- Danish National Board of Health (Sundhedsstyrelsen)
- Finnish Radiation and Nuclear Safety Authority (Säteilyturvakeskus, STUK)
- Icelandic Radiation Protection Institute (Geislavarnir Rikisins)
- Norwegian Radiation Protection Authority (Statens strålevern)
- Swedish Radiation Protection Authority (Statens strålskyddsinstitut)

UV-Radiation of Sun beds

Common public health advice from Nordic radiation protection and health authorities

The incidence of skin cancers is steadily increasing in the Nordic countries. Young people from 16 to 24 years of age are among the most prevalent users of sun beds. In addition, children and adolescents may be the age groups expected to be the most susceptible to the harmful effects of UV. Ultraviolet (UV) radiation is a known main risk for the development of skin cancers like basalioma (BCC), squamous cell cancer (SCC) and the most lethal skin cancer, the malignant melanoma (MM). Even though the main source of UV exposure for a majority of the population is the sun, the artificial tanning from sun beds contributes significantly to the total UV risk, especially for those who regularly use sun beds.

The use of tanning appliances is an intentional and aggressive intermittent UV exposure of the skin. Compliance of a sun bed with the essential safety requirements of the Low Voltage Directive can be shown by fulfilling the technical requirements of the European standard EN 60335-2-27, intended to cover also the UV risks[1]. In addition, some countries do have national regulations. In a recent opinion, the European Commission has stated that standard EN 60335-2-27 in its present form does not cover all the safety requirements of the Low Voltage Directive. The standard allows too high irradiances, far exceeding the irradiance of the tropical sun.

In order to achieve better harmonization of national regulations, without impairing good radiation protection already achieved by many countries in Europe, the Nordic health and radiation protection

[1] The LVD and the corresponding European standard for sun tanning devices do not sufficiently cover health aspects such as long term cancer risk.

authorities envisage that the Commission will start to prepare a Council recommendation as soon as possible, laying down the most significant UV-protection guidelines for sun beds.

Nordic advice

The main objectives of sun bed harmonisation should be to improve radiation protection of groups at risk and promote good control of UV doses and dose rates (irradiance) received by users. It is therefore prudent to keep the intensity and spectral distribution of artificial UV reasonably close to the levels of solar UV exposures.

General advice

1. There is no evidence to suggest that any type of sun bed is less harmful than natural sun exposure. Since the exposure to UV-radiation in general should be restricted, the use of sun beds for tanning or other non-medical purposes is not advisable. Young persons below 18 years and UV sensitive people (skin type I – II) are strongly advised not to use sun beds.

Specific advice for use

2. If sun beds are used, it is necessary to keep the annual UV dose low and to provide users with all information necessary to minimize skin damage and other health hazards.

3. It is important that the operators of sun beds and tanning facilities have sufficient knowledge of UV safety in order to help their customers minimize personal risk and avoid misuse of the tanning appliance. Because of the importance of personal advice and supervision, unattended sun beds and tanning facilities should be avoided by the consumers.

Specific advice for standardization bodies and manufacturers

4. The erythemally effective irradiance of a sun bed used for tanning purposes must not exceed the irradiance of the tropical sun and the spectral distribution of the radiation should not differ too much from the tropical sun. The irradiance and spectral distribution should be in accordance with UV type 3 appliances specified in the current standard EN-60335-2-27.

5. Spectral characteristics (UV-A, UV-B) and power levels of sun bed products vary significantly. In order to facilitate the choice of a specific product type and the field surveillance of sun beds by national health and radiation protection authorities, the different UV types should be clearly labelled and replaceable lamps clearly identifiable.

Rationale for the advice is given in Appendix 1 and health effects associated with the use of sun beds are discussed in Appendix 2.

More detailed safety precautions can be found in the recent recommendations presented by the World Health Organization (WHO 2003) and International Commission on Non-Ionizing Radiation Protection (ICNIRP 2003).

APPENDIX 1

Rationale for the advice (numbered in the same order)

1. EUROSKIN, ICNIRP, and the WHO do not recommend the use of ultraviolet (UV) appliances for tanning or other non-medical purposes. Adolescence and early adulthood appear to be among the most sensitive age periods for the effects of sunburn and sun bed use on melanoma risk (Veieröd et al. 2003). Persons unable to tan at all or unable to tan without burning when exposed to the sun, should avoid tanning and therefore not use UV appliances. This includes persons with skin types I and II[2]. Among these usually are persons with a natural red or blonde hair colour. Hair color is a better predictor for sun sensitivity and melanoma risk than self-perceived skin-type (Veieröd et al. 2003). The risk is highest for persons with red hair color.

2. Tanning per se always implies damage to cellular DNA in the skin with unpredictable long-term consequences. As a precaution, it is wise to reduce yearly doses as much as possible. Some epidemiological studies indicate an increased risk of malignant melanoma if a person has more than 10 sessions in a solarium per year (e.g. Westerdahl et al. 1994). However, based on the current data it is not possible to establish a precise limitation of exposure. It is important to try to change attitudes to tanning in order to limit all unnecessary UV exposure. However, an outright prohibition of sun beds should not be necessary.

3. As people may continue to want to use sun beds to acquire a cosmetic tan, there should be staff attended tanning facilities with properly-trained personnel and equipment that meets regulations. A considerable number of sun beds are used in non-attended situations including private homes, fitness clubs, swimming pools, and so forth, where trained personnel or even any personnel are unavailable. In these situations it is difficult to stop young people using the appliances and to ensure that people have understood the safety instructions and exposure schedules.

4. People in Northern Europe are accustomed to relatively weak solar UV levels in their countries. However, on their holidays they may also be exposed to stronger solar UV levels at more southern latitudes, reaching maximum levels around the equator. The erythemally effective irradiance in these tropical regions is typically twice as high as in the Nordic countries and of the order of 12 in terms of the global solar UV index. Extreme caution is necessary to avoid skin damage at such high solar UV levels. Therefore, this index value can be used as a guide value to set the upper limit of attended tanning facilities where the customer may get competent guidance. Higher UV irradiance levels from artificial tanning devices are not, under any circumstances, justifiable for the sole purpose of quick cosmetic tanning and will only increase the risk of skin

[2] People with pale or freckled skin, fair or red hair and blue eyes belong to skin types I and II. People with skin type I always burn in the sun and seldom tan after having been in the sun. People with skin type II usually burn in the sun and sometimes tan after having been in the sun.

damage as a consequence of small errors or misjudgements which are human or technical in origin.

5. In addition to the irradiance limitation, the spectrum of sun bed exposures should not deviate too much from the solar spectrum. In solar radiation about 80 percent of the erythemally effective irradiance is in the spectral range below 320 nm and 20 percent above 320 nm. As the relative importance of UV-B and UV-A for melanoma skin cancer is still unknown, it is necessary to retain a UV-type classification system using a short- and longwave UV band and to label tanning appliances accordingly to inform of their different spectral and UV-power levels. In artificial tanning, adequate spectral balance is retained by a UV type 3 sun bed as specified by the standard EN 60335-2-27.

UV emissions from below the natural ozone spectral cut-off of solar UV at 290 nm should be restricted to a negligible level[3]. This fraction below 290 nm of the spectrum is not useful for tanning.

[3] UV-radiation from emissions at wavelengths below 290 nm must be less than 1 percent of the total erythemal irradiance. At short UV-wavelengths, UV-radiation is significantly attenuated by the plastic sheet covering the UV emitting lamps. This attenuation cannot be taken into account in specifying characteristic data for a lamp and consequently total irradiance may increase unexpectedly when the lamps are replaced despite having the same equivalency data

APPENDIX 2

Biological effects associated with UV-exposure and artificial tanning

National surveys in Europe have indicated that 9-16 % of people use tanning appliances (sun beds), but usage among critical age groups can be much higher, 30 % or more among urban teenagers and young adults (Westerdahl et al. 1994; Brandberg et al. 1998; Boldemann et al. 1997; Boldemann et al. 2001, Jalarvo V. 2000). In Sweden, Finland and Norway the heaviest users are young adults (20-24 years old) and in Iceland approximately 50 % of people in the 16-24 years old age group use sun beds each year. In this context, it is interesting to note that in Iceland the melanoma incidence has sharply rised over recent years (Figure 1). In Denmark in 2004 more than half of both the 18-24 year old and the 25-39 year old have been using sun beds during the past two years.

Developments in artificial tanning technology do not look promising from the perspective of the health of the general population. An increase of ultraviolet (UV) emissions of lamps and the development of automatic unattended tanning facilities, have created new opportunities for the tanning industry and sun bed operators to increase the number of customers (Greinert et al. 2004). The Nordic countries represent a relatively large part, ca. 10 % (Wester et al. 1999) of the sun bed market, proportionally more than in other industrial countries. Additionally, at northern latitudes the solar radiation is weaker than in more tropical parts of the world. Consequently the relative contribution of sun beds to total UV doses is greater.

Among the biological effects of exposure to UV radiation are acute effects such as production of erythema, thickening of the epidermis (outer layer of the skin), DNA damage, suppression of several immune responses, damage to the cornea and conjunctiva of the eye, darkening of the skin and vitamin D synthesis. Long term effects are: increased risk of skin cancer, skin aging and cataract.

Solar radiation is a main risk for the development of skin cancer due to its UV radiation. The International Agency for Research of Cancer (IARC) has classified solar radiation as a group 1 carcinogen, which means that there is sufficient evidence in humans of the carcinogenic effects of broadband optical radiation emitted by the sun. Radiation from sun lamps and sun beds is, in addition to UV-A, UV-B and UV-C, classified as group 2A – “probably carcinogenic” (IARC 1992). There is still limited evidence for the carcinogenic effects of exposure to UV from sun beds and lamps because it is difficult to distinguish the skin cancers attributable to sun beds from the cancers caused by exposure from the sun. It has been estimated that in the United Kingdom, sun beds increase the mortality to malignant melanoma by about 6 % in the whole population, while the melanoma mortality related to solar exposure is about 80 % of all melanoma cases (Diffey 2003).

For sun beds, the epidemiological evidence on the increased skin cancer risk is growing, but still somewhat equivocal. Research in the United States has shown that people who have used artificial tanning devices are more likely to develop certain kinds of skin cancer than those who have never visited a solarium. The risks appear to be greatest for the young, with the chances of developing a tumour increasing by up to 20 % per decade of sun bed use before the age of 56 (Karagas et al. 2002). People who reported use of sunlamps were 2.5 times more likely to develop squamous cell

carcinoma than those who never used the devices. The risk of basal cell carcinoma increased 1.5 times with sun bed use.

The most critical question is the role of sun beds in continuously increasing incidence of melanoma (Figure 1) and other skin cancers (Figure 2), but the incidence data itself does not provide data on association with the use of sun beds. Although some studies have shown an association and some have not, there are strong reasons to effectively prohibit the use of tanning devices by people under 18 years of age (Young 2004). The epidemiological studies conducted thus far, however, have some significant methodological limitations to conclusively show in the population level, the cancer risk associated with sun beds. Most studies are case-control studies where the exposure assessment is based on queries of personal sun bed use where the cases (people who have contracted a skin cancer) may easily overestimate their exposure. Also, the potential role of sun-bed burns has not been assessed in several of these studies. Additionally, in earlier studies, the use of modern sun beds which arrived on the market in the 1980s may have not been sufficient long for the detection of an increased risk of cancer. However, several of these studies indicate an increased risk when using sun beds. Many of the methodological shortcomings of case control studies are avoided in a recent, well–conducted, very large Scandinavian prospective cohort study of 106 000 women where relative risk factors for melanoma varying from 1.4 to 2.3 were reported for those females in Norway and Sweden who used a sun bed more than once a month (Veieröd et al. 2003). It must be noted that this study is the only cohort study published so far and cannot solely form the basis for an evidence-based recommendation. However, the study seems to support the results of earlier studies, that adolescence and early adulthood age groups appear to be among the most sensitive age periods where sunburns and solarium use increase melanoma risk.

There is strong evidence from cell studies *in vitro* and animal experiments *in vivo* that artificial UV exposures increase the risk of skin cancer. It has been well established that chronic exposure to both short wavelength UV-B (280 -315 nm) and long wavelength UV-A (315-400nm) from various types of UV sources cause squamous cell carcinoma in mice (Gruijl et al. 1993). Also, induction of malignant melanoma, the most lethal form of skin cancer, has been observed in some animal studies, but it may be too early to say that the evidence is sufficient to draw firm conclusions. This is mainly due to the lack of good animal models.

Technically, tanning devices can emit long and shortwave ultraviolet radiation (UV-A, UV-B, and even UV-C) of all the various spectral distributions and power levels. The relative importance of UV-B and UV-A is well known for erythema and roughly also for squamous cell carcinoma, but the role of spectral distribution still remains to be determined for the malignant melanoma. Although the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2004) recently noted that the weight of current evidence suggests that UV-B is the primary risk factor for melanoma, there is accumulating data that suggests a potential role for UV-A in the pathogenesis of this disease (Pastila and Leszczynski, 2005). With the present level of knowledge, it is prudent to keep the artificial UV exposure in the spectral balance, not favouring either UV-A or UV-B. Therefore, it is essential to distinguish by clear labelling and categorization, different tanning devices on the basis of total UV irradiance and its distribution to UV-A and UV-B ranges.

During sun bed sessions, the total dose must be limited below the erythemal threshold. Too high dose rates increase the likelihood of burns due to misuse. Overexposures resulting in smarting redness are common (Boldemann et al. 2001). In addition, drug-induced photosensitivity may occur following high levels of either UV-A or UV-B exposure, and phototoxic reactions may result even for

commonly used pharmaceuticals. The development of extremely powerful sun beds with up to twice the UV levels of the natural tropical sun or more is likely to greatly increase severe health problems.

Dose rates that are too high should be avoided also because it is not known for certain whether the effects of the same UV dose, delivered with higher irradiance, are more dangerous. In general, the reciprocity law (or Bunsen-Roscoe law in photochemistry) holds true only for primary photochemical action, and *does not apply* to the end points observed in photobiology, such as erythema, pigmentation, and skin cancer, which are all indirect effects (Kohen et al. 1995).

There is also a beneficial health effect from exposure to UV. Vitamin D is synthesized in the skin from short UV-B exposures to hands and face in summer sunlight, but this can also be nutritionally supplied. Sun bed exposures are not recommended for Vitamin D synthesis because of a higher content of UV-A, which is not effective for that purpose. Additionally, high doses over the whole skin area are not useful due to the saturation of Vitamin D production.

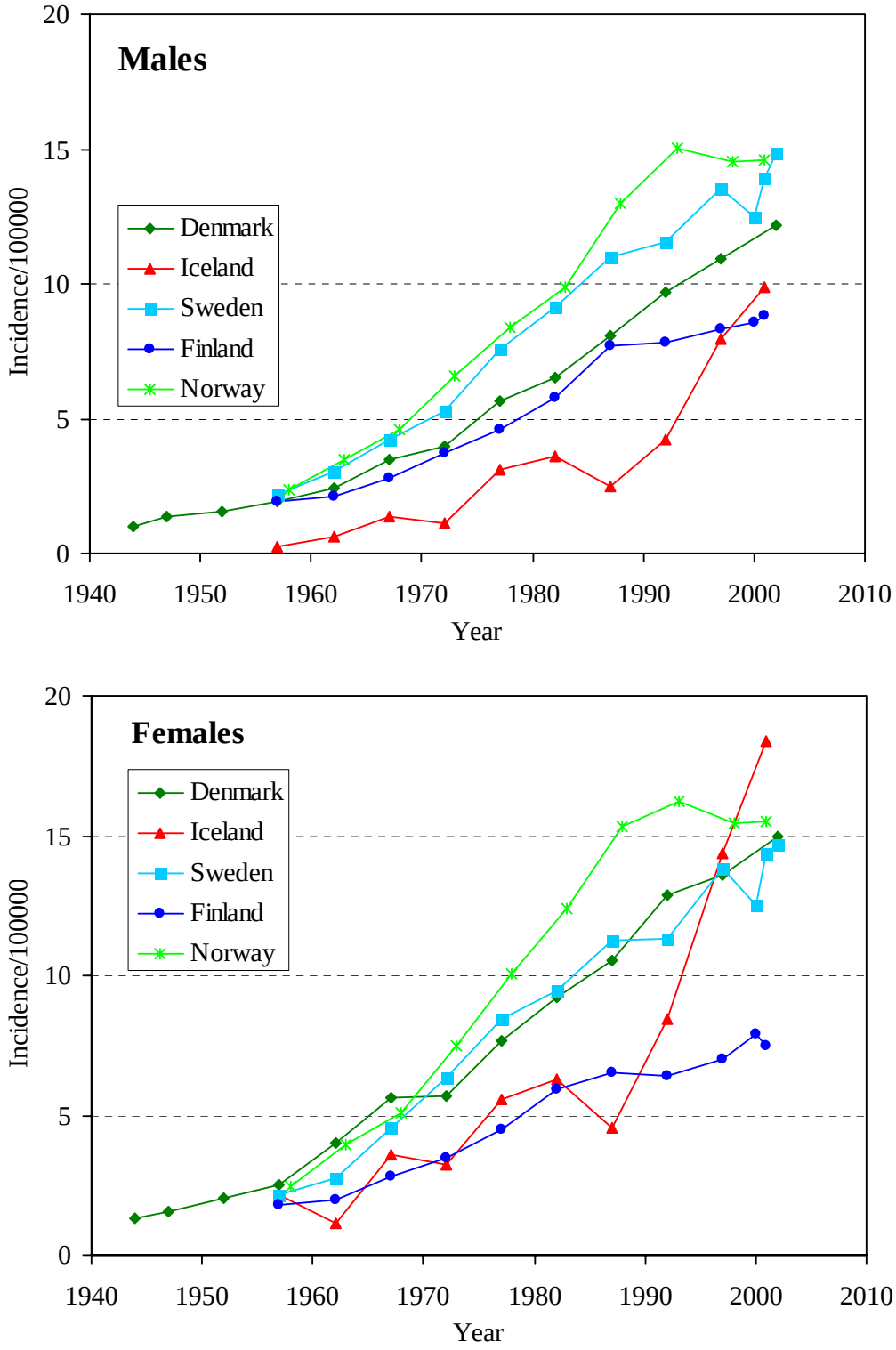

Figure 1. Melanoma incidence in Nordic countries, age standardised according to the WHO-world population.

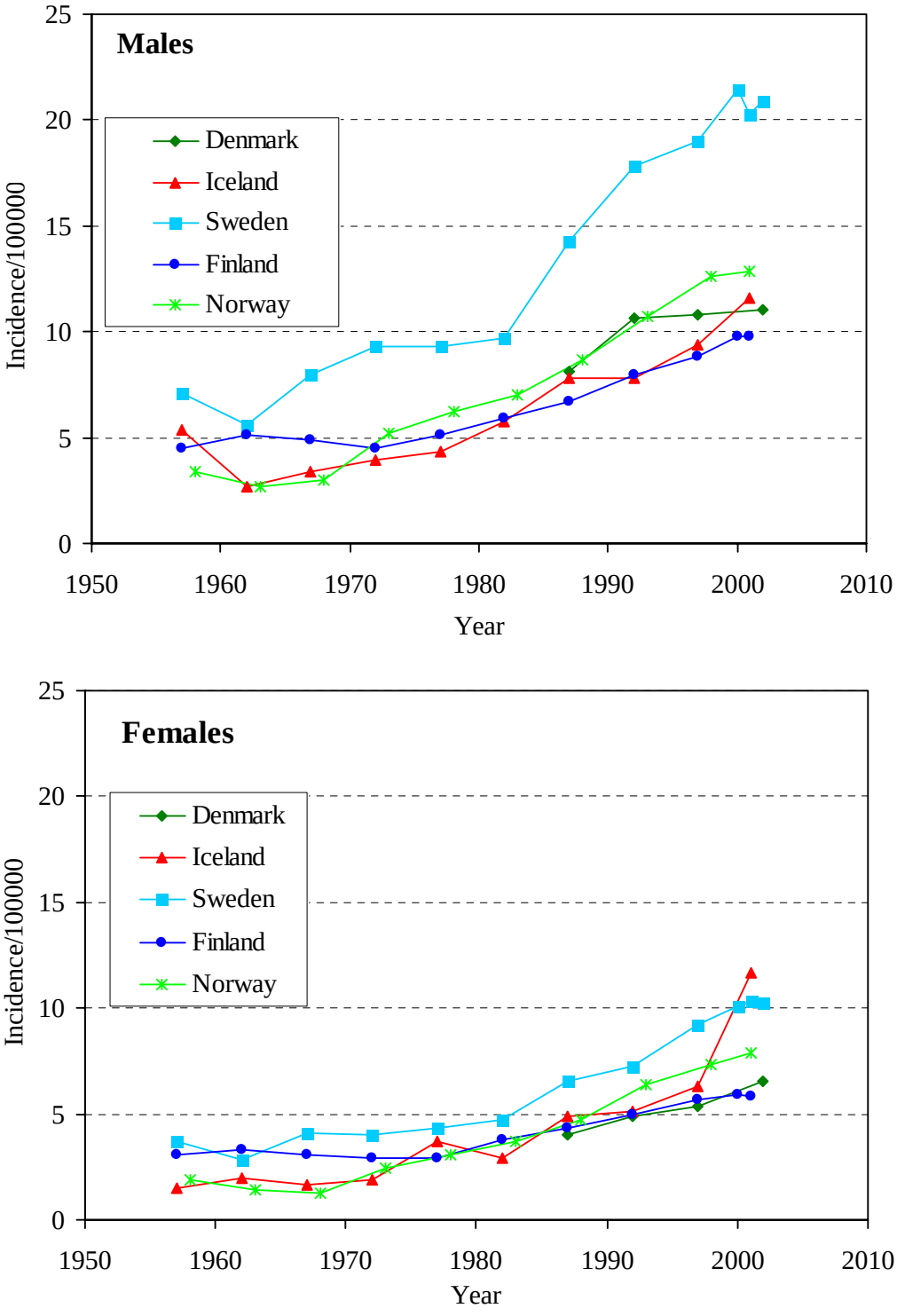

Figure 2. Non-melanoma skin cancer (excluding basaliomas) incidence in Nordic countries, age standardised according to the WHO-world population.

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