks from outdoor exposure.

The UV Index describes a range of 0 to 12 which depends on a person's position relative to the sun, the time of day, and the weather conditions. A sunny summer day in Germany is described by the UV Index value of around 8. The higher the UV Index value, the faster a sunburn can arise from unprotected exposure to the sun outdoors. Key values for the relative degree of UV exposure and the time it takes to cause a sunburn are given in the table.

Table: UV Index and sunburn risk for skin type II

UV Index	UV exposure	Likelihood of sunburn	Preventative measures against sunburn
0-1	low	unlikely	unnecessary
2-4	medium	after 30 minutes	recommended
5-7	high	after 20 minutes	necessary
8 and above	very high	in fewer than 20 minutes	absolutely necessary



What can lead to skin cancer?

Skin cancer is induced by frequent overexposure to UV radiation. The outbreak of the disease, however, occurs many years after the exposure. Skin cancer is grouped into the following types:

- Basal cell carcinoma
- Squamous cell carcinoma
- Malignant melanoma

Basal cell carcinomas and squamous cell carcinomas have the best chance of recovery with appropriate medical attention. The rather rare malignant melanoma is often terminal (approximately 2,500 cases every year in Germany).

The rate of skin cancer among the general public in Germany has been constantly increasing for some 60 years, and is now at an alarmingly high level (a total of 100,000 cases annually in Germany). This can be traced to the change in leisure time behaviour above all (sun bathing, distant holiday destinations, visits to solariums). The amount of exposure to UV radiation over the years is the most important determinant behind skin cancer. The UV dosage a person receives in the first few years of life play a particularly substantial role here. The risk that sunburn from childhood may later develop into skin cancer is high, and it rises with each additional sunburn. Children must thus be protected against intense sunshine particularly.

What protective measures can be taken?

Use the following precautions against UV radiation:

- Avoid exposure to intense sunlight. On days when the sun is particularly bright, keep in the shade or indoors. This is particularly true of the noon hours.
- Let your skin get used to the sunlight gradually. Limit the amount of time you spend exposed to the sun without skin protection. The UV Index provides some guidelines. Avoid sunburn by all means.
- Cover your skin with the appropriate clothing or headwear. Use sun blocker with the highest possible sun protection factor (SPF, 15 or higher).
- Particularly protect children from too much exposure to the sun.
- Follow the instructions and warnings when visiting a solarium. Observe the maximum exposure time limits. Avoid going to the solarium too often.
- Use suitable sunglasses. They should not be too dark, but they should provide UV protection (consult an optician), also against sun shining in from the periphery. The sunglasses should be in accordance with the European standard DIN EN 1836.



What limit values are there?

There are no limit values for UV radiation exposure in private. Yet there are values for sunburn-causing exposure that are very likely to cause sunburn once exceeded. For skin type II, this value is 250 J/m² (damaging UV exposure per m² of skin).

At work, there are limit values for UV radiation exposure recommended by the International Commission for Non-Ionising Radiation Protection (ICNIRP) (www.icnirp.org). These limit values depend on the wavelengths of the radiation and are devised in such a manner that if they are observed, the employees are not expected to be harmed by UV radiation.

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