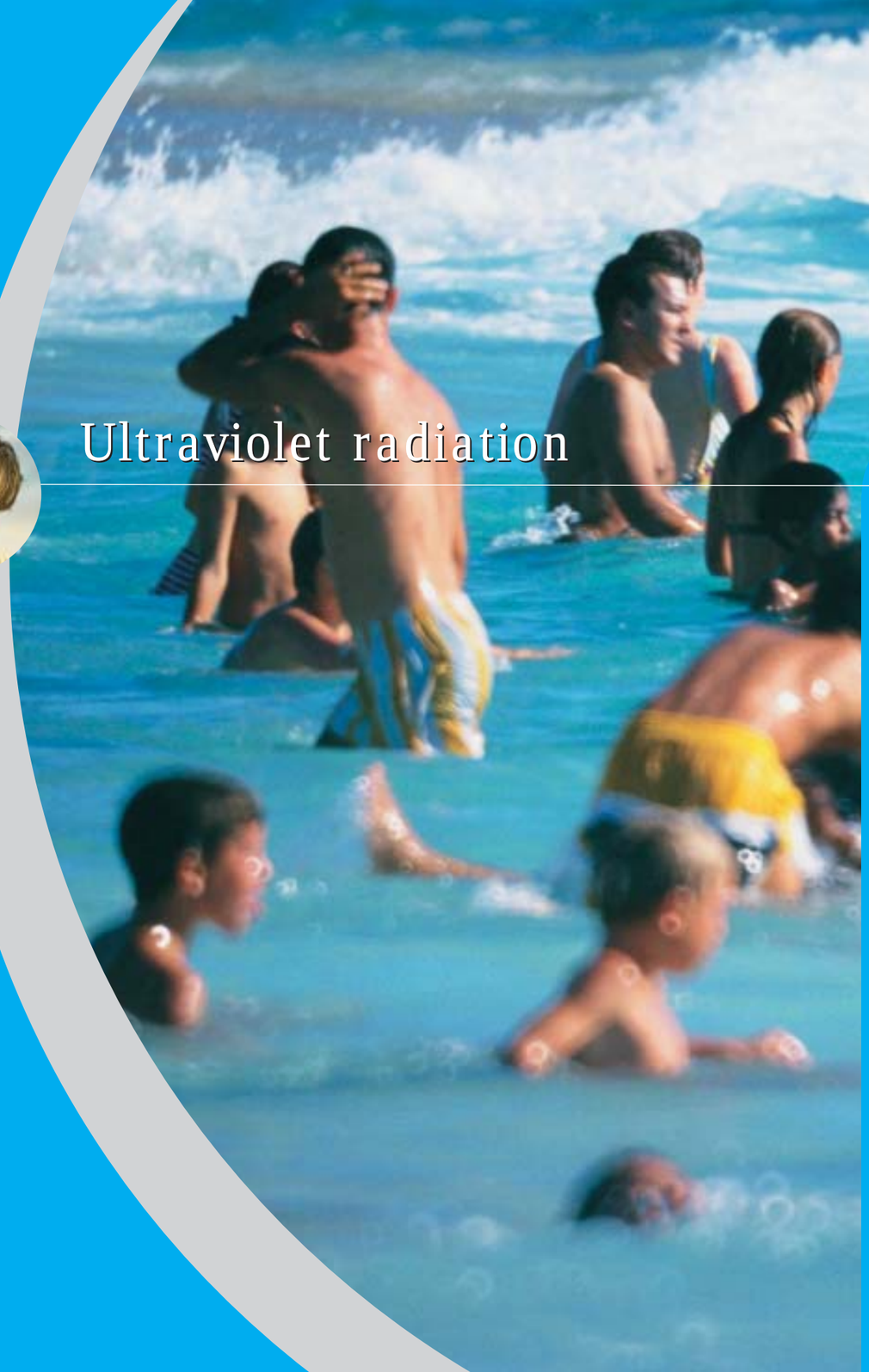
Programmes for preventing exposure to the sun have increased awareness in the targeted populations, and the results indicate that moderate changes had been achieved in attitudes to sun protection. In Australia, where the largest campaigns were conducted, a decrease in the incidence of skin cancer was observed after 15 years of intervention.

Early detection campaigns (both screening and early diagnosis) have also increased public awareness and have improved the diagnostic capability of health professionals. This led to a decline in the severity of skin melanoma, with a large increase in the median survival time of these patients. The efficiency of mass screening programmes has not, however, been fully demonstrated.

A faster, more efficient decrease in deaths from melanoma could be obtained by improving awareness of the availability of early diagnosis. Furthermore, the incidence of skin cancer could be reduced by comprehensive preventive interventions directed at children and adolescents.



Ultraviolet radiation

Ultraviolet radiation

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Ultraviolet radiation and cancer: burden of disease and established risk factors

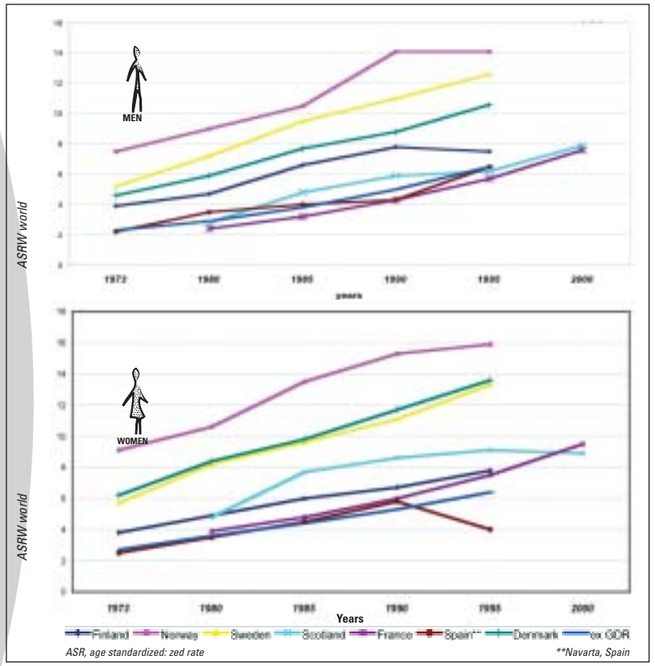
The two main types of skin cancer are carcinoma and melanoma. Carcinomas are the most frequent (standardized incidence rate in Europe, 30-100 cases per 100,000 population) but are rarely life-threatening. Melanomas are relatively rare (standardized incidence rate in Europe, 5–15 per 100,000), but their evolution can be lethal. The incidence of skin cancer has increased dramatically over the past 50 years in white populations (see Figure 1). Of several risk factors for skin cancer that have been identified, exposure to ultraviolet (UV) radiation is the foremost [1]. Other risk factors are ionizing radiation and certain chemicals (arsenic, coal-tars and mineral oils), generally encountered occupationally (see chapter on Occupational exposures). These environmental factors interact with different skin phenotypes (see box) to result in different risks.

Skin phenotypes

Type	Burn	Tan	Hair colour	Eye colour
I	Always	Never	Red or blonde	Light
II	Always	Lightly	Blonde or light brown	Light
III	Sometimes	Always	Blonde or brown	Any
IV, V	Rarely	Always	Brown or black	Brown or black

Figure 1

Time trends in the incidence of skin melanoma



The relationship between exposure to UV radiation, skin phenotype and skin cancer can be summed up as follows [2–5]:

- The risk for basal-cell carcinomas is greater (relative risk, 2–3) among persons of light skin phenotype with poor ability to tan and for those exposed to UV radiation in childhood.
- People susceptible to spinocellular carcinomas are those with phenotypes that make it impossible to tan and a basal pigmentation level, particularly red hair and fair skin. Length of exposure also plays an important role. The relative risk varies from 3 to 7, depending on the associations between these factors.
- Convincing evidence is available with regard to a causal role of UV radiation in the generation of melanomas in people with sensitive skin phenotypes (fair skin, little ability to tan). The risk increases with exposure to the sun in infancy (relative risk, 3–5) [5].

Skin cancer can be diagnosed early by simple visual examination. The number of melanoma-related deaths is proportional to the stage of development of tumours, particularly to the thickness of the lesion. Thus, the 5-year survival rate is greater than 95% for lesions less than 0.76 mm thick, 44% for lesions more than 4 mm thick, 30% for nodular (very thick) melanoma and 10% for metastatic melanoma [6].

The other types of skin cancer rarely lead to death, but early diagnosis could reduce the associated morbidity and cost. Basal-cell carcinomas grow slowly, but a late diagnosis could result in large, extended forms that are relatively inaccessible to treatment [7]. Spinocellular carcinomas are easily detected by the presence of precursor lesions such as actinic keratosis; their development is progressive. In the absence of treatment, metastases appear in about 2% of cases [8].

Ozone

The amount of UV radiation that reaches the Earth's surface varies according to the solar zenith angle, the column of ozone and its vertical distribution, gaseous and particulate air pollution, atmospheric aerosol load and cloudiness. A systematic variation in any of these factors would result in a trend. Estimates of the increases in skin cancer incidence that could result from predicted reductions in stratospheric ozone lack a well-founded numerical basis. The Intersun study has been planned to quantify the relationship between ambient solar radiation and the occurrence of health effects, but the results are not yet available [51].

Programmes to reduce exposure to the sun

The programmes

This review was based on an analysis of 27 studies published between 1982 and 2002, 12 of which were randomized controlled trials. Five of the other studies were not randomized but included a control group, and 10 had no control group.

The sun protection programmes were carried out at either a wide (city, region or country) or a restricted community level (schools, professional milieu) or for specific populations (e.g. travellers, mothers of newborns). The aim of all the programmes was to change the knowledge, attitudes, intentions and behaviour of the target populations with regard to exposure to the sun.

The methods essentially comprised dissemination of information through the media (radio, television and the press) or distributing tools such as comic strips, CD-ROMs, videos, brochures and slides, as well as sun protection promotional items [10–31].

> "A high risk strategy for melanoma prevention might seek to identify and target individuals with three or more risk factors (such as a number of moles, blonde or auburn hair, previous sunburn, and a family history of skin cancer). However, only 24% of cases of melanoma occur in this 9% of the population, so a targeted approach would succeed in identifying those at high risk but would do little for population levels of melanoma – 75% of cases occur in the 58% of the population with at least one risk factor. A population-wide strategy would seek to make sun protection a social norm, so that the whole population is less exposed to risk."
>
> **Source: World Health Organization [9]**

In some programmes, sun protection devices were also distributed, including parasols, hats, sunscreens and one-piece bathing suits [14, 17, 21, 23, 32]. In the professional milieu, staff training sessions were conducted, in the form of 30-45 minutes conferences [33] or 3 hours health education sessions [34].

The intervention tools and assessment methods differed from one study to the other. Most involved self-administered questionnaires or telephone interviews to assess knowledge, attitudes and intended behaviour. Nine authors validated their scales [12,23,25,26,30,32,33,35,36]. Others evaluated the incidence of naevi and freckles after the start of the programme. In a school-based study, real sun protection behaviour was assessed by observation.

The impact of the programmes was assessed either immediately afterwards or after a relatively long time. One-half of the studies included an assessment period of 2–4 months; the longest period was 4 years.

Impact of the sun protection programmes

Increased knowledge: All the studies showed a marked increase in knowledge scores immediately after programmes lasting 1–28 weeks among children and adults. The increase in knowledge appeared to be greater among the youngest children. The only study conducted in a nursery school showed a significant increase in scores for knowledge and understanding of the message 2–7 weeks after the programme [29]. Studies among primary school children also reflected an increase in knowledge [20,22,26]. Hornung et al. [26] noted the advantages of an interactive CD-ROM programme over an educational standard supplemented with a skin cancer prevention module: the group receiving the latter intervention showed little difference from the group that had no intervention.

The studies carried out among junior high-school children showed an increase in knowledge scores [11,12]. Hughes et al. [11] observed that girls scored higher than boys. In their study, there was no significant difference between the four interventions tested: workbook ± leaflet ± video, design of a poster or discussion of the message. Among high school students [30], more knowledge was linked significantly to taking strong precautionary measures against the harmful effects of sunlight and more frequent use of sunscreens.

In studies on the staff of leisure centres on the island of Oahu in Hawaii [35] and the employees of an Australian electricity company who worked outdoors [33], considerably more knowledge was acquired by the intervention group than the control group 3 months and 1 year, respectively, after the intervention.

Changes in attitudes and opinions: Heterogeneous results were obtained for changes in attitude. Two studies showed no effect of the programme on attitude by the end of the evaluation period [26,33]. The other six studies had variable results [11,12,20,22,30,35]. The main outcome was a reduced preference for tanning. One study [20] showed a marked decrease in the frequency with which 9-year-old children in the intervention group wished to tan 4 months after the programme had ended. A similar change in attitude was noted in 11-year-old children [22].

Another attitude measured was perception of minor skin damage after exposure to the sun. Two months after a programme, junior high-school students were more concerned about their degree of sunburn and the need for protection [12].

Increased intention to practise sun protection: An analysis of the programmes' impact on the intention of participants to protect themselves from the sun produced contradictory results.

Five studies did not show any change in intention to practise sun protection at the end of the evaluation period [11,13,20,26,29], whereas three others registered an increase among participants in the programme [21,22,35].

In a study conducted in an Australian city [37], one-third of the people interviewed said that they had seen a television programme about the dangers of sunlight and the need to avoid sunburn, broadcast as part of the intervention, and the knowledge of people who had seen it was significantly better than that of those who had not. More than half said that better sun protection was necessary, but fewer than one-third said that beauty spots should be monitored. Almost 75% of people considered that the prevention programme was relevant to them.

Increased sun protection: None of the studies with controls evaluated the effect of a prevention programme on subsequent sun protection. In one observational study [22], use of protective creams and external sun protection measures (e.g., hats, clothing, shade, parasols), less exposure to the sun and reduced sunburn were reported. In another study [37], after the airing of a television programme, 60% of the people interviewed said that they protected themselves more from the sun, kept a close watch on their skin, consulted a doctor or warned other people about the danger of skin cancer.

The impact of other programmes was mixed. Bolognia et al. [21], for example, recorded an increase in use of sunscreens and a decrease in sun exposure but no change in the use of hats, parasols or protective clothing 6 months after the intervention. One study [32] highlighted a paradoxical effect: children who had participated in the programme subsequently exposed themselves more to the sun!

Effect on numbers of freckles and naevi: The only study in which the impact of a programme on the number of benign naevi and freckles was assessed did not show significant differences between the control group and groups receiving high and low levels of intervention (one-piece bathing suits and a specific educational programme delivered by teachers) after a 4-year programme for 6-year-old schoolchildren [32].

Clothes and clothes

All textiles do not offer the same protection! Synthetic fibres protect more than natural fibres. Protection against UV radiation depends on the spaces between the fibres and the density of the weave. Protection decreases when clothes are wet, light-coloured or stretched.

Special, chemically treated protective clothes are now available. A 'UV standard' logo has been created in some countries (e.g., Switzerland) to guarantee the protective power of cloth.

Sunscreens

Sunscreens are given a numerical indicator, the sun protection factor (SPF), which identifies the level of protection that can be expected from UV radiation. The classification is calibrated according to the degree of solar erythema (redness or sunburn) and not in relation to protection from skin cancer.

Sunscreens help individuals to avoid sunburn by allowing them to choose a SPF that corresponds to their own phenotype and to local sunlight intensity. In no case do they permit longer exposure, particularly for people who do not tan easily.

Two strategies are available to increase early detection:

- systematic examination of all individuals in a healthy, targeted population by professionals, i.e. 'screening' (five studies), and
- increasing the awareness of individuals and health professionals about early symptoms and making a diagnosis as quickly as possible when initial symptoms appear, i.e., 'early diagnosis' (eight studies).

The same detection test, 'a complete body visual examination', is used in the two strategies, but they differ in the size and type of population targeted. For screening, the entire population is targeted, regardless of cutaneous lesions. For early diagnosis, only subjects presenting with skin anomalies are included. The advantages and costs of these two approaches are different.

Programmes to increase early detection of skin cancer

The programmes

This review was based on an analysis of 13 studies published between 1990 and 2002: three in Australia, three in the United Kingdom, two in the USA, two in Italy, and one each in Canada, France and Switzerland. The main aim of all the programmes was to diagnose skin tumours, especially malignant melanomas, as early as possible. The effect of early detection was measured as increased knowledge, the sensitivity and specificity of self-examination by individuals and of diagnosis by health professionals, the number of skin cancers detected, the stage of the diagnosed tumours, the mortality rate and cost.

Early detection was optimized by:

- training and sensitization of health professionals (first-aid workers, nurses, general practitioners and dermatologists) and disseminating information through the media [38–47]; training lasted 2–40 hours;
- dissemination of information in a televised prevention campaign [37];
- training people in self-examination by various means, such as photography in association with a visual examination [48]; and
- establishment of a screening centre [49].

The number of tumours detected and their thickness, the predictability, sensitivity and specificity of the test, and the mortality rate were determined either from tumour registries or from data provided by a representative sample of anatomo-pathological laboratories in collaboration with health professionals. Both knowledge and diagnostic abilities were evaluated from self-administered questionnaires.

Impact of early detection campaigns (screening or early diagnosis)

Increased self-examination of the skin: In one study [37], 55% of the participants looked for spots on their skin after the programme was aired, and 28% found spots; 60% of the people interviewed said that they kept a close watch on their skin or had consulted a doctor.

Improved performance by health professionals: The two studies involving training in the professional environment led to a significant increase in knowledge. McCormick et al. [36] measured a global knowledge index among nurses concerning prevention, early diagnosis and educational abilities. Katris et al. [43] assessed the performance of nurses trained in the early diagnosis of lesions suspected to be malignant. Thus, 94.8% of lesions identified by surgeons as likely to be malignant were also identified by the nurses, and no melanoma was missed. The sensitivity of the clinical examinations conducted by the trained nurses was 95%, and the specificity was 84%. In the same study, the surgeon's work was reduced by an estimated 70%.

Mikkilineni et al. [46] evaluated the effect of a training course for first-aid workers. They found an increase in knowledge and an increased ability to differentiate between lesions and to make a precise diagnosis of skin cancer. The training also strengthened the professionals' confidence in their diagnosis.

A study conducted in 17 national insurance health centres in France showed a clear increase in the sensitivity and specificity of clinical diagnosis by trained as compared with untrained general practitioners [50].
Edmondson et al. [48] showed that taking a photograph during a clinical examination by a doctor increased the number of lesions diagnosed and had a reassuring effect for 59% of persons being examined.

Increase in number of skin cancers detected and reduction in melanoma thickness and mortality rate: Diffusion of information by the media can increase the number of patients seen each day by general practitioners or hospital doctors for a skin lesion [42]. It can also increase the number of tumour samples sent to anatomo-pathology laboratory (an additional 20% in the study of Theobald et al. [37]).

Six studies showed a considerable increase in the number of melanomas diagnosed after the campaign and a tendency towards a reduction in tumour thickness [36,39,40,42,44,47]. A significant decrease in the average thickness of melanomas was observed in two studies [36,47]. Other authors divided the thickness into two categories: MacKie and Hole [44] recorded more melanomas of less than 1.5mm, and Theobald et al. [37] registered a greater number of melanomas of less than 0.75mm in the 2 years after the programme. Bonerandi et al. [39], however, found an increase in the number of tumours of less than 1mm and a decrease in the number less than 3mm, but not to a significant extent.

The increase in the number of skin melanomas diagnosed during the months immediately after the campaign varied between 116% and 143% [36,40], and a fairly rapid decrease was noted over time. In one study [40], two screening campaigns doubled the number of melanomas detected over the next 2 months, whereas the increase did not rise above 20% during the subsequent 12 months. The effect on thickness also seemed to fade with time: Theobald et al. [37] found a significant decrease in thickness during the first year and no significant decrease beyond that time.

Solar UV index

The solar UV index (UVI) describes the level of solar UV radiation at the Earth's surface. The values of the index range from zero upwards: the higher the index, the greater the potential damage to the skin and eyes and the less time it takes for harm to occur. The maximum UV radiation is encountered 4 hours around solar noon. Depending on geographical location, solar noon is between local noon and 14:00 h. The UVI is reported for Europe on the internet at: www.ozone.fmi.fi/SUDAMA/

Exposure category	UVI range
Low	< 2
Moderate	3–5
Very high	6–7
Extreme	8–10

From Intersun [51]

Only two studies considered the impact of their programmes on prognosis. Graham-Brown et al. [42] found no marked difference in the prognosis of tumours subsequent to the programme. MacKie et al. [45] noted a decrease in the mortality rate due to melanoma among women after the training of general practitioners and an extensive media campaign within a mass screening programme in Scotland. An Italian study estimated that 22 lives had been saved between 1977 and 1985 (74 deaths expected and 52 observed) in the region of Trentino, after a screening programme that included an educational campaign on early diagnosis for doctors and the general public [41].

Missing information and research topics

The quality of most of these programmes for primary prevention of skin cancer was not evaluated (see chapter on Evaluating cancer prevention activities). Nevertheless, like other prevention models, these initiatives improved knowledge about the determining factors of skin cancer and attitudes to protection. The incidence of skin melanoma in areas where intensive programmes have been implemented (Australia, Scandinavia and the United Kingdom) is decreasing in the youngest cohorts, particularly among women (see figure 1). Incidence rates are, however, influenced by two contradictory phenomena: an increase due to early detection, and particularly screening, and a decrease due to primary prevention. We still need effective, long-lasting, comprehensive prevention campaigns that include not only adequate information and educational programmes but also training of health professionals and lobbying of the media and politicians. Such campaigns must include an evaluation protocol.

In neither the programmes to increase awareness about early symptoms nor in the screening campaigns was the cost of the interventions measured. The numbers of false-negative and false-positive results, which increase the numbers of consultations and biopsies, and the cost of over-diagnosis (detection of tumours that would not have become invasive, metastatic types) were not evaluated, although some attempts were made to measure financial costs [39,41].

In biological research, new tools are needed to identify high-risk individuals, by either phenotype or genotype. Better knowledge about the biological effects of various times and doses, the mechanisms of natural photoprotection and how such mechanisms can be modified are other important fields of research.

Conclusions and recommendations

The evidence summarized in this review indicates that a faster, more efficient impact could be obtained by improving awareness about early diagnosis. On the basis of the experience of Australia, the incidence of skin cancer could be reduced by comprehensive preventive interventions, directed at children and adolescents. Long-term strategies are required to change people's habits with regard to exposure to the sun and the current social view that associates a tan with good health. Cooperation of medical, governmental and non-governmental organizations is necessary to implement far-reaching educational strategies [52].

The actions that NGOs can promote are:

Awareness about early diagnosis

- educating individuals about skin self-examination (early symptoms);

Key recommendations

Too much sun is dangerous, no matter what your age or skin colour, but:

For high-risk skins:

1. Babies must never be exposed to UV radiation, and children must be well protected.
2. People with fair skins or reddish hair are particularly sensitive and must use adequate protection.
3. Sunscreens protect from sunburn but do not give adequate protection for a longer stay in the sun.
4. Some people cannot tan and only burn; they must accept that.

For those who tan:

5. Exposure should be adjusted to the solar radiation index values given by weather forecasters, and the zenith time (12:00 h to 16:00 h in Europe) should be avoided.
6. Being tanned does not provide complete protection.
7. The best sun protection is shade or clothes; clouds are not a good screen.

Essential knowledge:

8. The negative effects of UV radiation are cumulative during life.
9. The higher the altitude, the more the sun burns the skin, and reflection of UV radiation by sand, water or snow increases the intensity of exposure.
10. Artificial UV radiation is also dangerous, and its use should be carefully controlled.
11. Some drugs and perfumes can create secondary effects (e.g., allergy, burning) with exposure to UV radiation. A doctor should be consulted before such products are used and when exposure to UV radiation is expected.

UV radiation index, skin type and protection

UV index	Phenotype	Protection Sunglasses*	Hat	Tee-shirt	Umbrella	Sunscreen (SPF)
11+	I, II			No exposure at all		
	III	Yes	Yes	Yes	–	30
	IV, V	Yes	Yes	Yes	–	30
8–10	I, II	Yes	Yes	Yes	Yes	30
	III	Yes	Yes	Yes	–	30
	IV, V	Yes	Yes	–	–	15
3–7	I, II	Yes	Yes	Yes	–	30
	III	Yes	Yes	–	–	15
	IV, V	Yes	–	–	–	15
1–2	I, II	Yes	Yes	–	–	15
	III	Yes	–	–	–	15

*Containing UVB and UVA filters

- training in early diagnosis for general practitioners, nurses and all health professionals who examine people's skin;
- encouraging other professionals, such as hairdressers, aestheticians and physical activity teachers, to advise their clients or students to consult a doctor; and
- providing tools for the education and training of various target groups.

Reducing exposure to the sun

- Avoidance of the sun during childhood has a greater effect in reducing health risk than sun protection during adulthood.

NGOs could disseminate valid, adapted information to appropriate target groups, about:

- the risks of exposure to UV radiation;
- high-risk populations (e.g., children, people with sensitive skin),
- variations in the intensity of UV radiation, by geographical region, altitude, season, hour of the day and length of exposure; and
- protective means (e.g., parasols, hats, special clothes, sunscreens, sunglasses).

NGOs could facilitate education in schools by providing paedagogic tools.

NGOs could lobby for collective protection by demanding:

- shaded areas on school grounds, at work places, in public outdoor places (beaches, swimming pools, stadiums, racetracks);
- low prices for protective devices; and
- legislation to establish standards for apparatus used for artificial UV delivery, either for lighting or for tanning (sun lamps and sun-beds).

Funding

- Well-organized communication campaigns, including an evaluation protocol, for either primary prevention or early detection
- Scientific research projects on determinants of behaviour, mechanisms of UV carcinogenesis, role of genetic factors, role of melanin production.

Measures and desired outcomes in skin cancer prevention

Measure	Desired outcome
Training	
Creating education tools (guidelines, school programmes)	Increased individual knowledge and awareness about harmful skin lesions
Programmes for early diagnosis for health professionals (general practitioners, nurses)	Increase performance of professionals; decrease mortality
Information and communication	
Disseminating evidence-based information on health effects of UV; use of UV index, focussing on young people	Increase efficacy of prevention Modify attitudes and behaviour of young people
Evaluating the impact incidence rate	Decrease in skin cancer
Advocacy and lobbying	
Contacting media, politicians, decision-makers, industries	Provide shade in public places; legislation on prices of protective devices and solaria; protection of outdoor workers
Health professionals	Motivate for counselling and early diagnosis
Cosmetic and fashion industries	Validated advertisements for sunscreens, sunglasses, tanning aids
Funding	
Mass media campaigns	Modify behaviour; increase early diagnosis
Coordination of funding sources and policy development to create educational tools	Modify behaviour
Epidemiological monitoring	Affect incidence trends
Research	Increase knowledge about high-risk populations; mechanism of UV carcinogenesis; specific protective devices; treatment

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