

Primary Skin Cancer Prevention – Global and Local Initiatives

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ABSTRACT

The occurrence of skin cancer is on the rise in many parts of the world. The World Health Organization has identified nine diseases caused by ultraviolet radiation (UVR) exposure, three of which are skin cancers. High levels of UVR exposure increase the risk of all three forms of skin cancer. Two types of UVR reach the earth: UVA and UVB. UVA penetrates deeper into the skin than UVB and causes premature skin aging and interferes with the human immune system. UVB is likely to be the main cause of sunburn and causes damage at the molecular level to deoxyribonucleic acid (DNA). This damage plays a central role in the development of melanoma. Children are at high risk of damage from UVR exposure because their skin is thinner and more sensitive. Epidemiological studies demonstrate that sunburn and frequent sun exposure during childhood is a risk factor for skin cancer. A substantial percentage of lifetime UV exposure occurs during childhood and adolescence due to more opportunities and more time for exposure. Special subgroups, such as outdoor workers, also receive intense and prolonged UVR exposure throughout their lives. Limiting sun exposure and practicing “sun intelligent behaviour” is an important public health issue to slow down the trend towards increased occurrence of skin cancer. Further research is required to “illuminate” the complex topic of natural and artificial UVR and its health effects on humans.

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Background

The World Health Organization (WHO, 2006) has identified nine diseases caused by ultraviolet radiation (UVR) exposure: eye diseases (three different forms, including cataracts), photo-aging, sunburn, reactivation of herpes simplex virus of the lip, and skin cancers (malignant melanoma and two forms of non-melanoma skin cancers).

Three of the nine assessed diseases were skin cancers (malignant melanoma and non-melanoma skin cancers). The others were eye diseases, photo-aging, sunburn, and reactivation of herpes simplex virus of the lip.

High levels of UVR exposure increase the risk of all three forms of skin cancer. Between 65% and 90% of malignant melanomas – the skin cancer with the highest risk for mortality - are caused by UVR exposure (Armstrong & Kricger, 1993).

This “global disease burden from solar ultraviolet radiation” (Lucas, McMichael, Smith, & Armstrong, 2006, p. 1) can be prevented by reducing sun exposure and promoting a series of simple sun prevention measures. Global and local projects, initiatives, studies and sun-awareness campaigns are being developed and delivered in various countries worldwide to slow down the trend towards increasing skin cancers.

Epidemiologic Features of Skin Cancer

Skin cancer is the most commonly diagnosed cancer in the United States (Greenlee, Murray, Bolden & Wingo, 2000). WHO estimates that up to 60,000 premature deaths a year worldwide are caused by UVR exposure (WHO, 2006).

The American Cancer Society (ACS, 2007) estimated about 59,940 new cases of melanoma in 2007 with about 8,110 resulting in death. Australia has the highest incidence and mortality rates for skin cancer in the world (Carter, Marks & Hill, 1999). In Germany, since the 1970s, incidence rates of skin cancer have been rising. In 2000, the incidence was about 12 per 100,000. Mortality of malignant melanoma was 2.6 per 100,000 for men and 1.6 per 100,000 for women. In addition, German skin cancer statistics showed that the risk, especially of non-melanoma skin cancers, increases with age and lifelong dose of UVR exposure (Robert Koch-Institut & Statistisches Bundesamt, 2004).

Epidemiologic Data Problem in Europe

In 1989 the European Network of Cancer Registries (ENCR) was established within the framework of the Europe against Cancer programme of the European Commission. One of the objectives of ENCR was to provide regular information about cancer in the European Union, but ENCR activities have been interrupted. Thus, only estimates of the incidence and mortality from cancer at a European level (Ferlay, Autier, Boniol, Heanue, Colombet, & Boyle, 2006) can be extracted from the GLOBOCAN 2002 database, national cancer registry websites or annual reports and predicted rates. The GLOBOCAN database has been built up using data available in the International Agency for Research on Cancer (IARC). IARC is part of the WHO.

UV Radiation (UVR) and the Solar Spectrum

The sun radiates energy in a wide range of wavelengths: UVR, visible light and infrared light.

Visible light is visible to human eyes, and infrared light is warm to human skin, but UVR is a portion of the solar spectrum that cannot be felt.

The International Commission on Illumination defines UVR as optical radiation between 100 nm and 400 nm and divides UVR into three bands of wavelength:

- UVC - Radiation at a wavelength of 100-280 nm
- UVB - Radiation at a wavelength of 280-315 nm
- UVA - Radiation at a wavelength of 315-400 nm

The shorter the wavelength, the more energetic is the UVR and the greater the potential for harm. UVC is the shortest and most energetic portion of the UV spectrum but UVC is totally absorbed by the ozone layer and not reach the earth's surface in quantity. Thus, UVC exposure is unlikely to cause acute or long-term damage to human skin. UVB is absorbed 90% or more by the atmospheric ozone layer (Roy, et al. 1998). UVA is not absorbed by the ozone layer.

Health Effects of UVA and UVB

Two types of UVR reach the earth: UVA and UVB. UVA penetrates deeper into the skin than UVB and causes premature skin aging and interferes with the human immune system. UVB is likely to be the main cause of sunburn and causes damage at the molecular level to the deoxyribonucleic acid (DNA) and this damage plays a central role in the development of melanoma (Gilchrest, Eller, Geller, & Yaar, 1999).

Many studies demonstrated the evidence of harm associated with overexposure to UVA and UVB but nevertheless "sufficient amount" of UVR exposure is essential for the synthesis of vitamin D which is essential for musculoskeletal health (Vieth, 2005). The question of sufficient exposure to maintain adequate vitamin D levels cannot clearly be answered, but strict sun protection causes vitamin D deficiency in risk groups (Holick, 2005).

Individual Vulnerability

Although anyone can get skin cancer, individuals differ in susceptibility. The scientific literature discusses the following factors:

- Individual and genetic factors (e.g. age, sex, skin types for UVR sensitivity, a family history of skin cancer, lifetime, critical life stage of exposure)
- Socioeconomic factors (education, income, marital status, body mass index)

- Cultural and behavioural factors (leisure time, outdoor recreational habits, sun-seeking or sun-protective behaviours, fashion trends promoting tanned skin, dress behaviours, migration of people)
- Environmental factors (stratospheric ozone levels, presence of clouds, latitude, season, time of day, atmospheric pollution, materials reflecting the sun)

Children are at high risk of suffering damage from UVR exposure because their skin is thinner and they are more sensitive. Epidemiological studies demonstrate that sunburn and frequent sun exposure during childhood is a risk factor for skin cancer (Whiteman, Whiteman, & Green, 2001). Several studies have documented that a history of sunburn in early life (critical life stage of exposure) nearly doubles the risk of developing malignant melanoma in adulthood (Naldi et al., 2000). A substantial percentage of lifetime UV exposure occurs during childhood and adolescence due to more opportunities and more time for exposure (Marks, 1988; Stern, Weinstein, & Baker, 1986). Special subgroups, such as outdoor workers, receive intense and prolonged UVR exposure throughout their lives (Glanz, Buller, & Saraiya, 2007).

Fair-skinned individuals are at high risk (skin types I and II) for skin damage and incidence of skin cancer. Fitzpatrick's Classification of Skin Types (Table 1) is used for classification of individual sun sensitivity. The lowest risk being in skin types V and VI.

Risk of melanoma is higher in individuals with larger numbers of moles (Armstrong, 1997). A changing or atypical mole is defined as a mole showing asymmetry (when half of the mole does not match the other half) with irregular border edges, variable pigmentation or colour, and a size of ≥ 5 mm in diameter. The ABCDs (asymmetry, border, colour, diameters) provide a guide for distinguishing moles from melanoma (Rager, Bridgeford, & Ollila, 2005). The risk for melanoma increases if there is a family history of melanoma (Kefford, 1999).

The risk of non-melanoma skin cancer increases with age and lifelong dose of UV radiation.

This point is important to note as one focuses on demographic development in the future.

There is a controversial discussion about socioeconomic factors (education, income, marital status, body mass index) and also about gender-specific differences and sun exposure. Garbe and Buettner (2000) found that sun safety is less normative for men than women. Men prefer hats, and women sunscreen. Thieden (2008) explored sun exposure among subgroups of the Danish population

and did not find significant differences in annual UVR dose between males and females in the total population. However, among children, “girls received a significantly higher UVR dose than boys due to more days with risk behaviour” and “the Exposure pattern, with women having more UVR peak days than men, was also found among adolescents and adults” (Thieden, 2008, p. 63).

Cultural and behavioural factors (leisure time, outdoor recreational habits, sun-seeking or sun-protective behaviours, fashion trends promoting tanned skin, dress behaviours, migration of people) are important with respect to sun exposure behaviour. Sunbathing and tanning habits established during the 1990s reflect the increased availability of leisure time and fashion trends promoting tanned skin.

Recent reports indicate that many people like sunbathing and tanning because they feel healthier with a tan and believe that suntanned skin is more attractive (Buller, Callister & Reichert, 1995). Users of commercial sunbeds are potentially overexposed (Miller, Hamilton, Wester, & Cyr, 1998). Gallagher, Spinelli, and Lee (2005) carried out a meta-analysis of nine case-control studies and one cohort study and came to the conclusion that sunbed use significantly increased the risk of melanoma.

There is a discussion if the increased incidence of melanoma is a result of “overdiagnosis” of earlier detection of melanoma (Jemal, Devesa, Hartge, & Tucker, 2001; Welch, Woloshin, & Schwartz, 2005) or if it is real, due to environmental factors like ozone depletion. “There is scientific evidence that stratospheric ozone concentration has declined over the Northern Hemisphere in the past 20 years” (Urbach, 1991, p. 175). Human-made chemicals like chlorofluorocarbons (CFCs) thin the stratospheric ozone layer. Although it is not clear how UV levels at earth’s surface have changed, estimates have been made that for 1 % decrease in stratospheric ozone, the biologically effective UVR could increase by 1.5% to 3 % (Moan, Dahlback, Larsen, Henriksen, & Starnes, 1989). In many populations, increases in melanoma incidence and mortality have been observed for up to five decades, especially among elderly men (De Vries, Bray, Coebergh, & Parkin, 2003).

National and International Study Results and Recommendations

Solar protection is a relatively new area, but nevertheless, we find national and international literature of the past 20 years dealing with sun protection interventions. The interventions cited in the literature often intend to increase knowledge and awareness for reducing UVR exposure and achieving life-style changes. The question as to whether this

literature provides evidence of effectiveness through education and policy interventions cannot be answered definitively.

Study results often reveal an increase of knowledge about sun exposure, but also reveal a failure of increasing motivation and compliance in behaviour changes (Lowe et al., 2000). McLean and Gallagher (1998) have shown that in 1992 only 53% of adults in the United States were “very likely” to protect themselves from the sun. Pagoto, McChargue, and Fuqua (2003) examined the efficacy of a multi-component intervention that targeted sun protection motivation and behaviour among beachgoers. Results revealed that the intervention significantly impacted sun protection behaviour, but not sun exposure behaviour. Interventions that increase personal susceptibility to skin cancer risk via sun protection education with melanoma patients (Robinson & Rademaker, 1995), or the use of photography that illuminates skin damage from ultraviolet radiation have shown potential to enhance sun protection behaviour (Weinstock & Rossi, 1998). A systematic evidence review from Glanz, Buller, and Saraiya (2007) summarizes the effectiveness of interventions to reduce UVR exposure among outdoor workers.

In current discussions of sun protection interventions, a systematic review from Saraiya et al. (2004) concluded that educational and policy approaches to increase sun-safe behaviours were effective when implemented in primary schools for children and in recreational or tourism settings for adults. There are insufficient data to allow for recommendations for other settings, for media campaigns alone, and for interventions oriented to parents or caregivers of children and community-wide multi-component interventions.

An economic analysis of the SunSmart campaign in Victoria, Australia was done from Carter, Marks, and Hill (1999). This analysis indicated clearly “that primary prevention campaigns in countries such as Australia with increasing mortality rates should continue” (Carter, Marks & Hill, 1999, p. 81). There is consensus that sun exposure advice and sun-safe behaviours should be taught early in life as a part of routine preventive health care (Marks, 1998; Buller & Borland, 1999).

Sun-safe Recommendations and Advise

Recommendations listed below to reduce UVR exposure and practice sun-safe behaviours are based on scientific literature, policy documents, current theories and principles in health education and promotion. The Public Health Portal of the European Union has developed new “pictogrammes” to inform consumers on dangers linked to sun exposure. Any organisation can use them and the pictogrammes can

be downloaded without cost. They are available at: http://ec.europa.eu/health/news/sun_uv_en.htm.

- Limiting or minimizing sun-exposure during midday hours when UVR is at the peak.
- Seek shade especially from (10 a.m. to 4 p.m) (Glanz, Buller, & Saraiya, 2007); (11 a.m. to 3 p.m) (Bundesamt für Strahlenschutz, Task Force, 2004)
- Wearing protective clothing, long pants, long sleeved shirt and a wide-brimmed hat to shade face, ears and neck (Task Force, 2004) and sunglasses
- Wearing sunglasses labelled as UV 400 which blocks all light rays with wavelengths up to 400 nm
- Use broad-spectrum sunscreen with UVA and UVB protection and with sun protection factor (SPF) 15 or higher (International Agency for Research on Cancer)
- Use sunscreen products correctly about 30 minutes before going outdoors and getting any UV exposure. Pay special attention to face, ears and nose. It is important to use sunscreen frequently in sufficient quantities: 35grams, approximately six filled tea spoons of sunscreen products for the whole body of an average-seized adult (The Public Health Portal of the European Union, 2007). Reapply sunscreen frequently, especially after leaving the water. (Bundesamt für Strahlenschutz, 2004).
- Use lip balm with a SPF of 15 or higher
- Avoid sunburn
- Avoid sunlamps and tanning beds (WHO, 2003)
- The European Commission has (EU, 2006) given a mandate to the European standardisation organisation CENELEC to include in its sunbed product safety standard recommendations of a report from the EU's Scientific Committee on Consumer Products (SCCP).
- Avoid direct sun exposure for babies and young children (The Public Health Portal of European Union, 2007)
- Be aware of the global solar UV Index
- Sunscreen alone cannot deliver total protection from UVR – combine all recommendations above (The Public Health Portal of European Union, 2008)

The UV Index (UVI) was developed by WHO, the United Nations Environment Programme, and the World Meteorological Organization. The UVI is a

measure of the intensity of the solar UV rays at the Earth surface on a given day. In many countries the UVI is presented as a part of the weather forecast. The development of the UVI is part of an international effort to raise public awareness of the risk of sun exposure. A higher number means more risk of sun damage. Thus, the numbers 1-2 are low risk; 8-10 are very high risk numbers and 11 and higher numbers represent extreme risk. WHO did not recommend a position of no UVR exposure.

Projects, Campaigns and Initiatives (Examples from the U.K., U.S., Australia and Germany)

A number of projects and sun-awareness campaigns are being developed and delivered in various countries throughout the world. Some of them are listed below:

- California Early Childhood Sun Protection Curriculum. Available at: http://www.dhs.ca.gov/cdic/cpns/skin/image/s/skin_sunproteccurriculum.pdf. Accessed November 5, 2007.
- Cancer Research UK: SunSmart campaign overview. Available at: <http://info.cancerresearchuk.org/healthyliving/sunsmart/aboutsunsmart/?a=5441>. Accessed November 5, 2007.
- Global School Health Initiative. Available at: http://www.who.int/school_youth_health/gshi/en/. Accessed January 5, 2008.
- Guidelines for School Programs to Prevent Skin Cancer. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5104a1.htm>. Accessed November 15, 2007.
- INTERSUN- The World Health Organisations Global UV Project. Available at: <http://www.who.int/uv/intersunprogramme/en/>. Accessed December 3, 2007.
- Mit Heiler Haut durch den Sommer (Germany) – Bundesamt für Strahlenschutz. Folder for children. Available at: <http://www.bfs.de/uv/uv2/Kinderflyer.pdf>. Accessed November 15, 2007.
- “Schatz brennst du?”, “Face the Sun”, “Fit for Sun”, “Sonnenschutz ist kein Kinderkram”, “Holen Sie Ihr Kind aus der Sonne”, “Kind & Sonne”. Campaigns in Germany. Available at: <http://www.unserehaut.de/adp/service/kampagneninfos.html>. Accessed, November, 5, 2007.

- Slip! Slop! Slap! Campaign information available at: <http://en.wikipedia.org/wiki/Slip-Slop-Slap>. Accessed December, 13, 2007.
- Sun Safety for Kids. Available at: <http://sunsafetyforkids.org/>. Accessed, December 5, 2007.
- The SunWise School Program. Available at: <http://epa.gov/sunwise/summary.html>. Accessed November 15, 2007.

Conclusion

Limiting sun exposure and practicing “sun intelligent behaviour” is an important public health issue to slow down the trend towards increased occurrence of skin cancers. Further research is required to “illuminate” the complex topic of natural and artificial UVR and its health effects on humans. WHO proposed that measurement of UVR exposure be in standard erythema dose (SED) units, rather than natural units, e.g. sunburns. There is need to communicate the complex issues and sun-safe advice in a way that is easily understood and targeted on understanding the relationship between individual behaviour and health. Study results and scientific discussion demonstrate that the research process must go on to determine evidence of effectiveness of the interventions. Data about significant improvements in outcomes like behaviour and follow-up times are required; qualifying study reports and study design are necessary; and homogeneity in evaluation methods for interventions are needed. There is a lack of globally available epidemiologic data. Recommendations are based on existing scientific literature, policy documents, national and international organisations contributing to the current discussion, theories and principles in health education and promotion.

Detailed risk group adapted sun exposure recommendations and advices are necessary to avoid diseases of UV overexposure. Preventive skin cancer initiatives and programmes can yield positive effects, if they are initiated early (e.g., in primary schools) for children. Schools, therefore, might be in a position to teach and model healthy behaviours and establish healthy and consistent patterns throughout life.

Health effects of artificial tanning are not yet known because data on the risk of skin cancer associated with artificial UVR sources are few. Implementation of standardization or regulation relating to sunbed use is an urgent public health issue. Cost-effectiveness of primary skin cancer prevention programs must be taken into consideration.

National and International Organisations Contributing to the Discussion

- ADP - Arbeitsgemeinschaft Dermatologische Prävention (Germany). Available at: <http://www.unsererahaut.de>. Accessed February 26, 2008.
- AWMF – Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (Germany). Guidelines Dermatology. Available at: <http://www.uni-duesseldorf.de/AWMF/11/013-049.htm>. Accessed November 17, 2007.
- BfS - Bundesamt für Strahlenschutz (Germany). Available at: <http://www.bfs.de>. Accessed December 13, 2007.
- BZgA - Bundeszentrale für gesundheitliche Aufklärung (Germany). Available at: <http://www.bzga.de>. Accessed December 13, 2007.
- CPSC -Consumer Safety Product Commission. Available at: <http://www.cpsc.gov/>. Accessed January 15, 2008.
- Deutsche Krebsgesellschaft e.V. (Germany). Available at: <http://www.krebsgesellschaft.de>. Accessed November 11, 2007.
- EPA – U.S. Environmental Protection Agency. Available at: <http://www.epa.gov/>. Accessed November 11, 2007.
- ESA - European Sunlight Association. Available at: <http://www.europeansunlight.eu/>. Accessed January 15, 2008.
- EUROSkin – European Society of Skin Cancer Prevention. Available at: <http://www.euroskin.eu>. Accessed December 5, 2007.
- HHS - U.S. Department of Health and Human Services. Healthy People 2010. Available at: <http://www.healthypeople.gov/document/html/>. Accessed January 5, 2008.
- NASD National Skin Cancer Prevention Education Program. Available at: <http://www.cdc.gov/nasd/docs/d000901-d001000/d000983.html>. Accessed December 5, 2007.
- NIEHS - National Institute of Environmental Health Sciences. Available at: <http://www.niehs.nih.gov/>. Accessed January 15, 2008.
- Public Health Portal of the European Union. Available at: <http://ec.europa.eu/health->

eu/news/sun_uv_en.htm. Accessed February 26, 2008.

- RKI – Robert Koch-Institut (Germany). Available at: <http://rki.de>. Accessed February 26, 2008.
- SCCP- Scientific Committee on Consumer Products. Opinion on Biological effects of ultraviolet radiation relevant to health with particular reference to sunbeds for cosmetic purposes. Available at: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_031b.pdf. Accessed February 26, 2008.
- SSK – Strahlenschutzkommission (Germany). Available at: <http://www.ssk.de/>. Accessed February 26, 2008.

- USPSTF - U.S. Preventive Services Task Force. Findings of the Task Force on Community Preventive Services on reducing exposure to ultraviolet light. Available at: <http://www.cdc.gov/MMWR/preview/mmwr.html/rr5215a2.htm>. Accessed December 5, 2007.
- WHO – World Health Organization. Available at: <http://who.int/>. Accessed February 26, 2008

Table 1 – Fitzpatrick’s Classification of Skin Types

Skin Phototype	Sun Sensitivity	Sunburn Susceptibility	Tanning Ability	Classes of Individuals
I	Very sensitive	Always sunburn	No tan	Melano-compromised
II	Moderate sensitive	High	Light tan	Melano-compromised
III	Moderate insensitive	Moderate	Medium tan	Melano-competent
IV	Moderate resistant	Low	Dark tan	Melano-competent
V	Resistant	Very low	Natural brown skin	Melano-protected
VI	Very resistant	Extreme low	Natural black skin	Melano-protected

Source: Aruru, M. & Salmon, J.W. (2007). *US Pharmacist*, 32(4), 33-37.

References

American Cancer Society. Cancer Facts and Figures 2007. Atlanta. Available at: http://www.Cancer.org/downloads/Stt/CAFF2007PW_secured.pdf. Accessed February 25, 2008.

Amstrong, B.K. (1997). Melanoma: childhood or lifelong sun exposure. In: Grob, J.J., Stern, R.S., MacKie, R.M., & Weinstock, W.A., *Blackwell Science: Epidemiology, causes and prevention of skin diseases*. London, pp. 63-66.

Armstrong, B.K., & Kricger, A. (1993). How much melanoma is caused by sun exposure? *Melanoma Research*, 3(6), 395-401.

Aruru, M., & Salmon, J.W. (2007). Indoor tanning: The role of pharmacists in increasing public awareness. *US Pharmacist*, 32(4), 33-37.

Buller, D.B., & Borland, R. (1999). Skin cancer prevention for children: A critical review. *Health Education & Behavior*, 26, 317-343.

Buller, D.B., Callister, M.A., & Reichert, T. (1995). Skin cancer prevention by parents of young children: health information sources, skin cancer

knowledge, and sun-protection practices. *Oncology Nursing Forum*, 22, 1559-1566.

Carter, R., Marks, R., & Hill, D. (1999). Could a national skin cancer primary prevention campaign in Australia be worthwhile? An economic perspective. *Health Promotion International*, 14(1), 73-82.

De Vries, E., Bray, F., Coebergh, J.W.W., & Parkin, D.M. (2003). European network of Cancer Registers. Changing epidemiology of malignant cutaneous melanoma in Europe 1969-1997: Rising trends in incidence and mortality, but recent stabilisations in western Europe and decreases in Scandinavia. *International Journal of Cancer*, 107, 119-126.

Ferlay, J., Autier, P., Boniol, M., Heanue, M., Colombet, M. & Boyle, P. (2006). Estimates of the cancer incidence and mortality in Europe 2006. *Annals of Oncology*, 18, 581-592.

Ferlay, J., Bray, F., Pisani, P., & Parkin, D.M. (2002). GLOBOCAN 2002: Cancer Incidence, Mortality and Prevalence Worldwide. *IARC Cancer Base No.5*, version, IARC Press 2004.

- Gallagher, R.P., Spinelli, J.J., & Lee, T.K. (2005). Tanning beds, sunlamps, and risk of cutaneous malignant melanoma. *Cancer Epidemiology Biomarkers & Prevention*, 14, 562-566.
- Garbe, C., & Buettner, P.G. (2000). Predictors of the use of sunscreen in dermatological patients in Central Europe. *Preventive Medicine*, 31, 134-139.
- Gilchrest, B.A., Eller, M.S., Geller, A.C., Yaar, M. (1999). The pathogenesis of melanoma induced by ultraviolet radiation. *New England Journal Medicine*, 340, 1341-1348.
- Glanz, K., Buller, D.B., & Saraiya, M. (2007). Reducing ultraviolet radiation exposure among outdoor workers: State of the evidence and recommendations. *Environmental Health*, 6-22. Available at: (<http://www.ehjournal.net/content/6/1/22>). Accessed February, 18, 2008.
- Greenlee, R.T., Murray, T., Bolden, S., & Wingo, P.A. (2000). Cancer statistics, 2000. *CA – A Cancer Journal for Clinicians*, 50, 7-33.
- Holick, M.F. (2005). The vitamin D epidemic and its health consequences. *The Journal of Nutrition*, 135, 2739-2748.
- IEC International Electrotechnical Commission. Safety of household and similar electrical appliances (1995). Part 2: Particular requirements for appliances for skin exposure to ultraviolet and infrared radiation, p. 335.
- International Agency for Research on Cancer (2001). Sunscreens. Vol. 5 of IARC handbooks of cancer prevention. Lyon, France.
- Jemal, A., Devesa, S.S., Hartge, P., & Tucker, M.A. (2001). Recent trends in cutaneous melanoma incidence among whites in the United States. *Journal National Cancer Institute*, 93, 678-683.
- Kefford, R.F. (1999). Counseling and DNA testing for individuals perceived to be genetically predisposed to melanoma: A consensus statement of Melanoma Genetics Consortium. *Journal Clinical Oncology*, 17(10), 3245-3251.
- Lowe, J.B., Borland, R., Stanton, W.R., Baade, P., White, V., & Balanda, K.P. (2000). Sun-safe behaviour among secondary school students in Australia. *Health Education Research*, 15, 271-281.
- Lucas, R., McMichael, T., Smith, W., & Armstrong, B. (2006). Solar Ultraviolet Radiation: Global burden of disease from solar ultraviolet radiation. World Health Organisation, Environmental Burden of Disease, 13, 258.
- Marks, R. (1988). Role of childhood in the development of skin cancer. *Australian Paediatric Journal*, 24, 337-338.
- Marks, R. (1998). Sun education in Australia. *Clinical Dermatology*, 16, 528-530.
- McLean, D.I., & Gallagher, R. (1998). Sunscreens. Use and misuse. *Dermatological Clinics*, 16, 219-226.
- Miller, S.A., Hamilton, S.L., Wester, U.G., & Cyr, W.H. (1998). An analysis of UVA emissions from sunlamps and the potential importance for melanoma. *Photochemistry and Photobiology*, 68, 63-70.
- Moan, J., Dahlback, A., Larsen, S., Henriksen, T., & Stamnes, K. (1989). Ozone depletion and its consequences for the influence of carcinogenic sunlight. *Cancer Research*, 49, 4247-4250.
- Naldi, L., Imberti, G.L., Parazzini, F., Gallus, S., & La Vecchia, C. (2000). Pigmentary traits, modalities of sun reaction, history of sunburns, and melanocytic nevi as risk factors for cutaneous malignant melanoma in the Italian population: results of a collaborative case-control study. *Cancer*, 88, 2703-2710.
- Pagoto, S., McChargue, D., & Fuqua, R.W. (2003). Effects of a multi-component intervention on motivation and sun protection behaviors among midwestern beachgoers. *Health Psychology*, 4, 429-433.
- Rager, E.L., Bridgeford, E.P., & Ollila, D.W. (2005). Cutaneous melanoma: update on prevention, screening, diagnosis, and treatment. *American Family Physician*, 72, 269-276.
- Robert Koch-Institut & Statistisches Bundesamt (2004). Themenheft 22: Hautkrebs. *Gesundheitsberichterstattung des Bundes*, 1-34.
- Robinson, J.K., & Rademaker, A.W. (1995). Skin cancer risk and sun protection learning by helpers of patients with nonmelanoma skin cancer. *Preventive Medicine*, 24, 333-341.
- Roy, C.R., Gries, H.P., Lugg, D.J., Toomey, S., & Tomlinson, D.W. (1998). The measurement of solar ultraviolet radiation. *Mutation Research*. 422, 7-14.
- Saraiya, M., Glanz, K., Briss, P.A., Nichols, P., White, C., Das, D., & Smith, S.J. (2004). Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *American Journal Preventive Medicine*, 27, 422-466.
- Stern, R.S., Weinstein, M.C., & Baker, S.G. Risk reduction for nonmelanoma skin cancer with childhood sunscreen use. *Archives of Dermatology*, 122, 537-545.
- Task Force on Community Preventive Services (2004). Recommendations to prevent skin cancer by reducing exposure to Ultraviolet radiation. *American Journal Preventive Medicine*, 5, 467-470.
- Thieden, E. (2008). Sun exposure behaviour among subgroups of the Danish population – Based on personal electronic UVR dosimetry and

corresponding exposure diaries. *Danish Medical Bulletin*, 1 (55), 47-68.

U.S. Department of Health and Human Services (2000). *Healthy people 2010*. 2nd ed. Washington DC: U.S. Government Printing Office.

Urbach, F. (1991). Potential health effects of climatic changes: Effects of increased ultraviolet radiation on man. *Environmental Health Perspective*, 96, 175-176.

Weinstock, M.A., & Rossi, J.S. (1998). The Rhode Island Sun Smart Project: A scientific approach to skin cancer prevention. *Clinics in Dermatology*, 16, 411-413.

Welch, H.G., Woloshin, S., & Schwartz, L.M. (2005). Skin biopsy rates and incidence of melanoma: population based ecological study. *British Medical Journal*, 331, 7518-7698.

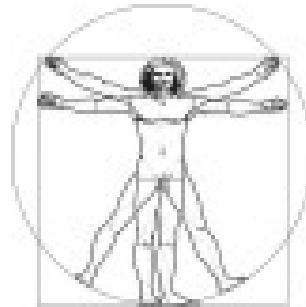
Whiteman, D.C., Whiteman, C.A., & Green, A.C. (2001). Childhood sun exposure as a risk factor for melanoma: a Systematic review of epidemiologic studies. *Cancer Causes Control*, 12, 69-82.

World Health Organisation (2001). Protecting children from ultraviolet radiation. Available at: <http://www.who.int/uv/resources/fact/en/fs261protectchild.pdf>. Accessed February 26, 2008.

World Health Organization (2003). Artificial tanning sunbeds - risks and guidance. Available at: <http://www.who.int/uv/publications/en/sunbeds.pdf>. Accessed February 26, 2008.

World Health Organisation (2006). Solar ultraviolet radiation: Global burden of disease from solar ultraviolet radiation. Available at: <http://www.who.int/uv/publications/solaradgbd/en/pri nt.html>. Accessed February, 26, 2008.

Zaza, S, Lawrence, R.S., Mahan, C.S, Fullilove, M., Fleming, D., Isham, G.J., & Pappaioanou, M. (2000). Scope and organization of the Guide to Community Preventive Services. *American Journal Preventive Medicine*, 18, 27-34.



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