



## Health Effects of Artificial Light

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**Summary & Details:**  
GreenFacts

### Level 2 - Details on Health Effects of Artificial Light

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The answers to these questions are a faithful summary of the scientific opinion produced in 2012 by the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR):  
*"Health effects of artificial light"*

The full publication is available at: <https://copublications.greenfacts.org/en/artificial-light/>  
and at: <http://ec.europa.eu/health/opinions/en/artificial-light/>

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- Each question is answered in Level 1 with a short summary.
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- Level 3 consists of the Source document, the internationally recognised scientific opinion which is faithfully summarised in Level 2 and further in Level 1.

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## 1. Why is artificial light a concern?

In general, artificial lights are very unlikely to cause any harm. However, some light sources emit blue light and ultraviolet radiation and these can aggravate the symptoms experienced by people with diseases such as chronic actinic dermatitis and solar urticaria. Some single-envelope compact fluorescent lamps (CFLs), , emit UV-radiation in amounts that can exceed the recommended limits set to protect from skin and retinal damage if they are used in close quarters and for extended periods of time. Lamps with a second glass envelope emit much less UV.



Single envelope CFL

Some associations of light sensitive individuals claim that energy-saving lamps (mainly CFLs) aggravate the symptoms of a wide range of diseases and dispute the efficiency of second lamp envelopes. There are also reports that screw-base halogen lamps and LEDs aggravate symptoms. Recent measurements show that a large proportion of the UV radiation from tungsten halogen lamps is in the UVC range, which is particularly harmful.

There are concerns that artificial light with a strong blue component could affect human circadian cycles and the hormonal system, and be involved as a result in a wide range of conditions ranging from sleep disorders, immune system disorders, and macular degeneration, to cardiovascular diseases, diabetes, osteoporosis and breast cancer.

## 2. How do artificial lights work?

Fire has long been the only source of artificial light and today still, a large portion of the world's population uses fire as their primary light source. Humans discovered fire early on in their history and used burning or heated materials as light sources. Today, approximately 1.6 billion people still use flame-operated lamps.



Metal halide lamps can pose a risk if used close to the skin, but they are not intended for that.

The first electrical light sources were also based on heating a substance until it glowed and this is how incandescent lightbulbs (carbon or tungsten) work. Halogen lamps are a modern type of incandescent source where the tungsten filament is contained inside a tube filled with a mixture of gases. One of the gases is a halogen and allows the tungsten to get very hot without melting. This makes the lamp more efficient and long-lasting and the light is brighter and closer to the colour of daylight, which is better for vision.

When electrical current flows through a gas, it can emit visible light and this process is used to make electrical discharge lamps. The basic design is a tube filled with gas and with an electrode at either end so that an electric arc can be sent between them. The actual light emitted depends on the pressure and the nature of the gas. Low pressure discharge lamps are very efficient but some models are bad at showing the natural colours of objects, as is the case for the yellow sodium lamps sometimes used for street lighting.

Fluorescent lamps are a specific type of low-pressure lamps where the visible light is produced by the phosphorous coating inside the tube that glows in response to the intense UV-light produced by the mercury vapors inside. Fluorescent lamps are cheap, long-lasting, efficient and very good for illumination. Compact fluorescent lamps (CFLs) consist of two, four or six small fluorescent tubes mounted on a base. They are very efficient and work in a similar way to conventional fluorescent lamps. High-pressure gas discharge lamps produce intense light. They are used in very specific applications and rarely in conventional indoor lighting. Flash lamps are designed to produce bursts of extremely intense light and are used

mostly in photography, scientific, medical and industrial applications. Dielectric-barrier discharge lamps are also used in industry.

Solid state lighting is a new technology that could become dominant in future:

- Light-emitting diodes produce light by a process called electroluminescence. Although LEDs are coloured, it is possible to combine several LEDs to produce white light. Today, low-power LEDs are used for signs, indicators and Christmas lights. High-power LEDs are used for lighting.
- Organic light emitting diodes produce flat panel displays with brightness and sharpness that is impossible to achieve in any other way, but this technology is still in the early stages.
- Field emission devices are based on the same principle as the luminescent material used in TV screens. These lamps are 4 to 5 times more efficient than existing lamps, do not contain hazardous materials, have long life spans and can be made to produce light similar to daylight. This technology is still at the experimental stage but expected uses are indoor lighting and projectors.

It is difficult to pinpoint the “typical” spectrum emitted by a type of lamp because individual designs vary. It is for this reason that each individual model of lamp needs to be classified according to the specific risks posed to health. This classification is made according to a number of health effects, as four risk groups (RG):

- RG0 (exempt from risk) and
- RG1 (minor risk) lamps are not hazardous during normal circumstances.
- RG2 (medium risk) lamps do not pose hazards because we naturally move away from lights which are too bright or too hot.
- RG3 (high risk) include only lamps where a short-term exposure poses a hazard.

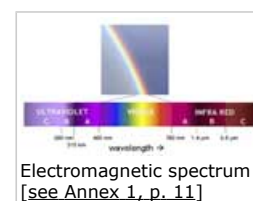
This classification is based on short-term exposures responses and applies only to individuals of normal sensitivity.

The majority of lamps used for normal lighting conditions are RG0 and most of the rare exceptions are RG1. Provided that these lamps are used at the distances for which they were intended, the UV, IR or blue light radiation they emit should pose little or no risk to non-photosensitive people. Halogen lamps are intended to be used with an external glass filter and they should also be non-hazardous, provided the filter is actually used.

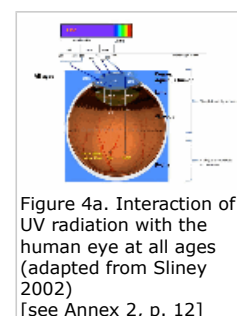
### 3. How does light affect living organisms?

#### 3.1 What is light and how is it absorbed and measured?

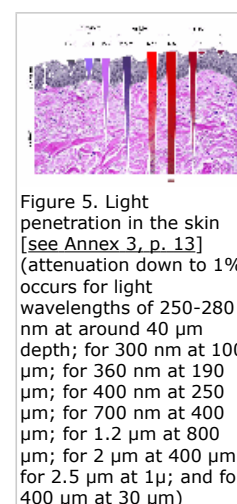
Light is electromagnetic radiation which is visible by the human eye and has a wavelength between 400 and 780 nm. (1 nm =  $10^{-9}$  m). Visible light constitutes a very small part of the whole electromagnetic spectrum and for instance, ultraviolet radiation covers the range from 100 nm up to 400 nm, and infrared (IR) radiation from 780 nm up to 1 mm. The UV and IR ranges are also subdivided into narrower bands (UVA/UVB/UVC and IRA/IRB/IRC). The Sun emits radiation over the whole electromagnetic spectrum but the Earth's atmosphere blocks UVC and some UVB.



The upper layers of the skin absorb most of the UV, IR and visible light they receive. Visible and IRA radiation penetrate deepest, down to the dermis. In the eye, UVC, IRB and IRC are absorbed by the cornea so they go no further. UVA and UVB go as far as the lens. Visible and IRA reach the retina, and more so in children than in adults.



The temperature of the skin or the eye increase when they absorb radiation, particularly IR. UV can also cause chemical reactions in the body, some of which are beneficial, and some which are harmful. Radiation of a specific wavelength is absorbed by parts of molecules in the body called chromophores and this produces a photochemical reaction. UV is the most photochemically active type of radiation and is absorbed by many molecules in the skin and in the eye.



Exposure to light is measured as the energy of the radiation that is received per unit area. Exposure calculations have to consider the detailed wavelength spectrum of the incident radiation, the medium it goes through, the chemical reaction involved and how well the chromophore absorbs light of each wavelength.

Skin exposures also depend on the distance from the light source. European standards use two different types of measurements depending on the potential use of the light source:

- Lamps designed to illuminate a large area such as workplaces or shopping areas, are usually placed in the ceiling relatively far away from users so these lights are evaluated at a distance that produces a certain level of illumination (500 lx)
- People who use task lights and downlights are more likely to look directly into the light source so these lights are tested at a distance of 20 cm.

## 3.2 How can light affect biological systems?

Excessive amounts of light or heat can be harmful, and the body has methods of protection against it. For instance, very bright sources make people close the eyes and turn their face away so they are not focused on the bright light for any substantial length of time. The iris responds to bright light by constriction so it can regulate the amount of light that enters the eye. Pain and reflexes also make people move away from sources of excessive heat so they protect the skin. However, these natural aversion methods are not always sufficient to avoid damage.

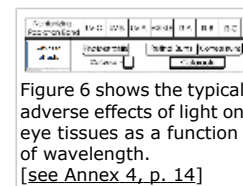


Figure 6 shows the typical adverse effects of light on eye tissues as a function of wavelength. [see Annex 4, p. 14]

The heat absorbed from light sources can be enough to damage cells permanently. Superficial damage can be repaired by new cells deep into the skin, and this process is used in some cosmetic treatments. However, deeper burns need hospital treatment and sometimes skin grafts. The eye is rarely harmed by excessive heat from domestic lamps but light from pulsed lamps and lasers can very quickly cause burns.

UV light can damage tissues indirectly by producing very reactive compounds (mainly free radicals and reactive oxygen) that go on to damage cells. The retina is very susceptible to this type of damage and is particularly vulnerable to radiation of short wavelength. The skin has agents that remove these very reactive species or repair damaged cells, and these are effective for low exposures but higher exposures can lead to cell death. The eye contains pigments that combine with reactive oxygen species and protect the retina. There are more of those pigments in the eyes of children than in older people so, with age, the retina can be more sensitive to damage, which leads to age-related macular degeneration. On the other hand, the lens becomes yellower with age and absorbs some blue light so the retinas of older people have some natural protection.

UV exposures that are not high enough to cause immediate burns can lead to an accumulation of damage and to loss of collagen and skin aging, as well as to skin cancer. Prolonged exposure of the eye to UV can make the edge of the lens cloudy and also lead to melanomas and tumors. UV and IR lights can induce cataracts.

## 4. What effects on health have been observed?

### 4.1 Thermal and chemical effects.

The body has a pain reflex that makes people move away when they feel a burning sensation so for a light source to cause burns, it must be very intense. Lasers or high-power flash lamps fall in this category but these are not normally used for illumination. If parts of the skin are regularly heated, this can lead over a long period of time to "erythema ab igne", which is associated with skin cancer. However, this is very unlikely from light sources used for illumination.



Exposure to light at night can disrupt the circadian rhythm

The skin can adapt to gradually increasing levels of UV exposure and in some people this causes tanning. However, it is harder for the skin to respond to sudden changes in UV as when people living in northern latitudes take a winter holiday in a very sunny resort. Some photosensitive individuals also find that their symptoms become worse in spring or summer if they have not had the chance to acclimatize their skin to sunlight during the winter months.

Overexposure to UVA and UVB causes sunburn. At first the skin reddens and if the dose is high enough there is an inflammatory reaction causing an increase in temperature and swelling, and after a few days the skin peels. Overexposure to UV or long term exposure to doses of UV which are just below those needed to cause sunburn, can aggravate bacterial and viral infections and lead to skin cancer. People who have been sunburnt severely many times, especially in childhood, are more likely to develop melanoma, the most fatal of skin cancers, as well as squamous cell carcinomas. Over the last few decades there has been an increase in the incidence of skin cancers, probably because of an increase in exposure to sunlight during holidays and leisure time.

Most of the lamps used for lighting are considered safe but some emit UV radiation. Under extreme circumstances and over a long period of time, exposure to these lamps could increase the chance of developing skin cancer in later life. The added personal risk is very small but there could be a significant (in the hundreds of cases) number of cancer cases over the whole population. This added risk could be virtually eliminated if the light was covered with plastic or glass that absorbs UV.

## **4.2 Effects on the eyes**

UV and IR radiation cause lesions in the cornea and the lens of the eye but these can often be repaired. Long term exposure to UV from sunlight can also cause cataracts of the lens. However, these types of damage are very unlikely from either short-term or long-term exposure to lamps used for lighting.

Damage to the retina is usually untreatable and permanent. Normal artificial lights are not intense enough to cause burns but they can initiate chemical reactions that proceed to harmful levels. The retina is particularly vulnerable to short wavelength radiation such as blue light and the susceptibility increases with age.

Natural pigments and vitamins in the eye protect the retina by mopping up free radicals and reactive species but, over time, people can develop age-related macular degeneration (AMD), particularly if they smoke. There is no evidence that sunlight exposure early in life may contribute to retinal damage that would lead to AMD in later life, but exposure to blue light could, particularly for older people.

## **4.3 Effects on the sleep, mood and the circadian rhythm.**

Life on Earth has evolved around a 24-hour day with roughly 12 hours of daylight followed by 12 hours of dark; and many biological processes follow this circadian rhythm. In mammals, this 24-hour "clock" is controlled by the hypothalamus but is also affected by external factors, mainly light.

Specific photoreceptors in the retina receive information on light and send the signal directly to the hypothalamus and to other parts of the body that influence sleep, mood and memory.

The production of melatonin, a powerful hormone, is also ruled by the circadian rhythm so that it is synthesized almost exclusively at night. This hormone sends signals to the rest of the body to tell whether it is day or night and promotes sleep. Melatonin also has other important roles as an antioxidant and a protective agent against "wear and tear" in tissues.

Exposure to light in late evening, at night or early morning disrupts the circadian rhythm and the production of melatonin, and hence has an effect on sleep, mood and cognition. Severe disruption of circadian rhythms is linked to breast cancer and could also play an



important role in the development of breast, prostate, endometrial, ovary, colorectal and skin cancers; cardiovascular diseases, reproduction, endometriosis, gastrointestinal and digestive problems, diabetes, obesity, depression and sleep deprivation.

Light itself has an effect on alertness, sleep, mood and the circadian rhythms regardless of the type of lamp used. Blue light or light enriched in blue has a more pronounced effect than other colours or white light but lamps available to the general population are not blue or blue-enriched.

## 5. What are the effects on people who have conditions that make them sensitive to light?

### 5.1 Skin diseases

There are two groups of patients who react abnormally to light: those whose diseases are induced by UV/IR or visible light (the photodermatoses) and those who have a pre-existing skin condition which is made worse by light.



LEDs do not emit UV

1. Some photodermatoses have an internal cause and can be inherited or immunity based. Inherited photodermatoses are a rare group which includes, for example, xeroderma pigmentosum (XP). Exposure to UVA/UVB is associated with an increased cancer risk in XP so patients are advised to avoid all sources of UV, including CFLs and unfiltered halogen bulbs.

Another group of photodermatoses have no known cause but are increasingly thought to be based on immune responses. The part of the spectrum that plays the main role is UV light, so the main concern is with light sources that emit UV, such as CFLs. The severity of these diseases varies widely between patients and the amount of UV required to produce symptoms is also variable:

- Polymorphic light eruption (PLE): Usually affects females and flares up in spring or early summer and results in an itchy, red, spotty rash on skin exposed to sunlight. For most patients, artificial light sources do not induce this disease.
- Chronic actinic dermatitis (CAD): This affects males over 50 years of age and results in sensitivity to various allergens, to UVA, UVB and also visible light for some patients. UV from artificial light could induce the disease in people with moderate or severe CAD.
- Actinic prurigo (AP): This uncommon disease happens all year round but is particularly bad in spring and summer. Skin exposed to sunlight develops itchy, red and inflamed bumps. Severe cases may be at risk from CFLs or other UV-emitting sources.
- Solar urticaria: This skin disorder affects both males and females and if it develops into a generalized urticaria, it can result in anaphylactic shock, so it can be fatal. Severely affected patients may be at risk from CFLs and unfiltered halogen sources producing UV/visible radiation.
- Hydroa vaccineforme: This is a rare disease that affects both sexes and produces blisters and scarring on skin exposed to sunlight. Low energy artificial light sources that emit UVA, can affect some patients.
- Lupus erythematosus (LE): This affects all age groups in both sexes and arises in people who produce antibodies against the breakdown products of their own cells so patients are susceptible to agents that cause cell death. Some drugs and factors such as UV (mainly UVB) exposure can induce this disease. At least some patients are at risk from long-term exposure to UV from CFLs and unfiltered halogen lamps.

- Porphyrias are a rare group of diseases that are inherited but are also induced by environmental factors and all relate to the accumulation of the photosensitive pigment porphyrin within the skin. Artificial light sources, including incandescent bulbs, can cause skin reactions and even burns in the most sensitive patients.

Some photodermatoses don't have an internal cause but instead, are induced by medicines or other chemicals. Many drugs can make people sensitive to light. In the majority of cases, the drug together with light starts photochemical reactions that make toxic levels of products. A smaller number of drugs sensitize the immune system instead. The effects depend on the drug but common symptoms are changes in skin pigmentation, blistering or redness.

Some medical treatments exploit the photosensitizing ability of chemicals and this is used for instance in anti-cancer drugs. People undergoing anti-cancer photodynamic therapy are intentionally given photosensitizers and they can have skin flares if exposed to light so they could have reactions from CFLs and LEDs. However, these patients are very aware that they need to take precautions.

2. Photoaggravated dermatoses are a large and diverse group of diseases that are made worse by light but also arise without exposure to visible or UV light. Sunlight affects only a small proportion of people with these diseases and the skin of most patients seems to react normally to UV and visible radiation. The role of artificial light in these diseases is unknown but is unlikely to be significant.

Table 4 "Light related" skin diseases [[see Annex 5, p. 14](#)]

## 5.2 Eye conditions

About 1.5 million people worldwide have some type of inherited disorder where the retina degenerates over time and, in terms of diseases, fall within a range from Retinitis pigmentosa (RP) to macular dystrophies. Patients with RP first lose night vision followed by lateral vision and, in the late-stage of this disease, vision is restricted to a narrow central cone. In macular diseases, central vision is lost but side vision remains good. There are also intermediate diseases where there is some loss of both central and side vision. The age at which symptoms start, the speed at which the disease progresses and the final outcome are all variable.

The effect of light on these patients depends on the specific mutation that has caused the disease. For instance, two forms of macular dystrophy (Ogushi disease and Stargardt disease) are aggravated by light and Stargardt disease is particularly affected by blue light, but this is not the case for other diseases. Since patients don't know which mutation they carry, they are advised to avoid unnecessary exposure to light.

## 5.3 Other conditions linked to light flicker

The intensity of some light sources goes up and down regularly and, if this oscillation is sufficiently slow, it is perceived by the human eye as flicker. Flicker depends mostly on the light source but is also affected by other factors such as the field of view and whether or not the person is moving.

Obvious flicker has been implicated in conditions such as epilepsy. However, lights that flicker too quickly to be noticed, can still cause headaches and eye strain.



Early fluorescent lamps flickered very noticeably but modern lamps are much better. However, flicker varies considerably from one lamp to another depending on the design so one cannot draw general conclusions.

Light from LEDs is usually flicker-free, but some poor quality LEDs do flicker, particularly if they are used together with a dimmer.

There is no scientific evidence that non-skin conditions such as Irlen-Meares syndrome, myalgic encephalomyelitis, fibromyalgia, dyspraxia, autism or HIV are worsened by exposure to light from CFLs. However, experiments using other light sources and epidemiological studies are needed before one can draw final conclusions.

## 6. How and where are people exposed to artificial light?

There is very little information on personal exposures to different indoor lights but it is possible to make estimates by choosing exposure situations where there is some potential risk, either because the eye or the skin are exposed to UV from the general ambient light, or because of direct exposure of the eye to the blue component of light.



Exposure to UV from artificial light is equivalent to one week vacation in a sunny destination

Office workers and school children are exposed to some UV and blue light from fluorescent lamps and task-lamps, for up to 8 hours a day. Those working in factories or large stores are exposed throughout the working day to more intense light sources but these are placed relatively far away in high ceilings. Customers visiting these shops are similarly exposed, but for much shorter periods of time. Performers and presenters on TV studios are under very bright lights so are exposed to UV, blue light and glare. Night drivers are also exposed to glare from headlights but only for a very short time so the main risk is that glare could cause them to have an accident rather than any eye or skin conditions. Finally, night reading for one or two hours using CFLs, LEDs or incandescent lights would expose people to some blue light.

People exposed to indoor lights receive some UV radiation which accumulates over a person's lifetime and contributes to the risk of developing skin cancer. Exposure to fluorescent light in the home is generally negligible compared to that at school and the workplace. Therefore, worst-case scenarios consider lifetime exposure in school of 6 hours a day for 40 school weeks a year from 5 to 20 years of age, and 8 hours a week at work from 20 to 65 years of age and for 48 weeks a year.

Exposure and consequent risk depend very strongly on the lamp used. As a comparison, the added annual risk from a lamp at the very top limit of what is classed as safe is equivalent to 1 week of holiday in the Mediterranean and about 100 times smaller than living in Australia. At the other extreme, lamps emitting low levels of UV pose almost no added risk.

In practice, exposure to fluorescent lamps is much lower than the worst-case scenarios considered here and more data on personal exposures is needed to improve these estimates.

Table 6. Examples of exposure situations from artificial light for the general population  
[see Annex 6, p. 15]

Table 7. Percent increase in SCC incidence and risk at 80 years of age due to certain added UV doses [see Annex 7, p. 16]

Table 8. Estimates of SCC risk [see Annex 8, p. 17]

## 7. Are there potential health risks linked to artificial lights?

All healthy individuals may be at some risk from UV radiation and blue light from indoor lighting, albeit to different degrees due to differences in genetic background and in the type of light source used. Short-term UV effects are negligible and long-term risks can only be estimated. Using worst case scenarios, regular exposure in school and at work to safe lamps with the highest levels of UV emission would add a dose of UV similar to a 3 to 5 days holiday in a sunny location. Most lamps would contribute considerably less.

As a very rough estimate, 250000 people in the EU have disorders that can be brought on or aggravated by light, and are particularly affected by light sources that emit UV or blue light. For this group of people, double-envelope CFLs is preferable to single-cover ones, and retrofit LEDs may be even better. Irradiation from lamps is highly variable so individuals with photosensitive diseases may need a list of lamp models that are suitable for their specific case.

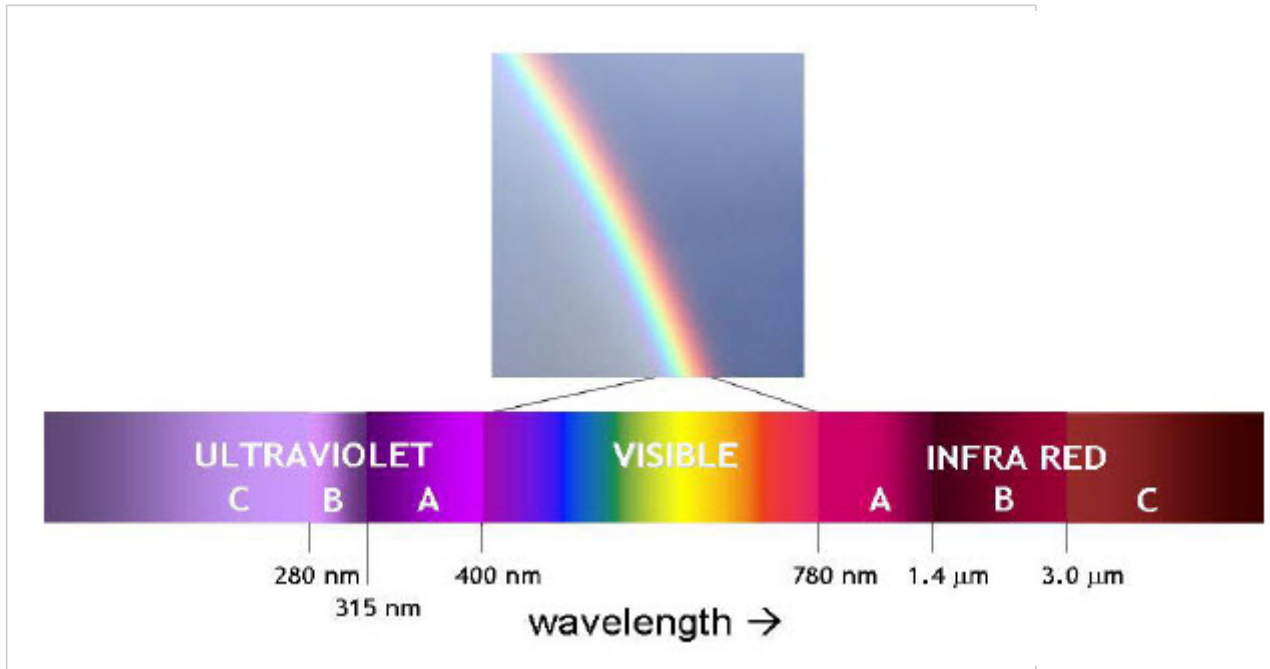
Several knowledge gaps have been identified:

- Manufacturer's data on the detailed light spectrum from every lamp model.
- Risk categories for lamps that include long-term risk of developing squamous cell carcinoma
- Exposure data to UV and blue light from indoor lamps
- Effect of long-term exposure to artificial light on the retina, including epidemiological studies.
- Effect of UVC on skin diseases
- Role of artificial light in the disruption of circadian cycles.
- Health effects of flicker

## Annex

### Annex 1:

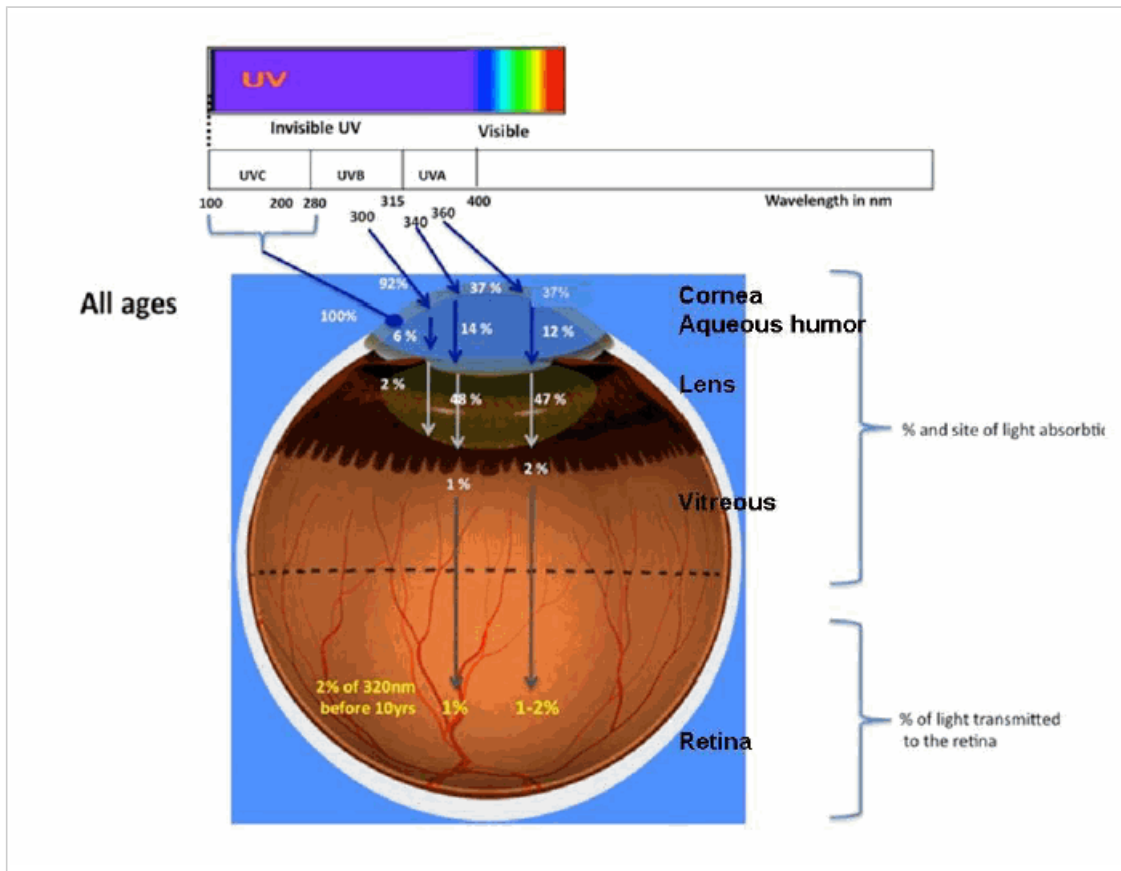
### Figure 2. Wavelength regions in optical radiation



Source: SCENIHR, Health effects of artificial light, 19 March 2012, 3.4.1 Optical radiation and 3.4.2 Radiant energy absorption, pp. 22-31. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenihr\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf)]

**Annex 2:**

**Figure 4a. Interaction of UV radiation with the human eye at all ages (adapted from Sliney 2002).**

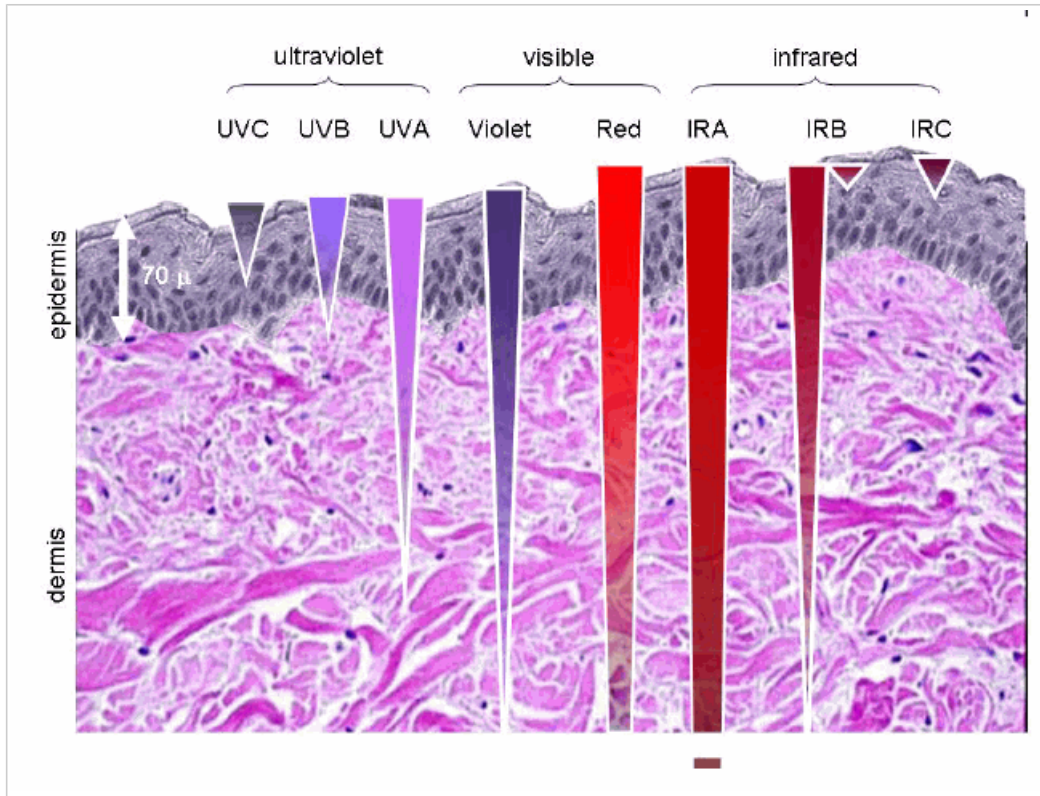


Source: SCENIHR, Health effects of artificial light, 19 March 2012, 3.4.1 Optical radiation and 3.4.2 Radiant energy absorption, pp. 22-31. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenhr\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenhr_o_035.pdf)]

## Annex 3:

### Figure 5. Light penetration in the skin

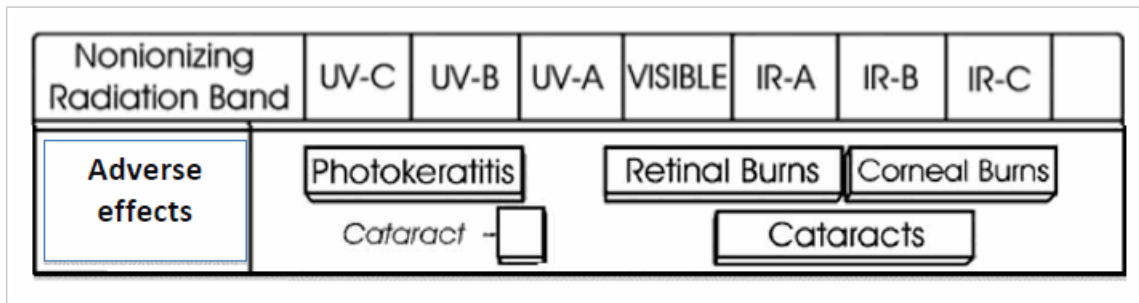
(attenuation down to 1% occurs for light wavelengths of 250-280 nm at around 40  $\mu\text{m}$  depth; for 300 nm at 100  $\mu\text{m}$ ; for 360 nm at 190  $\mu\text{m}$ ; for 400 nm at 250  $\mu\text{m}$ ; for 700 nm at 400  $\mu\text{m}$ ; for 1.2  $\mu\text{m}$  at 800  $\mu\text{m}$ ; for 2  $\mu\text{m}$  at 400  $\mu\text{m}$ ; for 2.5  $\mu\text{m}$  at 1  $\mu\text{m}$ ; and for 400  $\mu\text{m}$  at 30  $\mu\text{m}$ )



Source: SCENIHR, *Health effects of artificial light*, 19 March 2012,  
3.4.1 Optical radiation and 3.4.2 Radiant energy absorption, pp. 22-31. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenihr\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf)]

**Annex 4:**

**Figure 6. shows the typical adverse effects of light on eye tissues as a function of wavelength.**



Source: SCENIHR, Health effects of artificial light, 19 March 2012,

3.4.3 Biological effects, pp. 31-38. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenih\\_r\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_035.pdf)]

**Annex 5:**

**Table 4. "Light related" skin diseases**

| Light Induced Diseases (The photodermatoses)   |  |
|--|--|
| <b>Endogenous</b>  | <ul style="list-style-type: none"> <li>- <b>idiopathic</b> (or immune based)                             <ul style="list-style-type: none"> <li>Polymorphic light eruption</li> <li>Chronic actinic dermatitis</li> <li>Actinic prurigo</li> <li>Solar urticaria</li> <li>Hydroa vaccineforme</li> <li>Lupus erythematosus - (n.b. may also be photoaggravated)</li> <li>Porphyrias</li> </ul> </li> <li>- <b>genophotodermatoses</b> <ul style="list-style-type: none"> <li>Xeroderma pigmentosum</li> <li>Bloom's syndrome</li> <li>Cockayne's syndrome</li> <li>Rothmund Thomson syndrome</li> <li>Smith-Lemli-Opitz syndrome</li> </ul> </li> <li>- <b>porphyrias</b></li> </ul> |
| <b>Exogenous</b>   | <ul style="list-style-type: none"> <li>- Drug induced photosensitivity</li> <li>- Phytophotodermatitis</li> <li>- Chemical induced</li> </ul>  |
| <b>Photoaggravated Dermatoses</b>  |  |
| <b>"Classical" photoaggravated dermatoses</b> <ul style="list-style-type: none"> <li>- Lupus erythematosus</li> <li>- Atopic dermatitis</li> <li>- Psoriasis</li> <li>- Jessner's lymphocytic infiltrate</li> <li>- Dermatomyositis</li> <li>- Lymphocytoma cutis</li> <li>- Actinic lichen planus</li> <li>- Erythema multiforme</li> <li>- Acne vulgaris</li> <li>- Pemphigus and chronic benign familial pemphigus</li> <li>- Darier's disease, acantholytic dermatoses</li> <li>- Disseminated superficial actinic porokeratosis</li> <li>- Pellagra</li> <li>- Viral exanthema, including herpes simplex</li> </ul> | <b>Other photoaggravated dermatoses</b> <ul style="list-style-type: none"> <li>- Allergic contact dermatitis</li> <li>- Seborrhoeic dermatitis</li> <li>- Rosacea</li> <li>- Melasma</li> <li>- Mycosis fungoides</li> <li>- Vitiligo</li> <li>- Bullous pemphigoid</li> <li>- Linear IgA disease</li> <li>- Dermatitis herpetiformis</li> <li>- Chronic ordinary urticaria</li> <li>- Facial telangiectasia</li> <li>- Pityriasis rubra</li> <li>- Reticulate erythematous mucinosis</li> <li>- Keratotic pilaris</li> <li>- Actinic granuloma</li> </ul>   |

Source: SCENIHR, Health effects of artificial light, 19 March 2012,

3.6.1 The photosensitive skin diseases, pp. 61-68. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenih\\_r\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_035.pdf)]



**Annex 6:****Table 6. Examples of exposure situations from artificial light for the general population**

| Time/duration of exposure                          | Location                        | Type of lighting  | Distance to light source  | Number of light sources (single versus distributed light sources)   | Illuminance level   | Physical parameters potentially triggering health effects   |
|--|---------------------------------|---|---|---|---|---|
| 8 h  | Office                          | Linear fluorescent and CFLs (LEDs for task lights)  | Ceiling fixtures: minimum 1.50 m<br>Task light: minimum 20 cm   | Distributed large surface light sources (Except for task lights)  | 500 lx (general lighting)<br>[up to 1,000 lx for architects and designers working posts]  | UVR: Unlikely (1)<br>Blue light: Possible (2)<br>Thermal: None  |
| 8 h (for workers)<br>1-2h for customers on average | Supermarkets/<br>general stores | Linear fluorescent and CFLs for general lighting<br>LEDs and low power metal halide lamps (spots) for accentuation lighting | Ceiling fixtures: minimum 2 m<br>Accentuation lighting: variable distance   | Distributed, large surface light sources for general lighting<br>Spots and projectors for accentuation lighting | 750 lx (general lighting)<br>Accentuation lighting can use high brightness spots (>20,000 cd/m <sup>2</sup> )                                       | UVR: Unlikely (1)<br>Blue light: Possible (2)<br>Thermal: None  |
| ½-3 h for performers, presenters etc.              | TV studios                      | Linear fluorescent and CFLs for general lighting<br>LEDs and halide lamps projectors  | Ceiling fixtures: minimum 2-3 m<br>Projectors: 3-4 m but close to the line of sight   | Distributed, large surface light sources for general lighting<br>Projectors with white or/and coloured light    | TV-studios: about 520 lx at 90 cm from floor<br>High brightness projectors spotting using metal halide lamps the stage (>20,000 cd/m <sup>2</sup> ) | (retinal damage)<br>UVR: Unlikely (1)<br>Blue light: Possible (2)<br>Thermal: None<br>Glare from bright head lights may indirectly induce risks |
| ½ to 1 ½h  | Night reading                   | CFLs, LEDs, incandescent  | Minimum distance between 20 and 50cm  | Unique lamp with protection, directional lights (spots)   | Variable, on average 100 lx on the book is an indicative value  | UVR: Unlikely (1)<br>Blue light: Possible (2), (3)<br>Thermal: None   |
| 6-8 h  | Kindergarden, schools           | Linear fluorescent CFLs and LEDs for general lighting<br>Spots (incandescent, LEDs)   | Ceiling fixtures: minimum 2.5-3.0 m   | Distributed, large surface light sources for general lighting<br>Spots for specific area lighting               | 200-500 lx  | UVR: Unlikely (1)<br>Blue light: Possible (2), (4)<br>Thermal: None   |
| 1-5 min  | Night drivers                   | High beams from car in the opposite direction<br>Discharge lamps, LEDs (in the future)                                      | Distance varies from 100 m to less than 5m (car crossing situation). Truck drivers are more exposed due to high position relative to the road surface | Projectors with very high brightness  | N/A   | UVR: Unlikely (1)<br>Blue light: Unlikely (2), (4)<br>Thermal: None<br>Glare from bright head lights may induce accident                        |

Source: SCENIHR, *Health effects of artificial light*, 19 March 2012,

3.7 Exposure and health risk scenarios, pp. 71-78. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenihr\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf)]

**Annex 7:****Table 7. Percent increase in SCC incidence and risk at 80 years of age due to certain added UV doses**

| <b>% increase in annual UV dose during working years (age 20-65 yr)</b> | <b>37% lower increase in annual UV dose during school years (age 5-20 yr)</b> | <b>% increase in risk of a person of 80 yrs of having had an SCC with % increase given in columns 1 and 2</b> | <b>% increase in overall incidence of SCC with everybody subjected to % increase given in columns 1 and 2 (EU std population)</b> | <b>% increase in overall incidence of SCC with a wide spread* in annual solar UV dose and with an added annual dose given as % of median in columns 1 and 2</b> |
|---|---|---|---|---|
| 1   | 0.63  | 1.6   | 1.6   | 0.9   |
| 2   | 1.26  | 3.2   | 3.2   | 1.8   |
| 5   | 3.15  | 8.0   | 8.0   | 4.5   |
| 10  | 6.3   | 16.4  | 16.4  | 9.2   |
| 20  | 12.6  | 34.1  | 34.2  | 19.0  |

Note: the SCC incidence in Denmark in 2007 was 19.1 10-5/yr in males and 12 10-5/yr in females (Birch-Johansen et al. 2010), the corresponding risk of SCC at the age of 80 years is estimated to equal 0.020 in males and 0.013 in females (using equations 1-5).  
\* 95% in the range 3.3-fold under and over the median, according to a lognormal distribution similar to that in DK.

(from indoor lighting) to the annual UV dose in school and working years (added UV dose given as % of the annual solar UV dose)

Source: SCENIHR, *Health effects of artificial light*, 19 March 2012,  
3.7 Exposure and health risk scenarios, pp. 71-78. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenih\\_r\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenih_r_o_035.pdf)]

## Annex 8:

Incidence and cases per year in Denmark under the worst case scenario attributable to exposures to double- and single-capped fluorescent lamps with high, median and low UV emissions in offices and schools added to a basic personal annual solar UV dose, with a median of 166 SEDs/yr and 95% in the range 50 – 551 SEDs/yr. For comparison, the two bottom rows give the effects of adding a Mediterranean holiday to everybody's annual UV dose or having the Danish people living in Australia with the corresponding SCC risk and incidence.

### Table 8. Estimates of SCC risk

| Source (all RGO) at 500 lux   | Actinic UV in mW/m <sup>2</sup> | Eery/Eact, ratio erythematol over actinic UV | Erythematol UV in mW/m <sup>2</sup> | SED/h at 500 lx exposure | 30% exposure SED/y from working days (+% of median annual solar dose) | % increase in risk at 65y# with median solar exposure | % increase in incidence | in DK added # cases/y* |
|---|---------------------------------|--|-------------------------------------|--------------------------|---|---|-------------------------|------------------------|
| Just compliant with RGO limit   | max 1                           | > 3  | > 3                                 | > 0.108                  | > 62.2 (37.5)   | >87   | >38                     | >342                   |
| <b>high UV</b>  |                                 |  |                                     |                          |   |   |                         |                        |
| Double capped tube  | 0.328                           | 3.66   | 1.20                                | 0.043                    | 24.9 (15)   | 31  | 14.0                    | 126                    |
| Single capped tube  | 0.191                           | 3.30   | 0.630                               | 0.0227                   | 13.1 (7.9)  | 16  | 7.2                     | 65                     |
| <b>median UV</b>  |                                 |  |                                     |                          |   |   |                         |                        |
| Double capped tube  | 0.141                           | 3.24   | 0.4565                              | 0.0164                   | 9.45 (5.7)  | 11  | 5.2                     | 47                     |
| Single capped tube  | 0.00291                         | 3.85   | 0.0112                              | 0.000403                 | 0.23 (0.14)   | 0.27  | 0.13                    | 1.2                    |
| <b>low UV</b>   |                                 |  |                                     |                          |   |   |                         |                        |
| Double capped tube  | 0.00834                         | 5.59   | 0.0466                              | 0.00168                  | 0.97 (0.58)   | 1.1   | 0.52                    | 4.7                    |
| Single capped tube  | 3.64 10 <sup>-6</sup>           | 3.93   | 1.43 10 <sup>-5</sup>               | 5.15 10 <sup>-7</sup>    | 0.0003 (0.00018)  | 0.0003  | 0.0001                  | <<1                    |
| <b>Reference exposures</b>  |                                 |  |                                     |                          |   |   |                         |                        |
| Everybody 1 week Mediterranean vacation (50 SEDs) each year throughout life   |                                 |  |                                     |                          |   | 83  | 45                      | 405                    |
| Living in Australia   |                                 |  |                                     |                          |   | 4,440***<br>*   | 3,600                   | 33,500                 |
| <p>Note: Scenario with UV exposure from the fluorescent lamps during school years, 6 h/d, 5d/wk, 40 wks/y from 5 till 20 years of age, and during working days as an adult, 8 h/d, 5d/wk, 48 wk/y from 20 till 65 years of age; numbers in columns 2–5 pertain to full exposure to the lamps at 500 lux; annual dose in SEDs stated under "30% exposure" is a more realistic maximum exposure from working days than at full exposure; the first row under "sources" represents a hypothetical fluorescent lamp at the upper UV limit of the exempt risk category, RGO, according to CIE/IEC standardization. # Overall risk at 65 yrs of age scales to 0.0057 for males and to 0.0036 for females in Denmark, and equals 0.26 for males and 0.17 for females in Australia in 2002 (Staples et al. 2006). **Not calculated for median solar exposure, but risk estimated from actual cumulative (agespecific) incidence in the white Caucasian population of Australia (Staples et al. 2006).</p> |                                 |  |                                     |                          |   |   |                         |                        |

Source: SCENIHR, *Health effects of artificial light*, 19 March 2012, 3.7 Exposure and health risk scenarios, pp. 71-78. [see [http://ec.europa.eu/health/scientific\\_committees/emerging/docs/scenihr\\_o\\_035.pdf](http://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_035.pdf)]