

# INTERSUN

## The Global UV Project A Guide and Compendium

To reduce the burden of disease  
resulting from exposure to UV radiation  
while enjoying the sun safely



Radiation and Environmental Health Unit  
Protection of the Human Environment  
World Health Organization  
Geneva



WORLD HEALTH ORGANIZATION  
2003

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Designed by Con Stamatis, The Cancer Council Victoria

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# Contents

<b>Preface: Why Worry about UV Radiation Exposure</b> .....	iv
<b>Introduction: INTERSUN – WHO’s Global UV Project</b> .....	1
<b>Scope and Purpose</b> .....	2
<b>Ultraviolet Radiation</b> .....	3
<b>UV Radiation as a Risk Factor for Human Illness</b> .....	5
<b>INTERSUN’s Activities</b> .....	9
<b>The UV Index</b> .....	10
<b>Protecting children</b> .....	12
<b>Artificial tanning sunbeds</b> .....	14
<b>Tourism – tourists and tour operators</b> .....	15
<b>UV radiation as a hazard in the workplace</b> .....	16
<b>Filling gaps in scientific knowledge</b> .....	16
<b>Contact and Information Resources</b> .....	19

# Preface: Why Worry about UV Radiation Exposure

Overexposure to ultraviolet (UV) radiation from the sun and artificial UV radiation sources is of considerable public health concern. It plays a major role in the development of skin cancer and eye damage. There is increasing evidence that it suppresses the immune system, which could lead to a reduction in the efficacy of immunization programmes and increase the spread of infectious diseases.

Between two and three million non-melanoma skin cancers are diagnosed worldwide each year, but they are rarely fatal and can be surgically removed. Approximately 130,000 malignant melanomas occur globally each year, substantially contributing to mortality rates in fair-skinned populations. An estimated 66,000 deaths occur annually from melanoma and other skin cancers.

Worldwide some 12 to 15 million people become blind from cataracts annually, of which up to 20% may be caused or enhanced by sun exposure, according to estimates by the World Health Organization (WHO). These numbers will increase as the stratospheric ozone layer is depleted over the next decades, unless people become aware of the hazards of UV radiation exposure, especially from the sun.

The good news is that UV radiation education and prevention programmes are very cost-effective. A study completed by a WHO collaborating centre in Australia has shown that the average cost per head of population for the education campaigns is US\$ 0.08, while the average cost per head of population for treating skin cancer is US\$ 5.70. Thus the value of prevention campaigns is hugely cost-effective.

Promoting UV radiation protection in a positive way is essential to have the best impact. Use the theme "enjoy the sun safely".

# Introduction: INTERSUN – WHO's Global UV Project

In 1992, the United Nations Conference on Environment and Development agreed under Agenda 21 "to undertake as a matter of urgency, research on the effects on human health of increasing ultraviolet radiation reaching the earth's surface as a consequence of depletion of the stratospheric ozone layer; and on the basis of the outcome of this research, to consider taking appropriate remedial measures to mitigate the above mentioned effects on human beings".

In response to Agenda 21, WHO, in collaboration with the United Nations Environment Programme, the World Meteorological Organization, the International Agency on Cancer Research and the International Commission on Non-Ionizing Radiation Protection, established INTERSUN, the Global UV Project.

## INTERSUN'S MISSION STATEMENT

**"To reduce the global burden of disease resulting from exposure to UV radiation"**



INTERSUN provides sound scientific information and practical advice on the health impact and environmental effects of UV radiation exposure. The project encourages countries to take action to reduce UV radiation-induced health risks and provides guidance to national authorities and other agencies about effective sun awareness programmes.

Since 1995 INTERSUN has provided a wealth of information about research and public health measures concerning UV radiation and its health effects.

# Scope and Purpose

This document, prepared by Sabine Petry, is intended for national and local authorities and non-governmental organizations (NGOs) active in the area of UV radiation and sun protection. It highlights INTERSUN's priority activities and publications, which can be obtained from our homepage (<http://www.who.int/uv>) or by request ([uvinfo@who.int](mailto:uvinfo@who.int)).

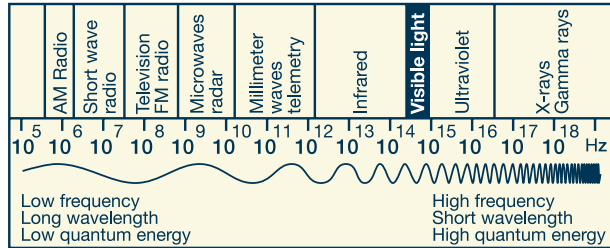
The purpose of this document is to provide information from INTERSUN that can be used to develop and implement integrated public health programmes which reduce health risks from excessive UV radiation exposure. An important objective is to facilitate the harmonization of national activities and coordination of international activities through the use of the Global Solar UV Index and its associated health protection messages.

# Ultraviolet Radiation

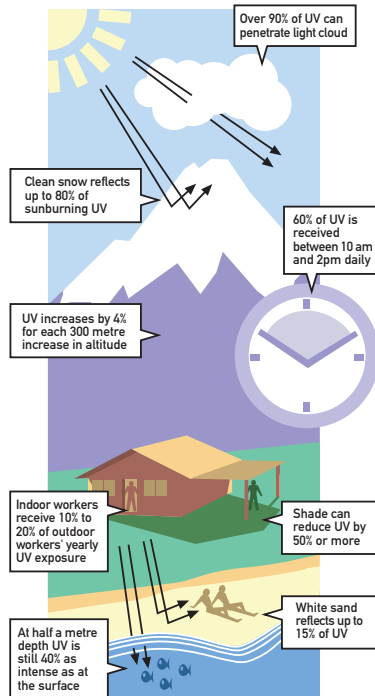
UV radiation is part of the electromagnetic spectrum emitted by the sun, and is divided by wavelength into three regions: UVA, UVB, and UVC. UVC (wavelengths of 100-280 nm) is completely absorbed by the atmospheric ozone, water vapour, and gases (O<sub>2</sub>, CO<sub>2</sub>). Most UVA radiation (315-400 nm) and about 10% of UVB radiation (280-315 nm) reaches the Earth's surface. Both UVA and UVB are of major importance to human health.

The intensity of solar UV radiation at the Earth's surface is influenced by several environmental factors (Figure 2), including the sun's height, latitude, altitude, ground reflection, concentration of atmospheric ozone, and presence of clouds, dust, haze, and several organic compounds.

Stratospheric ozone effectively shields us from the most harmful UV radiation (UVB). As this protective filter is gradually reduced (Figure 3) human beings and the environment are exposed to higher UV radiation levels. Moreover, people's tendency to wear lower coverage clothing,



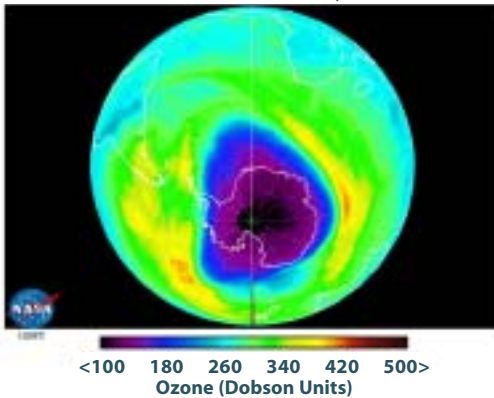
**Figure 1: The electromagnetic spectrum. Reproduced with permission of HyperPhysics.**  
(See <http://hyperphysics.phy-astr.gsu.edu/hbase/ems1.html>)



**Figure 2: Environmental factors that influence UV radiation intensity**

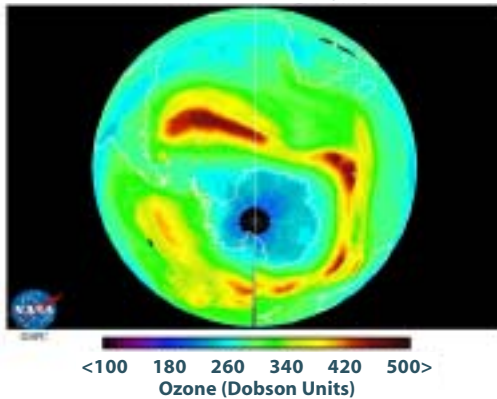
migration or holidays by pale-skinned people to areas of high ambient UV radiation, and behavioural practices such as sunbathing for long periods of time are likely to exacerbate adverse health effects in all populations of the world.

Earth Probe TOMS Total Ozone September 24, 2001



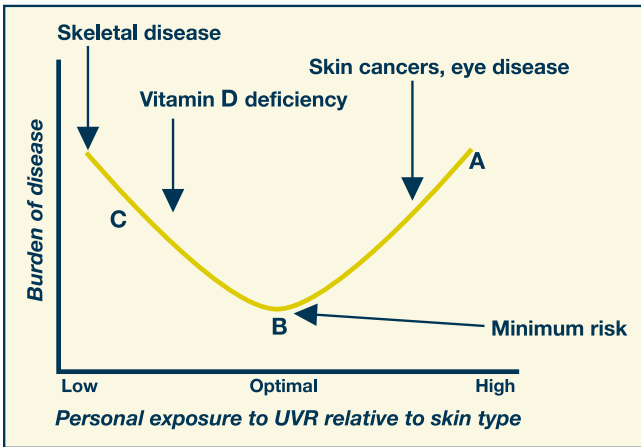
**Figure 3: Pictures of the Earth's ozone layer, Total Ozone Mapping Spectrometer (TOMS), reproduced with permission of the Ozone Processing Team, NASA's Goddard Space Flight Center. A dobson unit (DU) is the most basic measure used in ozone research. Areas with only 100 DU have a reduced ozone layer that can yield little protection for damaging UV radiation.**

Nimbus-7 TOMS Total Ozone September 24, 1980



# UV Radiation as a Risk Factor for Human Illness

Everyone is exposed to UV radiation from the sun and many people are exposed to UV radiation from sources used in industry, commerce, and recreation. Small amounts of skin exposure to UV radiation (about 10 to 15 minutes per day) are essential for the production of vitamin D, which plays a crucial role in skeletal development, immune function, and blood cell formation. Artificial UV radiation is also used to treat several diseases under medical supervision, including rickets, psoriasis and eczema.



**Figure 4: Schematic diagram of the relation between UV radiation exposure and the burden of disease (Source: Lucas RM & Ponsonby AL. Ultraviolet radiation and health: friend and foe. *Med J Aust*, 2002, 177:594-598. Reproduced with permission)**

On the other hand, overexposure to solar UV radiation may result in acute and chronic health effects on the skin and eye (Figure 4). The optimal amount of UV radiation exposure a person should receive is not known but is likely to depend on many factors related to skin type, diet, etc. Sunburn (erythema) is the most common acute effect of excessive UV radiation exposure. Over the longer term, UV radiation induces degenerative changes in cells of the skin, fibrous tissue, and blood vessels, leading to premature skin ageing, photodermatoses, and actinic keratoses. Other acute effects include inflammatory reactions of the eye such as photokeratitis and photoconjunctivitis, while chronic eye exposure can cause pterygium. The most serious consequences of overexposure to UV radiation are skin cancer and cataracts.

The range of consequences to UV radiation exposure is quite large, as shown in Table 1.

**Table 1: Summary of possible effects of solar ultraviolet radiation on human health (Source: *Climate change and human health - risks and responses*. Geneva, World Health Organization, United Nations Environment Programme & World Meteorological Organization, 2003.)**

## DETRIMENTAL EFFECTS

<b>Skin</b>	<ul style="list-style-type: none"> <li>• Malignant melanoma</li> <li>• Non-melanocytic skin cancer - basal cell carcinoma and squamous cell carcinoma</li> <li>• Sunburn</li> <li>• Chronic skin damage</li> <li>• Photodermatoses</li> </ul>
<b>Eye</b>	<ul style="list-style-type: none"> <li>• Acute photokeratitis and photoconjunctivitis</li> <li>• Climatic droplet keratopathy</li> <li>• Pterygium</li> <li>• Cancer of the cornea and conjunctiva</li> <li>• Lens opacity (cataract) - cortical and posterior subcapsular</li> <li>• Uveal melanoma</li> <li>• Acute solar retinopathy</li> <li>• Macular degeneration</li> </ul>
<b>Immunity and infection</b>	<ul style="list-style-type: none"> <li>• Suppression of cell-mediated immunity</li> <li>• Increased susceptibility to infection</li> <li>• Impairment of prophylactic immunization</li> <li>• Activation of latent virus infection</li> </ul>
<b>Other detrimental effects</b>	<ul style="list-style-type: none"> <li>• Non-Hodgkin's lymphoma</li> </ul>

## BENEFICIAL EFFECTS

- Cutaneous vitamin D production
  - prevention of rickets, osteomalacia, and osteoporosis
  - possible benefit for hypertension, ischaemic heart disease, and tuberculosis
  - possible decreased risk for schizophrenia, breast cancer, and prostate cancer
  - possible prevention of Type 1 diabetes
- Reduced risk of some autoimmune diseases

Between two and three million non-melanoma skin cancers, i.e. basal cell carcinoma and squamous cell carcinoma (*Figure 5*), are diagnosed worldwide each year, but are rarely fatal and can be surgically removed. Approximately 130,000 malignant melanomas (*Figure 5*) occur globally each year, substantially contributing to mortality rates in fair-skinned populations. An estimated 66,000 deaths occur annually from melanoma and other skin cancers.



**Basal cell carcinoma**



**Squamous cell carcinoma**



**Melanoma**

**Figure 5:**

**(Source: The Cancer Council Victoria. Reproduced with permission)**

Worldwide some 12 to 15 million people become blind from cataracts annually, of which up to 20% may be caused or enhanced by sun exposure, according to WHO estimates. Furthermore, a growing body of evidence suggests that environmental levels of UV radiation may suppress cell-mediated immunity and thereby enhance the risk of infectious diseases and limit the efficacy of vaccinations. Both of these act against the health of poor and vulnerable groups, especially children of the developing world. Many developing countries are located close to the equator; hence, people in these regions are exposed to very high levels of UV radiation.

## **Publications**

Lucas RM, Ponsonby AL. Ultraviolet radiation and health: friend and foe. *Med J Aust*, 2002, 177:594-598.

National Centre for Epidemiology and Population Health. *Comparative risk assessment: ultraviolet radiation*. Woolloomooloo, The Cancer Council NSW, 2002.

*Solar radiation and human health – too much sun is dangerous*. Geneva, World Health Organization, 1999 (WHO Fact Sheet No. 227).

*Solar eclipses – danger to eyesight*. Geneva, World Health Organization, 1999 (WHO Fact Sheet No. 228).

The Cancer Council Victoria. *Vitamin D. Position statement*. Carlton, The Cancer Council Victoria, 2003.

# INTERSUN's Activities

INTERSUN promotes and evaluates research on the health effects of UV radiation, and develops an appropriate response through guidelines, recommendations, and information dissemination. This information is for ministries/departments of health, national and local authorities, and NGOs to contribute to their programmes on protection of UV radiation-related health effects.

INTERSUN provides information directly to the public and the media through the use of press releases and fact sheets. Fact sheets on specific topics are written in easily understood language and are made available for the general public on the INTERSUN website (<http://www.who.int/uv/resources/uvfact/en/>). Information is also disseminated through the many WHO collaborating centres in different countries of the world. WHO collaborating centres are selected on the basis of having a high level of expertise in relation to UV radiation research or UV radiation protection, and for their geographic position and language.

## LOCAL AUTHORITIES

Local authorities can make a significant contribution to decreasing the negative human effects of UV radiation. This can be achieved by creating a physical environment that provides shade at areas where people congregate for example at bus stops, in school grounds or over tables in parks. Local authorities can also develop policies that can influence practices in schools and recreation centres. Lastly, local authorities can effect the social environment by influencing the knowledge, attitudes and behaviour of residents in their municipality through education and mass media.

### **Publications**

*Local authority guide on UV radiation and health.* Copenhagen, World Health Organization, Regional Office for Europe, 2003.

See also publications lists in following sections for details of WHO fact sheets.

## THE UV INDEX

Current evidence indicates that people’s sun-seeking behaviour constitutes the most important individual risk factor for UV radiation damage. WHO, in collaboration with the United Nations Environment Programme (UNEP), the World Meteorological Organization (WMO), and the International Commission on Non-Ionizing Radiation Protection (ICNIRP), developed and published the Global Solar UV Index in 1995.



The UV Index (UVI) is an important vehicle to raise public awareness of the risks of excessive exposure to UV radiation and the need to adopt protective measures. As a simple measure of UV radiation levels at the Earth’s surface, the values of the UVI range from zero upward (*Figure 6*) - the higher they are, the greater the potential for damage to the skin and eye, and the less time it takes for harm to occur. In many countries, the media presents a weather forecast with the UV radiation levels (as the UVI) for the following day, in which most emphasis is placed on the time when the UV radiation level is highest.

A practical guide, to harmonize communication of the UVI and the important health protection messages associated with each index value, was published in 2002 by WHO. In this guide the categories were revised to improve the use of the UVI as an educational tool to promote sun protection.

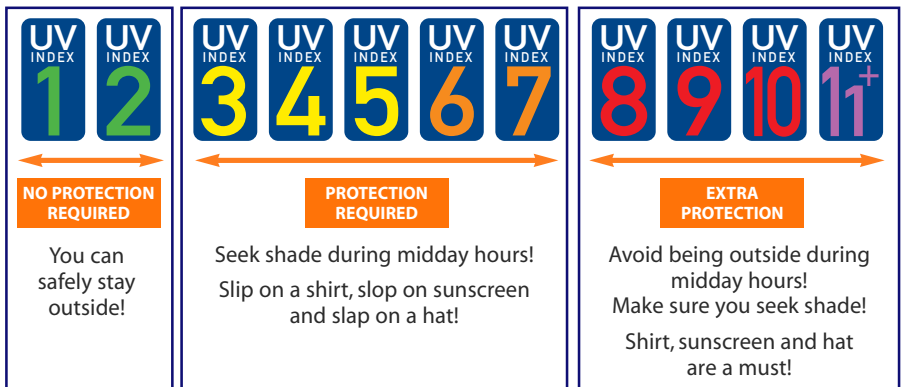


Figure 6: The UV Index logo and scale

INTERSUN promotes the harmonized use of the UVI, the use of the UVI as a tool in educational programmes, and advises governments to employ this index in their health promotion programmes. WHO encourages the media and tourism industry to publish the UVI forecast and promote sun protection messages. WHO also encourages physicians to be aware of the UVI as a tool for conveying protective messages about UV radiation and how it can be used to reduce the incidence of skin cancers. More details are provided in the article by Meves et al. (2003); see publications list below.

## **Publications**

*Global Solar UV Index – a practical guide.* Joint recommendation of World Health Organization, World Meteorological Organization, United Nations Environment Programme, International Commission on Non-Ionizing Radiation Protection, Geneva, 2002. This gives practical explanations and recommendations for harmonized reporting of the UVI and its use as a tool to promote sun protection and skin cancer prevention. (Available at: <http://www.who.int/uv/publications/en/UVIGuide.pdf>).

*Global Solar UV Index.* Joint publication by World Health Organization, World Meteorological Organization, United Nations Environment Programme, International Commission on Non-Ionizing Radiation Protection, Munich, 1995. This gives a description of the internationally agreed measure of UV radiation levels and its use as an educational tool to alert people about the adverse health effects of UV radiation exposure.

*Global Solar UV Index.* Geneva, World Health Organization, 2002 (WHO Fact Sheet No. 271).

Downloadable UVI graphics

([http://www.who.int/uv/intersunprogramme/activities/uv\\_index/en/index2.html](http://www.who.int/uv/intersunprogramme/activities/uv_index/en/index2.html)).

A standard graphic presentation to promote consistency in UVI reporting on news and weather bulletins, and to improve people's understanding of the concept.

Meves A, Repacholi MH, Rehfues E. Global solar UV index: a physician's tool for fighting the skin cancer epidemic (Commentary). *Int J Dermatol*, 2003, 42:846-849.

## PROTECTING CHILDREN

Children are more susceptible to UV radiation exposure because:

- sun exposure during childhood and adolescence increases the risk of both melanoma and non-melanoma skin cancers in later life;
- a significant part of a person's lifetime UV radiation exposure occurs before age 18;
- children have more time to develop diseases with long latency, and more years of life could be lost and more suffering endured as a result of impaired health.

Schools are an excellent place to teach healthy behaviours that can prevent overexposure to UV radiation. School children are especially susceptible to fashion trends. In an environment that is geared towards learning, teachers can play a major role in enhancing children's knowledge, attitudes, and behaviour regarding sun protection. Educational programmes in schools can significantly decrease adverse health effects and health care costs.



**Figure 7: Children require special protection (Source: The Cancer Council Victoria. Reproduced with permission)**

An effective school campaign can have an enormous impact on public health: the SunSmart Campaign (Figure 7), of The Cancer Council Victoria in Australia, has made significant progress in raising awareness of the issues of sun protection and skin cancer, as well as encouraging changes in sun-related lifestyle. For further information on their campaign see their webpage at: <http://www.cancervic.org.au/index.html> or <http://www.sunsmart.com.au>

A school programme on sun protection should adopt an integrated approach to help students, teachers, and the wider community to avoid the health risks of UV radiation exposure. The programme should include sun protection education, a healthy school environment, a school-endorsed sun protection policy, and community and family involvement. Activities

are most effective if they have a practical focus and are relevant to the students' own experiences. Sun protection can easily be integrated into a range of curriculum areas. Implementing and evaluating school health programmes is recommended by WHO.

WHO has developed a comprehensive package of materials for children's sun protection education. It is intended for ministries/ departments of health and education, as well as national and local authorities and NGOs active in the area of health promotion and sun protection programmes.

### **Publications**

*Children under the sun – UV radiation and children's skin.* Recommendations from 2nd EUROSkin Conference, 2001. (Available at: <http://www.who.int/uv/resources/recommendations/en/2ndEuroskinrec.pdf>)

*Protecting children from the sun.* Geneva, World Health Organization, 2001 (WHO Fact Sheet No. 261, available at: <http://www.who.int/inf-fs/en/fact261.html>).

Sun protection in schools: an educational package to protect children from ultraviolet radiation. Includes: *Sun protection and schools: how to make a difference* (describes the importance of sun protection in schools, and outlines the necessary steps for establishing a school program), *Sun protection: a primary teaching resource* (for primary school teachers - provides suggestions and ready-made teaching activities), and *Evaluating school programmes to promote sun protection* (for schools and educational and health authorities at the local and national level). Geneva, World Health Organization, 2003. (Available at: <http://www.who.int/uv/publications/sunschools/en/>).

## ARTIFICIAL TANNING SUNBEDS

The desire to acquire a tan for cosmetic purposes has led to the development of a large artificial skin tanning industry, mostly in Western countries where many residents have pale skins. In general, sunbeds predominantly emit UVA radiation, which is thought to be the least damaging part of the UV radiation spectrum. However in recent years, sunbeds have been made that produce higher levels of UVB radiation to mimic the solar spectrum and hasten the tanning process.



**Figure 8: UV tanning devices for cosmetic purposes bear risks as well**

Twenty-five per cent of Northern European artificial sunbed users are in the 16-24 years age group. At this stage, evidence for an association between sunbed use and increased melanoma risk is suggestive but not conclusive. This is largely because it is difficult to separate the effects of artificial and solar UV radiation. The evidence of a link between sunbed use and skin ageing, as well as squamous cell carcinoma, is significant.

While the WHO and WHO collaborating organizations (EUROSKIN and the International Commission on Non-ionizing Radiation Protection) recommend against the use of UV tanning devices for cosmetic purposes, it is recognized that sunbeds continue to be available to the public. For this reason there is a need for guidance to reduce the risks associated with their use. INTERSUN continues to promote research on the health effects of sunbed use and continuously updates its recommendations based on the results.

### Publications

*Artificial tanning sunbeds. Risks and Guidance.* Geneva, World Health Organization, 2003. This identifies risks and gives guidance to minimize health effects. Intended for government health authorities to assist them develop public health policy for sunbeds. (Available at: <http://www.who.int/uv/intersunprogramme/activities/uvartsunbeds/en/>).

*EUROSKIN recommendations on sunbeds*, 2000. (Available at: <http://www.who.int/uv/resources/en/recsunbed.pdf>)

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Health issues of ultraviolet tanning appliances used for cosmetic purposes. ICNIRP Statement. *Health Phys*, 2003, 84(1):119-127. (Also available at: <http://www.icnirp.de/documents/sunbed.pdf>)

## TOURISM – TOURISTS AND TOUR OPERATORS

Tourism is regarded as one of the world's largest industries. In 2001, 639 million tourists contributed US\$ 463 billion to the world's economy. Many tourists seek sunny and warm destinations. However, sunburn is a common holiday experience that can cause considerable pain and discomfort and may lead to more serious consequences.

Unfortunately skin cancer rates are on the rise in many parts of the world including the United States and Europe. A part of the reason for the rise can be explained by the combination of sun-seeking behaviour and the more recent affordability and accessibility of airline travel, particularly to warm and sunny destinations.

Tourism industry operators can play a crucial role in minimizing the risks associated with sun exposure by reminding their clients of the need to use sun protection measures and ensuring the facilities have shaded facilities available.



**Figure 9: In sunny holiday destinations, sun protection should be a priority**

### Publication

*Guide for tour operators: minimizing risks associated with ultraviolet radiation exposure.* Geneva, World Health Organization.

(Available at: <http://www.who.int/uv/publications/en/touoperators.pdf>)

## UV RADIATION AS A HAZARD IN THE WORKPLACE



**Figure 10: Optimal sun protection outfit for outdoor-workers (Source: The Cancer Council Victoria. Reproduced with permission)**

People may be exposed to UV radiation at work from artificial sources, such as arc welding, lamps used in the curing of paints, inks, etc. and sterilization of equipment in hospitals and laboratories using UV lamps. Well-designed engineering and administrative controls and the use of personal protective equipment can keep the risks to a minimum.

Outdoor workers are the most likely to suffer health consequences from exposure to UV radiation. A comprehensive strategy is required to minimize risks because the sun cannot be controlled like other workplace exposure hazards. Therefore, outdoor workers must be aware of the risks and take appropriate sun protection action. Employers also have an obligation to ensure protection of employees from exposure to UV radiation in the workplace.

### Publications

*Ultraviolet radiation as a hazard in the workplace.* Information about the occupational health risks of UV. Geneva, World Health Organization. (Available at: [http://www.who.int/uv/occupational\\_risk.pdf](http://www.who.int/uv/occupational_risk.pdf))

## FILLING GAPS IN SCIENTIFIC KNOWLEDGE

INTERSUN promotes and evaluates research on the health effects of UV radiation, and develops an appropriate response through guidelines, recommendations and information dissemination. INTERSUN encourages high-quality research activities that will fill gaps to improve health risk assessment and facilitate communication between researchers and funding agencies.

To do this INTERSUN collaborates with specialist agencies to:

- implement key research needs;
- develop reliable predictions of the health and environmental consequences of changes in UV radiation exposure with stratospheric ozone depletion;
- develop practical ways of monitoring change in UV radiation-induced health effects over time in relation to environmental and behavioural modifications.

### **Scientific reviews and meetings**

Scientific research is essential to understand how UV radiation causes effects on the skin, eyes, and immune system and the resulting impacts on health. Epidemiological studies on human populations are conducted to determine the effects of UV radiation exposure on people in their everyday lives. INTERSUN conducts and publishes reviews on specific topics and provides a forum for discussion at scientific meetings.

There is good evidence that UV radiation exposure has a suppressive effect on the immune system. INTERSUN strongly encourages researchers to investigate whether UV radiation exposure can affect vaccination programmes, particularly for children. In developing countries, a large range of vaccines is used to prevent disease, and many poor countries are exposed to the highest levels of UV radiation. Since many vaccine-preventable diseases are extremely contagious, any factor that causes even a small decrease in vaccine efficacy could have a major impact on public health.

### **Global burden of disease assessment**

An important research goal is assessing and quantifying health risks of UV radiation exposure. According to recent estimates, 25% to 33% of the global burden of disease can be attributed to environmental risk factors. However, the contribution of UV radiation to the global burden of disease has not yet been quantified. Therefore, one of INTERSUN's priorities is to develop a harmonized peer-reviewed methodology to assess the burden of disease, and to quantify the health effects of UV radiation on the skin, eyes, and immune system. National and global burden of disease assessments will allow WHO to monitor changes in mortality and morbidity with respect to behaviour change and ozone depletion, and to develop appropriate health responses for different regions of the world.

## Publications

National Centre for Epidemiology and Population Health. *Comparative risk assessment: ultraviolet radiation*. The Cancer Council NSW (in preparation).

McKinlay AF & Repacholi MH. Ultraviolet radiation exposure, measurement and protection. *Radiat Prot Dosimetry*, 2000, 91(1-3):11-12.

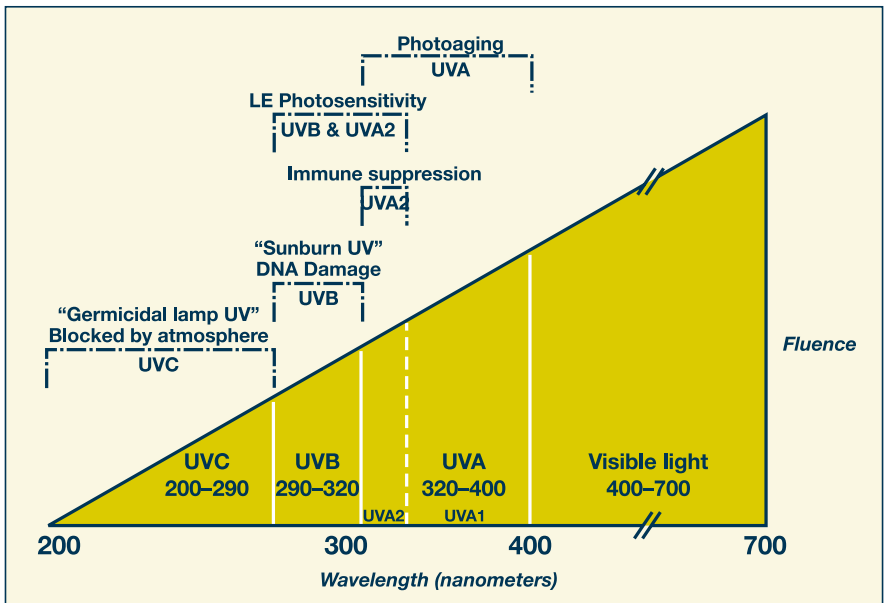


Figure 11: Ultraviolet spectrum and the proportional relationship between wavelengths and UV exposure (fluence) (Source: Ting WW, Vest CD, Sontheimer R. Practical and experimental consideration of sun protection in dermatology. *Int J Dermatol*, 2003, 42(7):505. Reproduced with permission.)

# Contact and Information Resources

For further information and ongoing activities please refer to the INTERSUN website <http://www.who.int/uv>. Publications are either downloadable or will be sent upon request ([uvinfo@who.int](mailto:uvinfo@who.int)). Your feedback is welcome at any time. If you require more information or guidelines, contact:

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CH-1211 Geneva 27, Switzerland

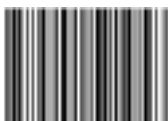
Note: WHO fact sheets are available at: <http://www.who.int/uv/resources/uvfact/en/>



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