Environmental Burden of Disease Series, No. 13

Solar Ultraviolet Radiation

Global burden of disease from solar ultraviolet radiation

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World Health Organization
Public Health and the Environment
Geneva 2006

WHO Library Cataloguing-in-Publication Data

Solar ultraviolet radiation : global burden of disease from solar ultraviolet radiation / Robyn Lucas ... [et al.] ; editors, Annette Prüss-Üstün ... [et al.].

(Environmental burden of disease series ; no. 13.)

1.Sunlight - adverse effects. 2.Ultraviolet rays - adverse effects. 3.Risk assessment. 4.Cost of illness. 5.Skin - radiation effects. 6.Eye - radiation effects. I.Lucas, Robyn. II.Prüss-Üstün, Annette. III.World Health Organization. IV.Series: Environmental burden of disease series ; no. 13.

ISBN 92 4 159440 3 (NLM classification: WD 605)
ISBN 978 92 4 159440 0
ISSN 1728-1652

Printed by the WHO Document Production Services, Geneva, Switzerland.

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Preface

Human exposure to solar ultraviolet radiation has important public health implications. Evidence of harm associated with overexposure to UV has been demonstrated in many studies. Skin cancer and malignant melanoma are among the most severe health effects, but a series of other health effects have been identified. The current report provides a quantification of the global disease burden associated with UV. The information presented forms a knowledge base for the prevention of adverse effects of UV exposure that is achievable with known and accessible interventions. UV prevention focuses on protecting the skin and other organs from UV radiation. On the other hand, a moderate degree of UV exposure is necessary for the production of Vitamin D which is essential for bone health. Additionally, evidence emerges that low Vitamin D levels are likely to be associated with other chronic diseases. Thus, public health policy on ultraviolet radiation needs to aim at preventing the disease burden associated both with excessive and with insufficient UV exposure.

This volume is part of a series on global estimates of disease burden caused by environmental risks, and guides for estimating the disease burden from specific risks at country or local level. This Environmental Burden of Disease (EBD) series responds to the need to quantify environmental health risks as input to rational policy making. Quantification of disease will provide information on the health gains that could be achieved by targeted action on protecting against specific environmental risks to health. An introductory volume (No. 1 of the series) provides further details on methods used for such quantification.

The methods for environmental burden of disease are part of a larger initiative - WHO has recently analysed 26 risk factors worldwide in the World Health Report (WHO, 2002). In 2006, a global estimate of the health impacts from environmental risks has shown that the 24% of global disease is due to the "modifiable" part of the environment[1].

A separate guide is being prepared to assist in the estimation of health impacts from UV radiation at country level.

[1] Preventing disease through healthy environments - towards an estimate of the global burden of disease. WHO, Geneva, 2006.

Affiliations and acknowledgements

The World Health Organization, through its INTERSUN programme, is actively engaged in protecting the public from health hazards of ultraviolet radiation. In the framework of this programme, an assessment of the global disease burden associated with solar ultraviolet radiation was performed by the National Centre for Epidemiology and Population Health (NCEPH) in Australia, implementing a contract between WHO and the New South Wales Cancer Council.

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The WHO and the authors wish to acknowledge the assistance of Ivan Hanigan (NCEPH) with reference retrieval and GIS mapping of population and UVR; Dr Diarmid Campbell-Lendrum (WHO) for his discussion of comparative risk assessment methodology; Dr Jenny Lucas (Bone Fellow, Auckland Hospital, New Zealand) for her help in the understanding of influences of vitamin D on the skeletal system; Dr Robin Marks for his helpful comments on disease models for skin cancers; and Dr Simon Hales for GIS expertise. Dr William B. Grant (Sunarc, USA), Reviewers at the German Bundesamt für Strahlenschutz, the US Environmental Protection Agency, the WHO (Drs Kate Strong and Andreas Ullrich) as well as Professor Rona M MacKie (University of Glasgow, UK) reviewed earlier drafts of the document.

Editorial and scientific support at WHO was provided by Drs. Annette Prüss-Üstün, Hajo Zeeb, Colin Mathers and Michael Repacholi.

Abbreviations

BCC	Basal cell carcinoma
CMM	Cutaneous malignant melanoma
DALY	Disability-adjusted life year
GBD	Global burden of disease
NMSC	Non-melanoma skin cancer
PAF	Population attributable fraction
RHL	Reactivation of herpes labialis
SCC	Squamous cell carcinoma
SCCC	Squamous cell carcinomas of the cornea and the conjunctiva
UVR	Ultraviolet radiation

Summary

A burden of disease analysis was undertaken to evaluate solar ultraviolet radiation as a risk factor for human illness. The objective was to assess the contribution of solar ultraviolet radiation to human ill health in both mortality and morbidity and taking account of the future stream of disability following disease diagnosis (using the disability – adjusted life year (DALY) as a common metric).

The initial step involved an analysis of the strength of the causal relationship between UVR exposure and a number of diseases identified in the literature as probably being related. Having identified nine disease outcomes with strong evidence of a causal relationship with excessive UVR exposure, and three diseases associated with under-exposure, an estimation of the population attributable fraction for UVR exposure was made for each of these outcomes, on the basis of published epidemiological studies.

Three separate methods were used to calculate the global burden of disease due to the above-identified diseases. The global burden of disease due to melanoma was already calculated as part of WHO's global burden of disease assessment. Calculated population attributable fractions for UVR exposure were applied directly to these estimates. For other diseases for which there are good epidemiological data on incidence and mortality, population level exposure-response relationships were developed. Using country-level population-weighted average (1997-2003) annual ambient UVR, incidence and mortality rates were imputed from these exposure-response curves and the burden of disease calculated and aggregated to WHO sub-regions. For those diseases for which much weaker epidemiological data were available, exposure to UVR was approximated by latitudinal position in ten-degree bands. Incidence and mortality rates were extrapolated from the available data to regions of similar latitude and the burden of disease calculated for each WHO sub-region.

Disease duration and disability weights for various health states were derived from the literature or estimated from diseases of similar severity based on the appreciation of a working group established for this study.

Globally, excessive solar UVR exposure caused the loss of approximately 1.5 million DALYs (0.1% of the total global burden of disease) and 60 000 premature deaths in the year 2000. The greatest burden results from UVR-induced cortical cataracts, cutaneous malignant melanoma and sunburn (although the latter estimates are highly uncertain due to paucity of data). Notably, a counterfactual of zero UVR exposure would not result in a minimum disease burden, but rather a high disease burden due to diseases of vitamin D deficiency.

1. Background

1.1 Introduction

Living organisms on Earth have evolved over millions of years as the planet and its atmosphere have changed. Selection pressures related to ultraviolet radiation (UVR) have likely been instrumental in the development of different skin pigmentation in humans, as they have migrated from areas of high ambient UVR to areas of lower ambient UVR (*1*). The contrasting requirements of protection from excessive ultraviolet radiation and receiving sufficient sunlight to promote the production of vitamin D by the skin have meant that those inhabiting low latitudes, with high UVR intensity, have darker skin pigmentation for protection from the deleterious effects of UVR, while those in higher latitudes have developed fair skin to maximize vitamin D production from much lower ambient ultraviolet radiation.

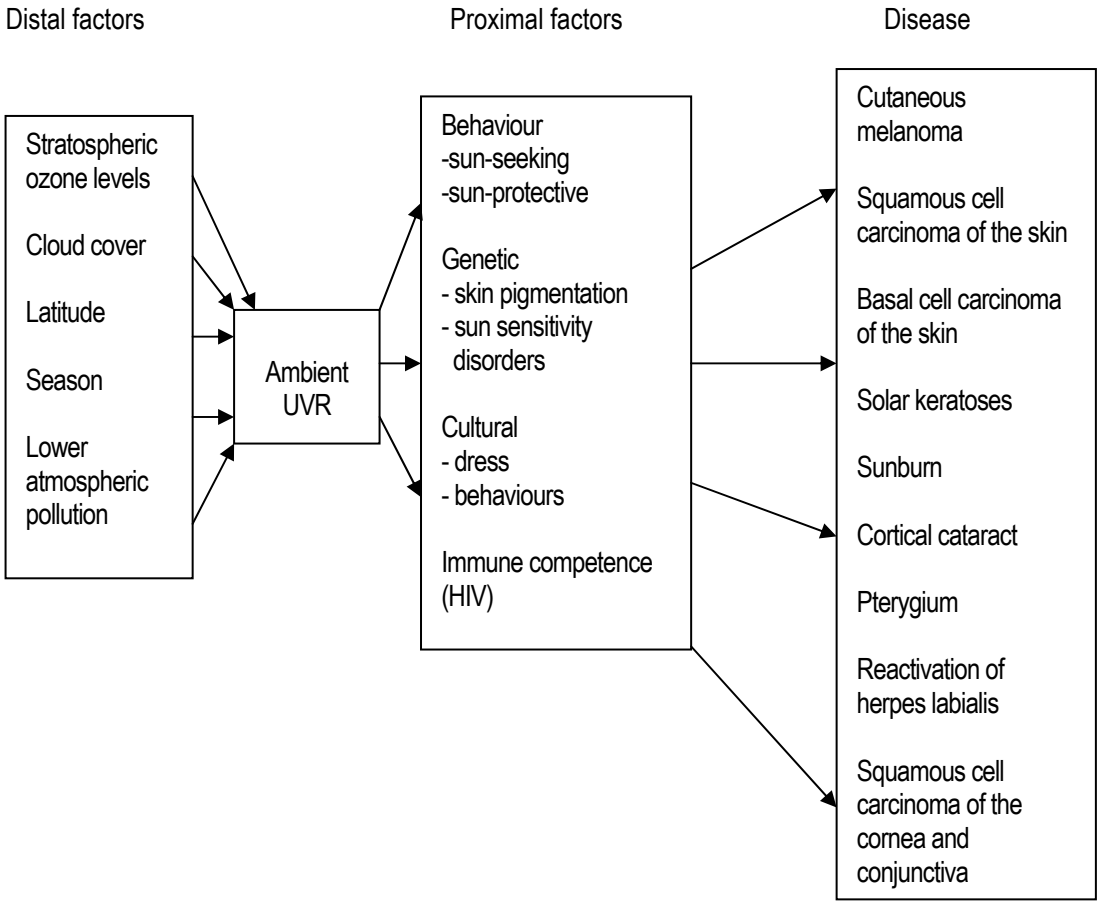
In the last few hundred years however, there has been more rapid human migration out of the areas in which we evolved, to all other parts of the world. No longer is our skin pigmentation necessarily suited to the environment in which we live. While dark-skinned populations at low latitudes have very low levels of melanoma and cancers of the skin, migration of these people to areas of high latitude has seen an increase in the incidence of rickets and osteomalacia (*2*). Fair skinned populations who have migrated to low latitudes have experienced a rapid rise in the incidence of melanoma and non-melanoma skin cancers. In addition, behavioural and cultural changes in the twentieth century have meant that many of us are now exposed to more, or less, ultraviolet radiation than ever before. Figure 1.1 presents an outline of the determinants of the health impacts of ultraviolet radiation.

Meanwhile, our industrialized society has produced chlorofluorocarbons (CFCs) that react chemically with the stratospheric ozone that has shielded Earth from most of the harmful wavelengths of ultraviolet radiation. The resulting loss of stratospheric ozone has been associated with increasing levels of some types of ultraviolet radiation reaching the Earth's surface. It is difficult to assess changes in UVR due to stratospheric ozone depletion, using ground-based measurements, due to UVR changes associated with fluctuations in cloud cover and increase in lower atmospheric pollution. However, monitoring in the Swiss Alps, where the atmosphere is relatively clear has indicated slightly increased levels of UVR in the northern hemisphere, while monitoring in Australia has demonstrated increased levels of ambient UVR in months when cloud cover has been particularly low (*3*). Increases in ambient UVR will be associated with increased adverse health effects due to excessive UVR exposure in the absence of behavioural changes and efforts at sun protection. Recent research has highlighted the beneficial effects to health of adequate UVR exposure due to UVR-induced vitamin D synthesis. The net health gain or loss from higher levels of ambient UVR will thus depend on the interaction of increased ambient UVR levels, skin pigmentation of those exposed and behavioural changes influencing personal exposure.

Ultraviolet radiation is ubiquitous. Almost everyone has some exposure to ultraviolet radiation on a daily basis. It is an exposure we cannot entirely avoid and, anyway, to strive for zero exposure would create a huge burden of skeletal disease from vitamin D deficiency. However, evaluation of the burden of disease created by excess exposure to UVR is very important since avoidance of excess exposure is a relatively simple public health message.

The purpose of this study is to evaluate the beneficial effects of adequate UVR exposure and the harmful effects of excess UVR exposure on human health, using the common metric, the DALY, to place into perspective the global burden of disease related to this ubiquitous risk factor.

Figure 1.1 Causal Web for Health Impacts due to Ultraviolet Radiation



1.2 Comparative risk assessment

Burden of disease risk factor assessment uses a comparative risk assessment framework designed to produce comparable and reliable analyses of risks to health (*4*). A detailed description of the conceptual framework and methodological issues is published elsewhere (*4*). In brief, there are four essential elements:

The burden of disease due to an observed exposure distribution in a population is compared with the burden of disease from a hypothetical, or counterfactual, exposure distribution(s).
A causal network including interactions among risk factors is developed for each disease outcome to allow making inferences about the effect of changes in combinations of risk factors.
The health loss due to a risk factor is calculated as a time-indexed stream of disease burden.
The burden of disease is calculated using a summary measure of population health, which allows the inclusion of mortality and morbidity data.

The following sections consider steps 1 and 2 in relation to UVR exposure as the risk factor.

1.3 Definition of the risk factor

Ultraviolet radiation is part of the spectrum of electromagnetic radiation emitted by the sun. It is arbitrarily divided into three bands of different wavelength although the exact wavelength at which the divisions are made differ for different disciplines (*5*). The divisions first proposed by the Second International Congress on Light in 1932 were as follows:

UVA	400-315nm
UVB	315-280nm
UVC	280-100nm

However, environmental and dermatological photobiologists commonly use slightly different divisions, more closely associated with the biological effect of the different wavelengths. That is:

UVA	400-320nm
UVB	320-290nm
UVC	290-200nm

UVC is totally absorbed by atmospheric ozone, has minimal penetration to the surface of the Earth and thus has little effect on human health. 90% or more of UVB is absorbed by atmospheric ozone (*6*), while UVA passes through the atmosphere with little change. Thus, the solar ultraviolet radiation of importance to human health consists of UVA and UVB.

While UVA penetrates the human skin more deeply than UVB, action spectra for biological responses indicate that it is radiation in the UVB range that is absorbed by DNA – subsequent damage to DNA appears to be a key factor in the initiation of the carcinogenic process in skin (*7, 8*).

The effect of solar radiation on human health depends on the amount and type of radiation impinging on the body. This in turn depends on, firstly, the concentration of atmospheric ozone that is available to absorb ultraviolet radiation, particularly UVB. Next, the amount and spectral structure of radiation reaching the body is dependent on the angle at which the sun's rays pass through the atmosphere – at low latitudes (closer to the equator) there is more intense solar UVR with a greater proportion of shorter wavelengths, related to the low angle of incidence of the incoming radiation (*9*). This strongly influences biological activity. Increasing altitude increases UVR intensity by decreasing the air mass through which solar radiation must pass. Similarly, time of day and season as well as presence of clouds, dust, haze and various organic compounds can alter the intensity of incident solar radiation. Variations in cloud cover usually reduce ground level UVR, although this effect is highly variable, depending on the characteristics of the cloud itself. Indeed, cloud cover can result in increased ground level UVR if both direct sunlight and light scattered from clouds, reach the earth's surface (*10*).

Moderating effect of behaviour

While levels of total annual ultraviolet radiation vary approximately four-fold across the globe (*11*), in any area there is likely to be at least a ten-fold difference in personal UVR exposure which is related to behavioural and cultural factors. Thus, even in areas of relatively low ambient UVR, it is possible to have high personal exposure.

Gies et al (*12*) have summarized our knowledge of variation in personal exposure to solar UVR. For most subjects, UVR exposures vary from between 5% to 15% of total ambient UVR, with the exception of outdoor workers whose exposures can reach 20-30% of ambient UVR. Groups of similar age tend to receive a similar proportion of ambient UVR in different locations, with boys consistently having higher UVR exposure than girls. However, individual exposure within population groups may vary from one tenth to ten times the mean exposure in

a particular location. In some persons or sub-populations, much of the annual exposure to UVR may be concentrated in a brief annual summer holiday.

Effect modification by skin pigmentation

For studies of the effects of UVR exposure on human health there is an effect modifier that may be stronger than that found in any other exposure-disease relationship. Skin pigmentation alters the exposure-disease relationship for all UVR-induced disease where the primary exposure of interest is skin exposure. Deeply pigmented skin provides important sun protection, with quantitative estimates varying, but including a skin protection factor of 13.4 (*13*), and an MED 33-fold higher than fair skin (*14*). Intermediate skin types have intermediate values of protection.

The most common classification of skin types for UVR sensitivity is the Fitzpatrick scale (Table 1.1).

Table 1.1 Fitzpatrick skin pigmentation scale

Type	Description
I	Fair skinned Caucasians who burn very easily and never tan
II	Fair skinned Caucasians who burn easily and tan slowly and with difficulty
III	Medium skinned Caucasians who burn rarely and tan relatively easily
IV	Darker skinned Caucasians who virtually never burn and tan readily, e.g. some individuals with Mediterranean ancestry.
V	Asian or Indian skin
VI	Afro-Caribbean or Black skin

Table adapted from (*15*).

For this analysis, the global population was broken down into three broad skin pigmentation groups, as there are insufficient data to separately quantify skin types I to IV:

Lightly pigmented – this includes skin types I to IV
Intermediate pigmentation – skin type V
Deeply pigmented – skin type VI

1.4 Measurement of the risk factor

Ambient UVR may be measured in purely physical units or weighted using an erythemal response function[2] to give biologically effective UVR, expressed as joules per square metre (Jm^{-2}), minimal erythemal dose (MED), standard erythemal dose (SED) or the solar UV index (Box2.1).

Unfortunately the MED is sometimes used in populations of different skin types where it means the dose of UVR required to produce a minimal erythemal response in a particular skin type – thus the dose of UVR may not be 200 Jm^{-2}, but must be defined for the skin type(s) under study. For example, in an investigation of the photoprotection of epidermal melanin pigmentation, the ratio of the values for the MED between skin type V and skin type I and II was 2.29 (*16*). The lack of a consistent baseline for MED measurement decreases its value for interstudy comparisons.

[2] A representation of the wavelength variation in production of erythema of the skin.

The SED (standard erythemal dose) has been developed as an erythemally weighted measure of radiant exposure, equivalent to 100 Jm^{-2}. The SED is independent of skin type and a particular exposure dose in SED may cause erythema in fair skin but none in darker skin (*5*). The global solar UV index was developed as an easy-to-understand measure of biologically effective UVR to promote public awareness of the risks of UVR exposure and to promote sun protection. Weather forecasts in many countries include a forecast of the solar UV index to guide public sun exposure.

Latitude provides a rough approximation to global variation in UVR (Figure 1.2). However, because of the elliptical nature of the earth's orbit around the sun there is a 7% difference in intensity between the hemispheres for any level of latitude, with the southern hemisphere having a greater intensity (*11*). In addition, clearer skies in the southern hemisphere can increase this difference in ambient UVR to 10-15% (*12*).

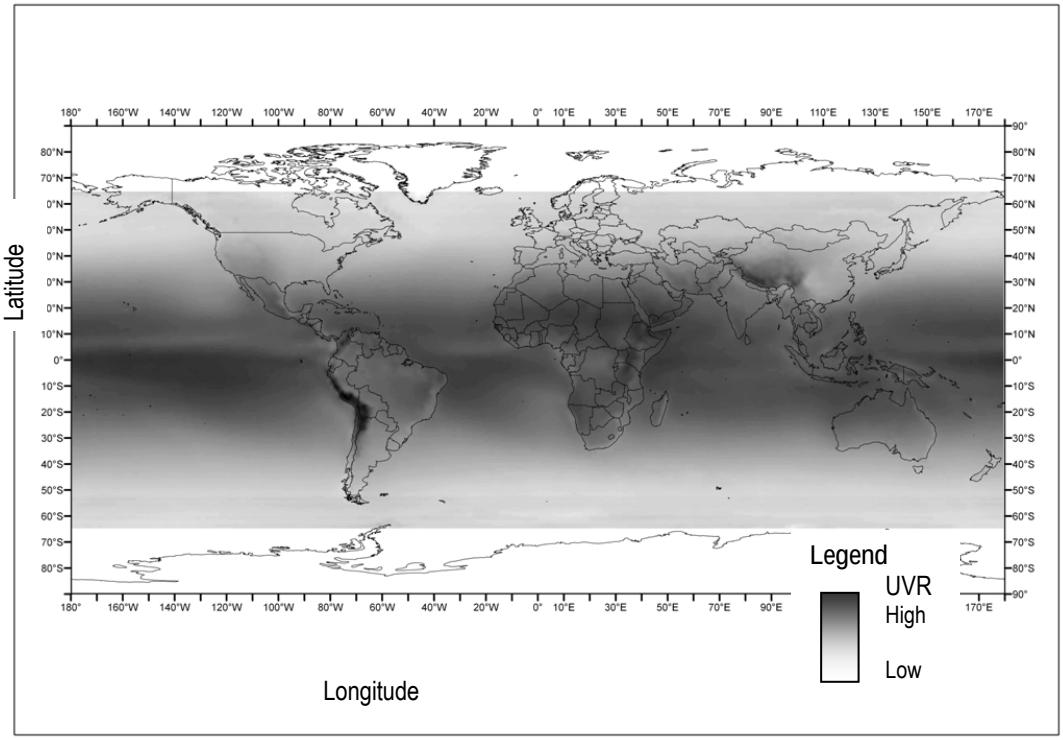
Box 2.1

MED: that dose of UVR required to produce a barely perceptible erythema in people with skin type 1 (200 Jm^{-2} of biologically effective UVR).

SED: erythemally weighted radiant UVR equivalent to 100 Jm^{-2}

Solar UV index: time weighted average effective UV irradiance in Wm^{-2} multiplied by 40 (Watts = joules/sec).

Figure 1.2 Monthly averaged annual ambient erythemally weighted UVR, 1997-2003



Ambient solar UVR is measured continuously by ground-level monitors, with publication of current values for particular locations. In addition, global ambient UVR levels, weighted to

biologically effective wavelengths, calculated from satellite data are available online from 1978 to 1993 and 1996 to 2004[3].

Personal UVR exposure is usually measured in epidemiological studies by recalled exposure over a number of years. This can include a measure of the number of sunburns experienced at various times of life, hours spent outdoors during recreational activities, or occupational history. Many of the studies examining the effects of UVR exposure on the eye have quantified ocular exposure by adjusting ambient UVR (years in a location for which average ambient UVR is known) for use of a hat, sunglasses and surface albedo (*17*). However, such indices also rely on recall of the use of these sun-protective devices. Thus the estimation of the risk factor exposure level at the individual level in epidemiological studies is imprecise, given in varying "natural" units which have no fixed relationship to the physical units used to measure ambient UVR, and is particularly subject to recall inaccuracy.

We stress that even if extensive networks to precisely measure ground level UVR existed, this would not accurately represent the population distribution of individual UVR exposure. One problem is the geometrical difference between a (usually) horizontal fixed detector and the curved body surface that will produce significant deviations in exposure. These deviations have recently been quantified. But, Gies et al note that "population groups are not homogeneous as regards UVR exposure" and "Some subjects have consistently high or consistently low exposures in comparison to the mean…, from a tenth to ten times the mean" (*12*). As already noted, behavioural and cultural differences mean that for any ground level measure of UVR, there may be a hundred-fold difference in personal UVR exposure. It would be erroneous to interpret highly precise estimates of ground-level UVR as accurate estimates of personal UVR exposure. Furthermore, variations in skin pigmentation and use of sunscreen determine the exposure to biological structures in the context of variations in ambient UVR.

The estimations for this burden of disease assessment involve assuming a population-level exposure represented by annual ambient erythemally weighted UVR (calculated from satellite data) or a proxy such as latitudinal position.

1.5 Defining the counterfactual exposure

The disease burden attributable to a particular risk factor should generally be estimated as compared to an alternative exposure (or "counterfactual" exposure). This counterfactual exposure may represent the exposure resulting in a theoretical minimum disease risk, a plausible or feasible decrease in exposure and thus disease risk, or the cost-effective decrease in exposure level for decreased disease risk (*4*).

One possible choice of counterfactual exposure might be a "feasible" reduction in exposure to the risk factor. Sun avoidance and protection messages have been widespread for more than twenty years. Hill et al (*18*) described a reduction in sunburn and increased sun protective behaviours following an intensive health promotion campaign in Melbourne. Such decreases in exposure are relatively small (crude proportion of sunburnt fell from 11% to 7%, increase in hat wearing from 19% to 29% and sunscreen use from 12% to 21% over three years) but could cause a significant decrease in incidence of skin cancers and UVR-related eye diseases (*18*).

A preferable choice of counterfactual exposure for UVR might be that required to produce a theoretical minimum risk of disease. Murray et al (*4*) describe the choice of theoretical minimum exposure distributions based on categories of risk factors: physiological,

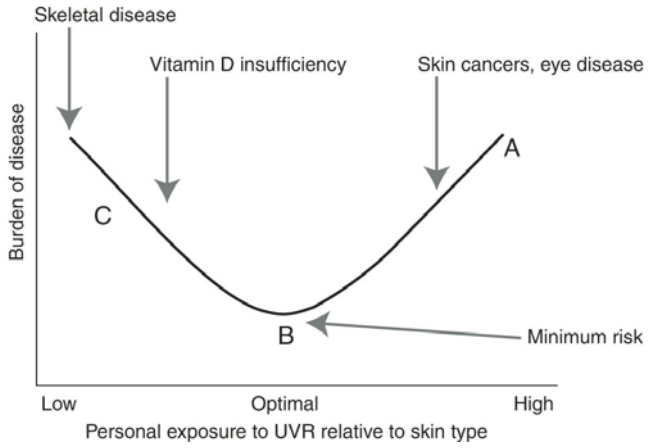
[3] http://iridl.ldeo.columbia.edu/SOURCES/.NASA/.GSFC/.TOMS/.

behavioural, environmental and socioeconomic. UVR exposure could fit into any of the first three of these categories:

Environmental toxicity for most environmental risk factors increases monotonically with increasing exposure, so that the theoretical minimum would be the lowest physically achievable level of exposure. Although solar UVR is an environmental exposure, there is clearly not a monotonic association between health risks and UVR exposure.
Physiological (e.g. vitamin D levels) and behavioural (sun exposure patterns) risk factors may demonstrate U or J shaped exposure response relationships. UVR exposure is best considered within this type of exposure-disease association.

Some UVR exposure is required for induction of synthesis of vitamin D, which is essential for musculo-skeletal health. Clearly, the minimum burden of disease for UVR exposure would thus not occur under a scenario of no UVR exposure (see Figure 2.1). Such a lack of exposure to UVR would lead to vastly increased disease load due to the increase in vitamin D deficiency. Conventionally we view this as causing only rickets, osteomalacia and osteoporosis, but recent research suggests that vitamin D may also have an extremely important role in the immune system, such that even subclinical hypovitaminosis D may have a causal role in the development of several cancers and contribute to the development of autoimmune disorders such as multiple sclerosis and type 1 diabetes (*19*). The theoretical minimum risk is therefore the turning point of the exposure-response curve. For UVR exposure this would equate to the minimum population distribution of UVR exposure that maintains vitamin D sufficiency, given the current diet. This distribution is, as yet, undefined, and varies by age, sex and skin type.

Figure 2.1 Schematic diagram of the relation between ultraviolet radiation (UVR) exposure and the burden of disease



Points A and C represent inappropriate UVR exposure. Fair-skinned populations in Australia with high outdoor UVR exposure typify point A. Point C represents people with insufficient UVR exposure, whose dietary vitamin D intake will also be important in determining their vitamin D status. Point B represents optimal UVR exposure: a person with careful titration of correct UVR dose for skin type.

Lucas, RM and Ponsonby, AL. Ultraviolet radiation and health: friend and foe. MJA 177:594-598

Holick et al (*20*) estimate that exposure of the whole body in a bathing suit to 1 (individual) MED is equivalent to ingesting 10,000 IU of vitamin D. Thus exposure of 6-10% of the body surface to 1 MED is equivalent to ingesting 600-1000 IU. The current recommended daily intake of vitamin D for children is 400 IU and for adults is 200 IU (*21, 22*), although recent

research suggests that this should be increased to 600 IU (with some suggesting daily intake of up to 4000IU) in the absence of sunlight exposure. Based on these data, daily exposure of 6-10% of the body surface (one arm, one lower leg, or face and hands) to 1 MED should be sufficient to maintain vitamin D sufficiency (>50nmo/l). It should be noted however that recent research suggests that the lower level of vitamin D sufficiency should be raised to at least 80nmo/l (*23*).

Although it should be possible to calculate the mean daily UVR exposure required to maintain vitamin D sufficiency, at any location for a particular skin type using available global data on annual ambient UVR (*12*), this has yet not been done. At higher latitudes there is insufficient UVB to produce vitamin D over the winter months (*24*). Inhabitants of such areas would need to achieve higher levels of vitamin D synthesis in other seasons and rely on stored vitamin D over the winter. Even so, in the limited dose-response data available for basal cell carcinoma and melanoma (*25, 26*) this level of exposure would result in a zero incidence of cutaneous melanoma and an odds ratio of 1.0 for developing basal cell carcinoma.

A counterfactual exposure distribution of minimum UVR exposure to allow adequate synthesis of vitamin D is likely to represent a minimum risk for diseases of both over- and under-exposure, that is, there should be no need to accept an increased risk of diseases of excessive exposure, in order to achieve minimal risk of diseases of underexposure.

To summarize, for UVR exposure there are some difficulties with the comparative risk assessment methodology used in burden of disease assessment:

While there is a theoretical counterfactual exposure required to achieve a minimum disease burden (that required to maintain vitamin D levels), there is a lack of data that transfer this theoretical exposure into a measurable population exposure distribution.

The exposure distribution of populations is unclear. While data on ambient UVR are available, these do not easily translate to actual population exposure distribution. To achieve such data would require individuals of various ages and skin types to wear personal UV monitors continuously, and for a number of years, to evaluate both acute and chronic effects on health. Epidemiological studies have not been able to measure past UVR exposure with accuracy, but rather use measures such as number of sunburns or estimated hours in the sun. Further, these imprecise measures are based on recall of events usually well in the past.

2. Methods

2.1 Outcomes to be assessed

That there are effects of ultraviolet radiation on human health is clear. Absence of exposure to UVR causes a lack of vitamin D with subsequent effects on calcium and phosphorus levels and eventually rickets, osteomalacia and osteoporosis. Excess exposure to ultraviolet radiation is a relatively new problem, occasioned by less coverage by clothing, migration of pale-skinned peoples to areas of high ambient UVR and behavioural practices such as sunbathing.

There are both direct, e.g. skin cancers, and indirect effects, e.g. altering food productivity of plant and aquatic ecosystems, of ultraviolet radiation on human health. The current assessment is confined to direct effects due to human solar UVR exposure.

A systematic review of the epidemiological literature review was undertaken to ascertain a list of diseases where UVR exposure was implicated as a risk factor.

Initially a search was undertaken for major review papers in this area (*8, 27*), using search terms for the disease and "ultraviolet radiation". The Environmental Health Criteria 160 (EHC 160) document of 1994 included an extensive review of diseases possibly associated with UVR exposure so that subsequent searches were limited to references since 1994 in cases where there were a large number of "hits" for the initial search terms. A Medline search was undertaken for more recent evidence on these diseases, supplemented by searches of the bibliographies of other papers.

Following this, Medline was searched for "ultraviolet radiation" AND "health". The retrieved references were scanned for any new diseases that may have an association with ultraviolet radiation and then further more specific searches were undertaken for these diseases and UVR.

Secondly, the association between UVR and the identified disease outcomes was explored in more detail. Medline was searched using the following search terms: each disease, ultraviolet radiation and "ecologic studies" or "case-control studies" – again limited to after 1994 if the "hits" were greater than 100. Using the latter, an assessment of the current evidence for a causal relationship with ultraviolet radiation was undertaken, using Hill's criteria for causality (*28*), but particularly examining the biological plausibility of a causal relationship, the consistency of the results and the strength of the association between each disease and UVR exposure. This builds on work undertaken for EHC 160 and is described for each health state in Appendix 1.

Most information on diseases related to UVR exposure comes from white populations in developed countries, so areas such as Asia, the Middle East, Africa and South America were selectively searched to try to get as broad a global picture as possible.

Table 2.1 outlines the diseases that were considered, those that were found to have strong evidence of a causal relationship with UVR exposure and those that were subsequently included in this burden of disease analysis.

Table 2.1 Candidate, and selected, health outcomes to be assessed for the burden of disease related to ultraviolet radiation

Outcomes associated with UVR	Strong evidence of causality	Included in the Burden of Disease study
Immune effects		
Acute		
Suppression of cell-mediated immunity		
Increased susceptibility to infection		
Impairment of prophylactic immunization		
Activation of latent virus infection - herpes labialis	Activation of latent virus infection - herpes labialis	Activation of latent virus infection - herpes labialis
Chronic		
Activation of latent virus infection - papilloma virus		
Rheumatoid arthritis*		
Type 1 diabetes mellitus*		
Multiple sclerosis*		
Effects on the eyes		
Acute		
Acute photokeratitis and conjunctivitis	Acute photokeratitis and conjunctivitis	
Acute solar retinopathy	Acute solar retinopathy	
Chronic		
Climatic droplet keratopathy		
Pterygium	Pterygium	Pterygium
Pinguecula		
Squamous cell carcinoma of the cornea	Squamous cell carcinoma of the cornea	Squamous cell carcinoma of the cornea
Squamous cell carcinoma of the conjunctiva	Squamous cell carcinoma of the conjunctiva	Squamous cell carcinoma of the conjunctiva
Cataract	Cortical cataract	Cortical cataract
Ocular melanoma		
Macular degeneration		
Effects on the skin		
Acute		
Sunburn	Sunburn	Sunburn
Photodermatoses	Photodermatoses	
Chronic		
Cutaneous malignant melanoma	Cutaneous malignant melanoma	Cutaneous malignant melanoma
Cancer of the lip		
Basal cell carcinoma of the skin	Basal cell carcinoma of the skin	Basal cell carcinoma of the skin
Squamous cell carcinoma of the skin	Squamous cell carcinoma of the skin	Squamous cell carcinoma of the skin
Chronic sun damage/solar keratoses	Chronic sun damage/solar keratoses	Solar keratoses
Other direct effects		
Acute		
Medication reactions		
Chronic		
Vitamin D production*	Vitamin D production	Vitamin D production
- rickets, osteomalacia, osteoporosis	- rickets, osteomalacia, osteoporosis	- rickets, osteomalacia, osteoporosis
-tuberculosis		
Non-Hodgkins lymphoma*		
Other cancers *-		
-Prostate		
-Breast		
-Colon		
Hypertension*		
Psychiatric disorders*		
-Seasonal affective disorder		
-Schizophrenia		
-General well-being		
Indirect effects		
Effect on climate, food supply, disease vectors, atmospheric chemistry		

* Possible beneficial effects of adequate UVR exposure

On further examination, although there is strong evidence of causality, the following diseases were excluded from the analysis because of lack of availability of data on incidence or prevalence:

Acute photokeratitis and photoconjunctivitis (snow blindness)
Acute solar retinopathy (eclipse blindness)

In addition, this assessment did not include disability due to the group of diseases known as the photodermatoses. These disorders are an idiosyncratic reaction to sunlight rather than diseases of excess or insufficient UVR exposure. Actinic prurigo, solar urticaria, photoallergic contact dermatitis and hydroa vacciniforme are rare disorders for which there are insufficient data for incidence or prevalence to include them in this analysis. Polymorphic light eruption is common, but data on the prevalence and clinical course are limited.

Although not included in this analysis, as evidence of causality is not yet persuasive, we believe that it is likely that other diseases may need to be considered in future analyses of burden of disease related to ultraviolet radiation. These include:

Diseases with increasing incidence where UVR exposure/vitamin D is inadequate:

Autoimmune diseases:
Multiple sclerosis
Type 1 diabetes
Rheumatoid arthritis

Cancers:
Prostate
Breast cancre
Colorectal cancer
Ovary cancer
Non-Hodgkin lymphoma

Psychiatric disorders:
Seasonal affective disorder
Mood disorders
Schizophrenia

Diseases with increasing incidence where UVR exposure is excessive

Acute macular degeneration
Posterior subcapsular cataract
Nuclear cataract
Ocular melanoma

2.2 Estimation of risk factor-disease relationships

Measurements of ambient UVR give an indication of "possible" UVR exposure of a population. However, the relationship between an outcome and the risk factor occurs at an individual level. As already indicated, understanding the population distribution of personal UVR exposure under a particular level of ambient UVR is not straightforward. In addition to difficulties in ascertaining accurate exposure data, for many diseases there is a long lag period between exposure to the risk factor and development of disease. And, for some diseases, such as cutaneous melanoma and basal cell carcinoma of the skin, it is likely that the relationship is not a simple dose-response relationship, but may involve thresholds of UVR exposure as well as critical life stages of exposure.

The epidemiological literature and international disease databases were searched to ascertain as much incidence and prevalence data as possible from diverse regions of the world, recording all data by geographical position of the study region and year of publication for studies from 1979 (when the first satellite data for UVR were available) to 2003.

Where possible, direct estimates of whole population incidence, prevalence and mortality were taken from published data (*29, 30*). Where this was not available, data from epidemiological studies on subpopulations were used. Studies were excluded where it was clear that the study population was very small or where incidence and prevalence estimates were from a non-population based sample – both situations where the sample may not be representative of the population as a whole, e.g measuring prevalence of ocular disease in an ophthalmology clinic, a clearly non-representative sample (*31*). For cataract and pterygium, preference was given to studies for which there were uniformly defined diagnostic criteria, such as the LOCS system of cataract classification. Some studies sought to prove a link to ultraviolet radiation by proving a link to another disease thought to be caused by UVR exposure, without a critical evaluation of the evidence for this second link, e.g. using the association between cataract and pinguecula to infer an association between cataract and UVR exposure (*32*). Such studies were not included in this evaluation.

In the absence of data on the population distribution of personal UVR exposure, annual ambient erythemally weighted UVR was used as the "exposure" to develop exposure-disease relationships for those diseases for which there are adequate global incidence data, i.e. the non-melanoma skin cancers. Spreadsheets were developed (Microsoft Excel) to record data on incidence, prevalence and mortality for the diseases under consideration, by sex and age group. Age group data were converted to WHO age groups[4] using DISMOD II[5]. Annual ambient erythemally weighted UVR for grids of one degree of latitude and 1.25 degrees of longitude was calculated for each year that a full year of data was available (*33*). For each study providing incidence data we therefore recorded age and sex-specific incidence (in WHO age groups) and annual ambient UVR for that study location and year (of publication).

Using these data, population-level exposure-response curves (annual ambient erythemal UVR vs. incidence rate) were constructed for each WHO age group, for lightly pigmented populations. Based on scanty literature comparing comparative disease rates by different levels of skin pigmentation (*34*), the exposure–response relationships were then adjusted for medium and deeply pigmented groups. These "dose-response" curves were then used to derive incidence rates for those areas for which no data were available.

Using ambient UVR as the exposure measure does not overcome the difficulties of not understanding the true population exposure experience (of individuals within the population). By using available data to extrapolate to data-poor regions, we are assuming that such regions have a similar pattern of personal UVR exposure, for a certain level of ambient UVR, as those regions for which there are data. Since most data come from fair-skinned populations in developed countries, such generalizations may not be warranted. Similarly, by using data accumulated over the past twenty five years (for the relation of ambient UVR to disease incidence), to provide estimates of current disease incidence, we implicitly assume that the relationship between ambient UVR and the population exposure history and distribution, has remained constant over time.

For other diseases in the assessment (sunburn, solar keratoses, reactivation of herpes labialis, pterygium and squamous cell carcinoma of the cornea and conjunctiva), for which global incidence/prevalence data are limited, "exposure" was approximated by the latitudinal

[4] WHO age groups: 0-4 years, 5-14 years, 15-29 years, 30-44 years, 45-59 years, 60-69 years, 70-79 years, 80+ years.

[5] DISMOD II is a program that estimates parameters of diseases that are unknown, by iteration, based on those data that are available (incidence, prevalence, remission rate, case fatality etc) for various age groups. It is available at http://www.who.int/evidence/bod.

position of the study, within ten-degree bands of latitude. Use of smaller units of UVR variation, while desirable, will depend on the availability of more extensive epidemiological data. While recognizing the inadequacies of latitude as a proxy for actual UVR exposure, it is used in an attempt to gain some initial understanding of the global burden of disease related to UVR exposure.

Incidence rates were recorded by age group, skin type and study location within ten-degree latitude bands. Data from northern and southern hemisphere ten-degree latitude bands were aggregated, as data were too sparse to consider these separately. (note that during summer, ambient UVR is 10-15% higher for equivalent latitudinal position (*12*) in the southern hemisphere due to elliptical orbit of the sun (and thus the sun and earth are closer during the southern summer than during the northern summer), ozone depletion and clearer skies. This difference is less marked in winter).

Available age and sex-specific incidence data were then used to extrapolate to data-poor regions within the same latitude band and to age groups for which there were no data, using Excel spreadsheets and graphs. For example, in one latitude band, data may be available for all age groups; in a second latitude band data may be available for only three age groups. Using the age group incidence pattern of the first band, missing cells were calculated in the second band. Similarly if data were available for all latitude bands in one age group, but only for three or four latitude bands for a second age group, incidence rates were calculated for missing cells using the latitudinal pattern of the first age group to extrapolate to the second age group. Using this technique it was possible to complete cells in the table, albeit with a high level of uncertainty.

In view of limited data on the population distribution of UVR exposure, we have derived ecological dose-response associations, with varying levels of precision, for the purpose of calculating disease risk in populations for which there are no available data.

2.3 Evaluation of population attributable fraction

In order to calculate the burden of disease due to a risk factor using a counterfactual risk assessment approach, we must know what proportion of each disease is attributable to the risk factor. We know that the incidence of most UVR-related diseases varies by latitude (and therefore ambient UVR), at least in white populations (although there is some evidence that this relationship is declining) (*35*). However, there are exceptions that may be explained on pigmentary characteristics of different populations (*36*). In fact, many of the countries in the areas of highest ambient UVR have deeply pigmented populations as their native inhabitants. In addition, many of these populations have adapted to the high ambient UVR with behavioural adaptations as well as pigmentary adaptations – not sunbathing, staying out of the sun in the middle of the day, covering up – and presumably as a result, have very low incidence rates of UVR-induced disease. It seems likely that the countries of highest risk of UVR-related disease are actually those with pale skinned inhabitants who have either relocated to areas of high ambient UVR or, with the advent of international travel and a degree of affluence, are able to holiday in areas of high ambient UVR.

In addition to incidence variation by latitude, we might suspect that the fraction of disease caused by UVR exposure (the population attributable fraction) may also vary by latitude e.g., risk factors for squamous cell carcinoma of the skin include UVR exposure and chronic irritation. In high ambient UVR locations, UVR may be relatively more important than chronic irritation, while the reverse may be true in situations of low UVR exposure. Again this is likely to be affected by the moderating effect of behaviour (including clothing and sunscreen usage) and skin pigmentation on actual exposure of susceptible tissues.

There is little consistency in the epidemiological literature on measures of sun exposure, making inter-study comparison difficult. Sun exposure measures vary from calculated

accumulated hours of exposure over a lifetime (*37*), average annual UVB exposure (*38*), average daily global irradiance (*25*) to number of sunburns and/or number of holidays in a sunny environment. All of these are examined in the context of case-control studies with a long lag time from exposure to disease, so that accurate recall may be a problem. In addition, it seems likely that several of the UVR-related disorders have a complex relationship to UVR exposure that may not be directly 'more is worse'. Thus, both melanoma and basal cell carcinoma may be more related to the intermittency of high-dose exposure than high-dose exposure per se (*39*).

For each disease, a Microsoft Excel spreadsheet was developed to record data from case-control and ecological studies for each disease. The location of the study was recorded and latitude assigned using the Longman Atlas (*40*).

Population attributable fractions (PAFs) were calculated using the method of Bruzzi (*41*), i.e.

$$AR_C = 1 - \sum_j \frac{p_j}{\widetilde{R}_j}$$

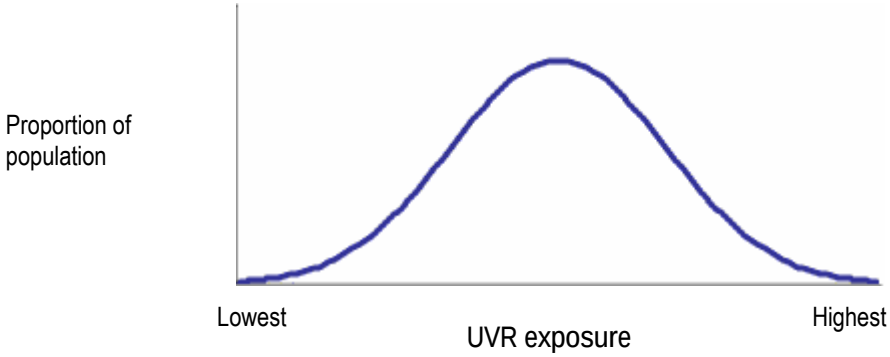
where AR_c is the attributable risk adjusted for confounding, p_j is the proportion of cases in the jth stratum of exposure, and R_j is the adjusted relative risk for the jth stratum of exposure compared to the unexposed group

Appendix 2 and Appendix 3 give details of the results of these calculations. PAF was graphed according to the latitude at which the study was undertaken and a PAF for each disease for each ten degree band of latitude was then derived from the line of best fit.

For those diseases for which there are both ecologic and case-control studies, there are very wide differences in calculated PAF. Thus for cutaneous malignant melanoma, Armstrong calculated a PAF of 0.96 for males and 0.92 for females by comparing the incidence of disease in US white populations with US black populations (*42*). The PAF calculated from case-control studies is however of the order of 0.2, with a small (non-significant) latitudinal gradient (independent of the exposure measure used in the study). In such cases, lower and upper estimates of the PAF were provided to take account of this variation.

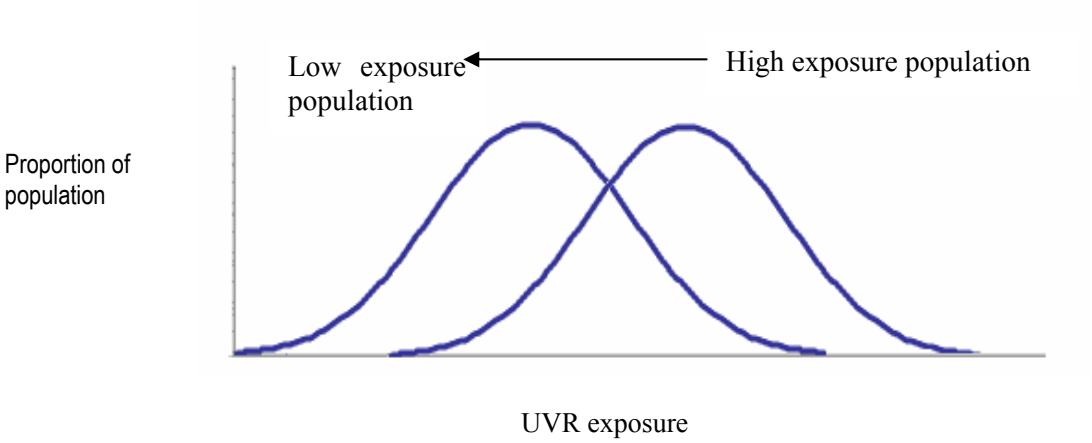
It is clear that PAFs calculated from different study types are estimating quite different parameters. The low PAFs, based on individual-level data and comparisons, are subject to substantial recall error, and this (as predominantly random misclassification of individual exposure) will generally cause an attenuation of the estimated relative risk. Further, that type of study does not compare exposed and unexposed groups (or even absolutely high and low groups) – rather, it compares individual level risks between relatively higher and lower exposure groups within a single population. For both reasons, the calculated PAF from case-controls studies does not truly capture the full attributable risk within the study population overall. Figure 2.2 represents the distribution of UVR exposure in a theoretical population. The PAF calculated from case control studies examines the risk of disease in those with highest UVR exposure, compared to those with lower UVR exposure, under this distribution of UVR exposure.

Figure 2.1 Distribution of UVR exposure in a theoretical population



On the other hand, the PAF calculated from ecologic studies compares the incidence of disease in quite different populations. It represents a distribution of exposure in one population that could be shifted to a lower level of exposure, on a population basis (see Figure 2.3).

Figure 2.2 Distribution of UVR exposure in two different (theoretical) populations



In summary, comparative risk assessment using counterfactual analysis uses the population attributable fraction (PAF), defined as "the proportional reduction in disease that would occur if exposure to the risk factor were reduced to zero" (*4*). PAF is based on relative risk, which provides an estimate of disease risk under a certain exposure distribution, compared to disease risk under a counterfactual exposure distribution – in case control studies this counterfactual is specific to the population under consideration and consists of "lesser exposure" (rather than no exposure, since in most populations everyone has some UVR exposure). In addition, "exposure" is difficult to measure with accuracy, being based on recall of events, often from many years earlier. Estimates of PAF from case control studies will thus be conservatively biased. In ecological studies, we can compare the disease incidence in populations having high ambient UVR (our current best measure of population UVR exposure) to disease incidence in populations with low exposure – either in low ambient locations (in which case the counterfactual is lower "exposure" and the calculated PAF will tend to be conservatively biased) or in deeply pigmented populations (in which case, the effective biological exposure may be very low, or zero). However even the latter may be conservatively biased, since paler populations tend to live in low sun exposure areas and more deeply pigmented populations in higher sun exposure areas.

We have presented the data using calculations of PAF from both ecologic and case control studies in an "upper estimates" and "lower estimates" form. It is likely that the true burden of disease attributable to UVR exposure lies somewhere between.

2.4 Development of disease models

Data on disease course, case fatality rates etc from varied parts of the world were recorded to enable construction of disease outcome models. (See Appendix 2 for details of the studies used for these data). Disease models were then refined in consultation with clinical experts.

Development of disease models recognizes that for every diagnosis of a disease there may be a continuing stream of disability over the remaining life course. Diagnosis may be followed by premature death after some period of morbidity, cure with no subsequent disease but initial morbidity, or initial cure, followed by relapse. Disability is calculated for each stage of the disease model.

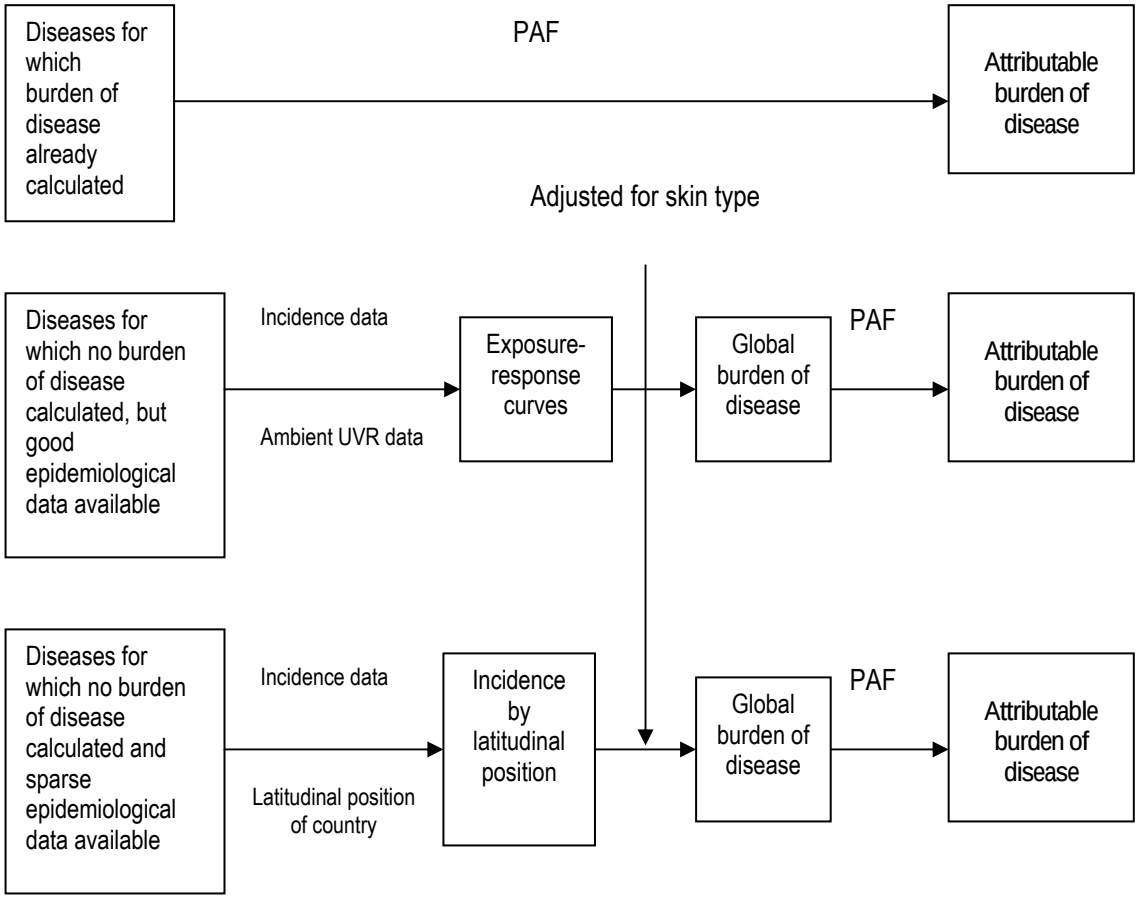
As disease outcome may vary with adequacy of available health services, separate disease models were developed for WHO ABC subregions and DE subregions (see Annex 4). The disease burden was estimated for the year 2000.

Disability weights were assigned according to the GBD 1990 study (*43*) in the first instance. Those not available from this study were taken from the Dutch study (*44*) or the Australian Burden of Disease Study (*45*). For those diseases for which no disability weight was available, we imputed a weight based on diseases or illnesses that we considered to have similar disability, as it was outside the scope of this study to carry out a thorough estimate for new disability weights.

3. Burden of Disease Assessment

The three different methodologies used to calculate the burden of disease are represented schematically in Figure 3.1.

Figure 3.1 Methods of calculating attributable burden



3.1 Diseases with pre-existing BOD analyses completed

The burden of disease from these diseases is available in the Global Burden of Disease statistics (available at www.who.int/evidence/bod). The calculated attributable fractions for UVR exposure were applied to these estimates.

3.2 Diseases where adequate epidemiological data are available

Exposure response curves were developed as outlined in Section 2.2 and disease models as outlined in Section 2.4.

Population-weighted annual averaged (1997-2003) ambient erythemally weighted UVR for each country was calculated. Using the exposure-incidence rate curves (Section 2.2), age, sex and country specific incidence rates were derived and applied to the population of each country to obtain estimates of the number of cases in each age and gender group in each country.

These case numbers were then summed to the WHO sub-region level. Incidence rate to mortality rate ratios were derived from the Australian Burden of Disease and Injury Study (*45*) and applied to the age and country-specific incidence rates to obtain mortality rates. These were applied to the country population (by age and gender group) to obtain estimates of number of deaths, which were then summed to the WHO sub-region level. Overall regional mortality rates were calculated from the total number of deaths for the region per year, divided by the total population (by age and gender).

3.3 Diseases with scanty global data

For each WHO region, countries were assigned to bands of ten degrees of latitude. For those countries that spanned several bands, a proportion of the population was assigned to each band by inspection of maps of population density (*46*). (See Appendix 4).

For each country, the population was separated into three pigment groups using available data on race and ethnicity by country (*47*). The proportions in each pigment group were assumed to hold for each age group and similar proportions were assumed to inhabit each different band of latitude for that country. (See Appendix 5).

For each latitude band, the population in each pigment group was summed to give, for each WHO sub-region, several bands of latitude, with a total population for each band, subdivided into three groups by pigmentation.

Using available data, incidence and mortality rates (or prevalence) were extrapolated to areas that were data-poor but with similar populations at similar latitudes (as outlined in Section 2.2).

Tables of disease incidence (or prevalence) and mortality for each age group, pigment group and gender, for each latitude band were constructed. See Appendix 6.
A detailed model of each disease and its sequelae was constructed, assigning disability weights and duration of disease stage, either from the literature or estimated from similar diseases or sequelae.

Using the incidence and mortality data from 3.2 and 3.3 above, the burden of disease in DALYs was calculated for each WHO region. Following this the calculated population attributable fraction was applied to the estimated disease burden to obtain upper and lower estimates of the burden of disease attributable to excess UVR exposure.

Note that in order to evaluate the burden of disease due to UVR exposure we have estimated the global incidence of diseases that are related to UVR exposure and used PAFs to estimate the proportion of that disease that is due to UVR exposure. This means that although we have defined the theoretical counterfactual exposure of least disease burden, this is not specifically used in this assessment due to the lack of global data on its distribution. Although the PAF is calculated from case-control studies, there are no data on how the exposure of the control groups compares to this theoretical counterfactual. Control groups are not unexposed, but may already represent populations that have higher exposure than the counterfactual, thus causing us to underestimate the true risk from the exposure in case groups.

4. Outcome assessment for diseases caused by excessive UVR exposure

4.1 Cutaneous malignant melanoma

Incidence

For cutaneous melanoma, global data are available on incidence and mortality. The global burden of disease estimates for the year 2000 (available at www.who.int/evidence/bod) used incidence and mortality estimates from Globocan 2000 (*29*) to calculate the burden of disease due to melanoma. The assessment of the burden of disease due to UVR from melanoma was derived in the current work by applying the calculated population attributable fraction estimates to these data.

Population attributable fraction

The fraction of disease in the population attributable to UVR exposure has been estimated at 96% in males and 92% in females in the USA, by comparison of white and black populations (*42*). Comparison of white populations in New South Wales, Australia, with ethnically similar populations in England and Wales gives a PAF of 89% (males) and 79% (females) (*42*).

Examination of ecological and individual-level studies indicates little relationship of PAF to latitude (see Appendix 3). There is also little relationship between PAFs estimated from ecologic studies and those estimated from case-control studies. As discussed in section 2.3 above, this presumably reflects both a difficulty with measuring exposure and the difficulty in finding a truly non-exposed population as the control group in epidemiological studies.

We therefore did not apply a PAF which varies with latitude, but used constant PAFs for upper and lower estimates of the burden of disease from CMM, that is caused by UVR.

Estimation of disease burden

There is generally an increase in incidence of melanoma with decreasing latitude. This has been shown within the Nordic countries, the USA and Australia. However, this relationship does not persist across non-homogeneous populations – mortality from melanoma is four to six times higher in Nordic countries than in the Mediterranean countries (*48*) and there is an opposite relationship of melanoma incidence to latitude in Italy (*36*). Since melanoma is likely to be related to intermittent high intensity sun exposure, particularly in fair-skinned individuals, those at greatest risk are likely to be fair skinned people from higher latitudes who intermittently are exposed to high intensity UVR on holidays (*49*).

Langford used multilevel modeling to examine the relationship between melanoma mortality and UVB exposure in several countries (*50*). He found that the United Kingdom, Ireland, Belgium and the Netherlands generally showed a positive relationship, whereas France showed very little relationship, Italy showed a negative relationship. Germany and Denmark, while having higher rates of melanoma mortality, did not show a positive relationship of UVB exposure with mortality.

Few studies have been done in dark-skinned populations and these have been mainly descriptive. In these populations, the incidence of melanoma is very low and the behaviour of the disease is quite different – melanoma occurs at a later age and affects the plantar and palmar surfaces of the feet and hands. This is unlikely to be due to UVR exposure (lack of exposure to this site) and may represent a baseline of incidence of cutaneous melanoma.

WHO has estimated the burden of disease for the year 2000 (*51, 52*) from cutaneous malignant melanoma using incidence and mortality data derived from Globocan 2000 (*29*). As noted in Appendix 3, case control studies indicate that the population attributable fraction

is approximately 0.2. However, it seems likely that there is a great deal of error inherent in the exposure measurement in these individual-level epidemiological studies that may systematically bias the effect estimate towards the null. Thus, upper (0.9, derived from ecological data) and lower (0.5, based on a consensus of expert opinion) estimates for population attributable fraction were applied to the WHO melanoma GBD estimates (see Appendix 3 for full explanation).

The global incidence and mortality from cutaneous malignant melanoma are summarized in Tables 4.1 and 4.2. The global burden of disease as estimated by WHO is summarized in Table 4.3. The attributable burden of disease was obtained by multiplying the PAF with the burden of disease in each age group and WHO subregion. The disease burden attributable to UVR exposure in the year 2000 is summarized in Tables 4.4 (upper estimates) and 4.5 (lower estimates).

Table 4.1 Incident cases of Malignant Melanoma 2000
by 17 WHO subregions (see Appendix 4)

MALE

AGE	RO1	RO2	RO3	RO4	RO5	RO6	RO7	RO8	RO9	RO10	RO11	RO12	RO13	RO14	RO15	RO16	RO17	Total
0-4	18	32	21	0	4	0	1	6	0	0	3	14	44	0	0	1	0	144
5-14	13	12	0	25	57	1	4	60	1	1	0	5	95	0	1	2	1	277
15-29	177	410	1 492	201	32	19	28	668	100	14	153	42	131	139	80	8	4	3 696
30-44	300	600	9 507	920	82	32	50	3 197	515	26	787	91	191	663	173	12	8	17 155
45-59	1 045	1 057	18 376	1 307	235	117	44	5 884	891	72	1 277	330	402	1 709	909	33	28	33 715
60-69	942	771	13 054	1 189	194	84	33	5 179	755	94	1 075	439	583	1 509	778	33	20	26 733
70-79	778	504	15 606	1 235	196	63	20	5 727	726	86	757	241	489	1 883	520	33	13	28 876
80+	305	222	6 609	668	165	20	6	2 811	314	16	212	82	204	1 001	146	22	7	12 812
Total	3 577	3 608	64 665	5 546	963	336	185	23 533	3 303	309	4 264	1 244	2 139	6 904	2 606	143	82	123 408

FEMALE

AGE	RO1	RO2	RO3	RO4	RO5	RO6	RO7	RO8	RO9	RO10	RO11	RO12	RO13	RO14	RO15	RO16	RO17	Total
0-4	7	1	0	6	0	0	0	7	3	0	0	0	24	0	4	1	0	55
5-14	7	2	32	23	16	2	3	12	10	1	5	0	81	21	23	4	1	245
15-29	130	218	1 149	368	54	48	42	1 282	169	31	364	75	88	278	114	10	4	4 423
30-44	210	363	5 574	1 088	136	86	73	4 096	587	28	1 267	268	121	872	424	27	13	15 233
45-59	591	597	7 693	1 343	211	72	93	6 348	805	54	1 353	493	464	1 103	675	20	33	21 950
60-69	1 024	1 198	5 202	981	185	84	43	4 452	634	71	1 311	472	442	786	425	20	8	17 337
70-79	969	1 413	4 736	878	163	52	40	5 206	694	55	1 048	399	286	839	353	6	4	17 140
80+	321	473	2 157	973	181	17	9	5 134	576	53	588	166	164	1 116	194	5	2	12 131
Total	3 258	4 266	26 542	5 660	946	362	304	26 537	3 477	294	5 937	1 873	1 671	5 016	2 214	93	66	88 514

BOTH SEXES

AGE	RO1	RO2	RO3	RO4	RO5	RO6	RO7	RO8	RO9	RO10	RO11	RO12	RO13	RO14	RO15	RO16	RO17	Total
0-4	25	34	21	6	4	1	2	13	3	0	3	14	68	0	4	2	0	199
5-14	20	14	32	48	73	3	7	72	11	2	5	5	176	21	24	6	2	521
15-29	306	628	2 641	569	86	66	70	1 950	269	45	517	117	219	418	193	17	7	8 119
30-44	510	963	15 080	2 008	218	119	122	7 293	1 102	54	2 054	359	313	1 535	597	39	22	32 387
45-59	1 636	1 654	26 069	2 650	446	189	137	12 232	1 696	125	2 630	823	867	2 812	1 584	53	62	55 665
60-69	1 966	1 969	18 256	2 170	379	168	76	9 632	1 390	165	2 386	911	1 025	2 295	1 203	53	28	44 070
70-79	1 746	1 917	20 342	2 113	358	115	59	10 932	1 420	141	1 805	640	775	2 722	874	39	17	46 017
80+	626	695	8 767	1 641	346	37	15	7946	889	70	801	248	369	2 118	340	27	10	24 943
Total	6 835	7 874	91 207	11 206	1 909	698	489	50 070	6 780	603	10 200	3 117	3 810	11 919	4 820	236	147	211 921

Table 4.2 Mortality from Malignant Melanoma 2000 (0.1% of total global mortality) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	7	12	1	3	2	0	1	1	0	0	1	18	2	0	48
5-14	4	4	1	16	3	0	1	2	3	4	0	34	0	0	74
15-29	48	185	105	84	8	24	43	121	64	39	3	87	17	27	853
30-44	88	300	745	293	13	61	79	716	222	386	8	132	102	98	3 244
45-59	327	599	1 947	704	46	55	270	1 661	477	1 093	85	384	320	378	8 344
60-69	458	575	1 715	610	46	117	215	1 660	497	1 060	177	187	351	397	8 066
70-79	573	399	2 014	590	67	149	31	2 102	464	1 007	105	268	454	283	8 508
80+	304	229	1 730	429	48	48	16	1 716	307	435	51	183	409	129	6 035
TOTAL	1 810	2 303	8 258	2 729	232	455	656	7 980	2 034	4 023	429	1 294	1 655	1 313	35 171

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	6	1	2	9	0	0	6	0	7	2	0	4	0	2	39
5-14	3	1	2	3	0	1	16	1	4	0	0	11	2	8	51
15-29	20	66	56	60	7	69	49	100	28	72	17	48	20	33	646
30-44	52	163	385	233	20	11	81	505	180	418	62	77	76	129	2 391
45-59	222	314	831	364	48	45	124	1 126	352	900	123	251	160	225	5 085
60-69	669	800	728	368	56	35	148	1 072	328	924	129	212	142	196	5 809
70-79	864	1 298	1 031	506	74	100	94	1 710	537	1 202	226	122	237	195	8 199
80+	317	469	1 405	497	58	11	36	2 598	592	976	100	69	483	158	7 770
TOTAL	2 152	3 113	4 441	2 040	263	273	555	7 112	2 027	4 495	658	794	1120	947	29 990

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	13	13	3	12	2	0	7	1	7	2	1	22	2	2	87
5-14	7	5	3	19	3	1	17	3	7	4	0	45	2	8	125
15-29	68	251	161	144	15	93	92	221	92	111	20	135	37	60	1 499
30-44	140	463	1 130	526	33	72	160	1 221	402	804	70	209	178	227	5 635
45-59	349	913	2 778	1 068	94	100	394	2 787	829	1 993	208	635	480	603	13 429
60-69	1 127	1 375	2 443	978	102	152	363	2 732	825	1 984	306	399	493	593	13 875
70-79	1 437	1 697	3 045	1 096	141	249	125	3 812	1 001	2 209	331	390	691	478	16 707
80+	621	698	3 135	926	106	59	52	4 314	899	1 411	151	252	892	287	13 805
TOTAL	3 962	5 416	12 699	4 769	495	727	1211	15 092	4 061	8 517	1 087	2 089	2 775	2 260	65 161

Table 4.3 Disease burden due to malignant melanoma in DALYs (000) by 14 WHO subregions (see Annex 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.241	0.425	0.031	0.103	0.059	0.005	0.031	0.044	0.000	0.000	0.021	0.625	0.083	0.003	1.672
5-14	0.164	0.150	0.040	0.614	0.135	0.005	0.049	0.083	0.122	0.141	0.014	1.306	0.000	0.015	2.839
15-29	1.625	6.200	3.658	2.805	0.273	0.830	1.416	4.219	2.157	1.293	0.105	2.975	0.622	0.901	29.077
30-44	2.249	7.697	19.531	7.230	0.300	1.568	1.972	18.658	5.581	9.362	0.215	3.290	2.830	2.434	82.916
45-59	5.129	9.329	32.651	11.123	0.707	0.867	4.114	27.022	7.874	17.962	1.205	6.184	5.487	5.881	135.536
60-69	4.079	5.360	16.767	5.629	0.427	1.095	2.060	16.018	4.578	10.007	1.665	1.675	3.565	3.709	76.633
70-79	2.854	1.987	10.997	3.048	0.342	0.736	0.177	11.370	2.398	5.372	0.534	1.331	2.658	1.433	45.235
80+	0.721	0.548	3.829	0.920	0.108	0.089	0.041	3.652	0.632	0.874	0.117	0.412	0.986	0.306	13.235
TOTAL	17.062	31.696	87.505	31.471	2.350	5.195	9.859	81.067	23.341	45.011	3.876	17.798	16.230	14.681	387.144

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.217	0.039	0.080	0.323	0.000	0.006	0.208	0.000	0.255	0.055	0.000	0.146	0.000	0.057	1.386
5-14	0.106	0.034	0.075	0.116	0.000	0.029	0.590	0.040	0.141	0.000	0.001	0.442	0.092	0.308	1.974
15-29	0.709	2.294	2.158	2.082	0.236	2.375	1.690	3.804	0.959	2.496	0.587	1.682	0.839	1.151	23.064
30-44	1.351	4.180	10.977	5.907	0.491	0.274	2.041	13.954	4.580	10.586	1.586	1.991	2.318	3.295	63.533
45-59	3.610	5.151	15.257	6.233	0.803	0.842	2.070	19.808	6.029	15.228	2.086	4.158	3.032	3.788	88.094
60-69	6.502	7.674	7.847	3.680	0.542	0.382	1.521	11.453	3.283	9.469	1.267	2.146	1.598	1.985	59.349
70-79	4.975	7.447	6.213	2.844	0.430	0.565	0.559	10.264	3.003	6.977	1.294	0.701	1.495	1.127	47.895
80+	0.830	1.241	3.136	1.098	0.142	0.031	0.093	5.731	1.355	2.212	0.253	0.172	1.110	0.405	17.810
TOTAL	18.301	28.061	45.742	22.285	2.644	4.505	8.772	65.052	19.606	47.024	7.075	11.438	10.484	12.117	303.104

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.458	0.464	0.111	0.426	0.059	0.011	0.239	0.044	0.255	0.055	0.021	0.771	0.083	0.060	3.058
5-14	0.270	0.184	0.115	0.730	0.135	0.034	0.639	0.123	0.263	0.141	0.015	1.748	0.092	0.323	4.812
15-29	2.333	8.495	5.815	4.887	0.509	3.205	3.106	8.023	3.116	3.789	0.693	4.657	1.460	2.052	52.141
30-44	3.600	11.877	30.508	13.137	0.791	1.842	4.013	32.612	10.161	19.948	1.801	5.280	5.148	5.729	146.449
45-59	8.739	14.480	47.908	17.357	1.509	1.710	6.184	46.830	13.902	33.190	3.291	10.342	8.519	9.669	223.630
60-69	10.581	13.034	24.614	9.310	0.968	1.477	3.580	27.471	7.861	19.476	2.932	3.821	5.163	5.694	135.982
70-79	7.830	9.434	17.210	5.892	0.772	1.301	0.736	21.633	5.401	12.350	1.828	2.032	4.153	2.560	93.130
80+	1.551	1.790	6.965	2.018	0.250	0.120	0.134	9.383	1.988	3.086	0.370	0.584	2.095	0.710	31.045
TOTAL	35.363	59.757	133.247	53.756	4.994	9.700	18.631	146.120	42.948	92.034	10.950	29.237	26.715	26.797	690.248

Table 4.4 Disease burden from malignant melanoma attributable to ultraviolet radiation DALYs (000) – upper estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.217	0.383	0.028	0.092	0.053	0.004	0.028	0.040	0.000	0.000	0.019	0.563	0.075	0.003	1.505
5-14	0.147	0.135	0.036	0.553	0.121	0.004	0.044	0.075	0.110	0.127	0.012	1.176	0.000	0.013	2.555
15-29	1.462	5.580	3.292	2.524	0.245	0.747	1.274	3.797	1.941	1.164	0.095	2.677	0.560	0.811	26.170
30-44	2.024	6.927	17.578	6.507	0.270	1.411	1.774	16.792	5.023	8.426	0.194	2.961	2.547	2.190	74.625
45-59	4.616	8.396	29.386	10.011	0.636	0.781	3.703	24.320	7.086	16.166	1.085	5.566	4.938	5.293	121.982
60-69	3.671	4.824	15.090	5.066	0.384	0.985	1.854	14.416	4.120	9.006	1.498	1.508	3.208	3.338	68.970
70-79	2.569	1.788	9.897	2.743	0.308	0.662	0.159	10.233	2.158	4.835	0.480	1.198	2.392	1.289	40.712
80+	0.649	0.493	3.446	0.828	0.097	0.080	0.037	3.287	0.569	0.786	0.106	0.371	0.887	0.275	11.912
TOTAL	15.356	28.527	78.755	28.324	2.115	4.675	8.873	72.961	21.007	40.510	3.488	16.019	14.607	13.212	348.429

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.195	0.035	0.072	0.291	0.000	0.006	0.187	0.000	0.229	0.049	0.000	0.131	0.000	0.051	1.248
5-14	0.096	0.030	0.067	0.105	0.000	0.026	0.531	0.036	0.127	0.000	0.001	0.398	0.083	0.278	1.776
15-29	0.638	2.065	1.942	1.874	0.212	2.138	1.521	3.424	0.863	2.247	0.529	1.514	0.755	1.036	20.757
30-44	1.216	3.762	9.879	5.317	0.442	0.247	1.837	12.558	4.122	9.527	1.427	1.792	2.086	2.966	57.179
45-59	3.249	4.636	13.731	5.610	0.722	0.758	1.863	17.827	5.426	13.705	1.878	3.742	2.729	3.410	79.285
60-69	5.852	6.907	7.062	3.312	0.487	0.344	1.369	10.307	2.955	8.522	1.141	1.932	1.438	1.786	53.414
70-79	4.478	6.702	5.591	2.560	0.387	0.509	0.503	9.237	2.703	6.280	1.165	0.631	1.346	1.015	43.106
80+	0.747	1.117	2.823	0.988	0.128	0.027	0.084	5.158	1.220	1.991	0.228	0.155	0.999	0.364	16.029
TOTAL	16.471	25.255	41.168	20.056	2.379	4.054	7.895	58.547	17.645	42.321	6.367	10.294	9.436	10.905	272.794

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.412	0.418	0.100	0.383	0.053	0.010	0.215	0.040	0.229	0.049	0.019	0.694	0.075	0.054	2.752
5-14	0.243	0.165	0.104	0.657	0.121	0.031	0.575	0.111	0.237	0.127	0.013	1.573	0.083	0.291	4.331
15-29	2.100	7.645	5.234	4.398	0.458	2.885	2.795	7.221	2.805	3.410	0.623	4.191	1.314	1.846	46.927
30-44	3.240	10.690	27.457	11.823	0.712	1.658	3.612	29.351	9.145	17.953	1.621	4.752	4.633	5.156	131.804
45-59	7.865	13.032	43.117	15.621	1.358	1.539	5.565	42.147	12.512	29.871	2.962	9.308	7.667	8.702	201.267
60-69	9.523	11.731	22.152	8.379	0.871	1.329	3.222	24.724	7.075	17.528	2.639	3.439	4.647	5.125	122.384
70-79	7.047	8.490	15.489	5.303	0.695	1.171	0.662	19.470	4.861	11.115	1.645	1.829	3.738	2.304	83.817
80+	1.396	1.611	6.269	1.816	0.225	0.108	0.120	8.445	1.789	2.777	0.333	0.525	1.886	0.639	27.940
TOTAL	31.826	53.782	119.922	48.381	4.495	8.730	16.768	131.508	38.653	82.831	9.855	26.313	24.043	24.117	621.223

Table 4.5 Disease burden from malignant melanoma attributable to ultraviolet radiation DALYs (000) – lower estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.120	0.213	0.016	0.051	0.030	0.002	0.016	0.022	0.000	0.000	0.010	0.313	0.042	0.002	0.836
5-14	0.082	0.075	0.020	0.307	0.067	0.002	0.025	0.042	0.061	0.070	0.007	0.653	0.000	0.007	1.419
15-29	0.812	3.100	1.829	1.402	0.136	0.415	0.708	2.110	1.078	0.646	0.053	1.487	0.311	0.450	14.539
30-44	1.125	3.848	9.766	3.615	0.150	0.784	0.986	9.329	2.790	4.681	0.108	1.645	1.415	1.217	41.458
45-59	2.565	4.664	16.326	5.562	0.353	0.434	2.057	13.511	3.937	8.981	0.603	3.092	2.743	2.940	67.768
60-69	2.039	2.680	8.383	2.815	0.213	0.547	1.030	8.009	2.289	5.003	0.832	0.838	1.782	1.855	38.317
70-79	1.427	0.993	5.499	1.524	0.171	0.368	0.088	5.685	1.199	2.686	0.267	0.666	1.329	0.716	22.618
80+	0.361	0.274	1.915	0.460	0.054	0.045	0.020	1.826	0.316	0.437	0.059	0.206	0.493	0.153	6.618
TOTAL	8.531	15.848	43.753	15.736	1.175	2.597	4.930	40.534	11.671	22.505	1.938	8.899	8.115	7.340	193.572

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.108	0.020	0.040	0.162	0.000	0.003	0.104	0.000	0.127	0.027	0.000	0.073	0.000	0.028	0.693
5-14	0.053	0.017	0.037	0.058	0.000	0.014	0.295	0.020	0.071	0.000	0.000	0.221	0.046	0.154	0.987
15-29	0.354	1.147	1.079	1.041	0.118	1.188	0.845	1.902	0.480	1.248	0.294	0.841	0.419	0.575	11.532
30-44	0.675	2.090	5.489	2.954	0.246	0.137	1.021	6.977	2.290	5.293	0.793	0.995	1.159	1.648	31.766
45-59	1.805	2.576	7.628	3.117	0.401	0.421	1.035	9.904	3.014	7.614	1.043	2.079	1.516	1.894	44.047
60-69	3.251	3.837	3.923	1.840	0.271	0.191	0.760	5.726	1.641	4.735	0.634	1.073	0.799	0.992	29.675
70-79	2.488	3.723	3.106	1.422	0.215	0.283	0.280	5.132	1.502	3.489	0.647	0.350	0.748	0.564	23.948
80+	0.415	0.621	1.568	0.549	0.071	0.015	0.046	2.866	0.678	1.106	0.126	0.086	0.555	0.202	8.905
TOTAL	9.150	14.031	22.871	11.142	1.322	2.252	4.386	32.526	9.803	23.512	3.537	5.719	5.242	6.058	151.552

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.229	0.232	0.055	0.213	0.030	0.005	0.120	0.022	0.127	0.027	0.010	0.386	0.042	0.030	1.529
5-14	0.135	0.092	0.058	0.365	0.067	0.017	0.320	0.062	0.132	0.070	0.007	0.874	0.046	0.162	2.406
15-29	1.167	4.247	2.908	2.444	0.254	1.603	1.553	4.012	1.558	1.895	0.346	2.329	0.730	1.026	26.070
30-44	1.800	5.939	15.254	6.568	0.396	0.921	2.006	16.306	5.080	9.974	0.901	2.640	2.574	2.865	73.224
45-59	4.370	7.240	23.954	8.678	0.755	0.855	3.092	23.415	6.951	16.595	1.646	5.171	4.260	4.835	111.815
60-69	5.291	6.517	12.307	4.655	0.484	0.738	1.790	13.735	3.930	9.738	1.466	1.911	2.581	2.847	67.991
70-79	3.915	4.717	8.605	2.946	0.386	0.650	0.368	10.817	2.700	6.175	0.914	1.016	2.077	1.280	46.565
80+	0.776	0.895	3.483	1.009	0.125	0.060	0.067	4.692	0.994	1.543	0.185	0.292	1.048	0.355	15.522
TOTAL	17.681	29.879	66.623	26.878	2.497	4.850	9.316	73.060	21.474	46.017	5.475	14.618	13.357	13.399	345.124

4.2 Squamous cell carcinoma

Disease incidence

We reviewed epidemiologic studies examining the incidence, and mortality of squamous cell carcinoma of the skin (SCC). While incidence varies with latitude (decreasing incidence with increasing latitude) and is increasing over time (*53*), there are great difficulties in obtaining comprehensive global data on current incidence rates.

Few cancer registries record incidence of non-melanoma skin cancers and those that do rely on notification, with or without histological proof, of the diagnosis of SCC. A number of SCC may be misclassified as solar keratoses, and many may be removed in a way that destroys tissue, making histological confirmation impossible. It is likely that there is considerable underreporting of SCC and we are reliant on those studies that have prospectively surveyed a random sample of the population with dermatological examination, and then repeated this at a later time.

The disadvantage of such studies is that unless the sample size or the incidence is great, the number of incident cases may be small, giving an unreliable estimate (*54*). In addition, most studies are carried out on predominantly white populations, so that the incidence and risk factors for SCC in black populations are even less clear.

The incidence of SCC is rising by 3-7% per year in most countries, so that deriving incidence data from studies undertaken at different times does not give comparable results that can be used as an incidence rate in 2000. To take account of this, incidence data from epidemiological studies were recorded by age group, study year and study location. All age group data were converted to the standard age groups used in burden of disease analysis, using DISMOD II. Latitude and longitude coordinates for each study location were assigned according to the Longman Atlas (*40*). Annual erythemally weighted UVR data were derived from monthly estimates for the year of the study. Thus for each study location age-specific incidence and annual ambient UVR data were available. These data formed the basis of "dose-response" plots for each gender within each age group. Subsequent incidence rate data were derived from the averaged annual ambient UVR (1997-2003) for each country, weighted by population distribution, and applied to the population estimates (by age and gender) for 2000 (*46*).

Incidence rates for those of intermediate and deeply pigmented skins were calculated by applying a multiplier to the rates for lightly-pigmented populations, based on studies that compared rates in different groups (*34, 55*), i.e. 0.1 for intermediate pigmentation, 0.018 for deeply pigmented populations. These rates were then generalized to populations with no data, on the basis of annual ambient UVR levels and skin pigmentation distribution. Note that Hoy (*34*) found a gender difference in the comparison of incidence rates in Hispanic and non-Hispanic whites, i.e. for age standardized incidence rates, Hispanic males had one-tenth the incidence rate for non-Hispanic males, whereas for females the incidence rate in Hispanic women was 0.4 times that of non-Hispanic women. In this study non-Hispanic women had very low rates of SCC compared to those in white populations in other epidemiological studies and this may have a behavioural explanation peculiar to this population. For this reason, the comparative rate for males was used to adjust the incidence rate for lightly pigmented populations to an incidence rate for populations of intermediate pigmentation for both genders.

In deeply pigmented populations, SCC seems to arise in areas of chronic inflammation and scarring, e.g. sites of tropical ulcers. While this has been interpreted as possibly due to the effects of UVR exposure on the depigmented scar tissue (*56*), it also may be unrelated to UVR exposure as many SCC occur on non-sun-exposed sites (*13*). There does appear to be a

latitudinal gradient in the incidence of SCC in deeply pigmented persons (*57*) and SCC, while uncommon, is more common than BCC.

Population attributable fraction

The population attributable fraction was estimated from case-control studies using the methods described in section 2.3 (see Appendix 3). PAF was graphed by latitude. While the trendline is suggestive of a latitudinal gradient in PAF, this is not significant ($p = 0.55$). The PAF applied to the burden of disease estimates was constant across all latitudes.

The mean PAF from case-controls studies was 0.35, intercept (extrapolated) is 0.5 and there is no significant latitudinal gradient. As case-control studies tend to give low PAF because of difficulties in measuring exposure and in defining a non-exposed population we assumed a lower estimate of PAF of 0.5 and an upper estimate of 0.7 in lightly pigmented groups, based on the extensive epidemiological experience of members of this working group. We could find no studies examining the PAF in intermediate and deeply pigmented populations, however it is likely that UVR is considerably less important in the causation of SCC in these populations. Based on limited epidemiological data (see Appendix 3), we have assigned a PAF for intermediate pigmented populations that is one-fifth that of white populations, and for deeply pigmented populations, a PAF one-fifth of that of the intermediate populations.

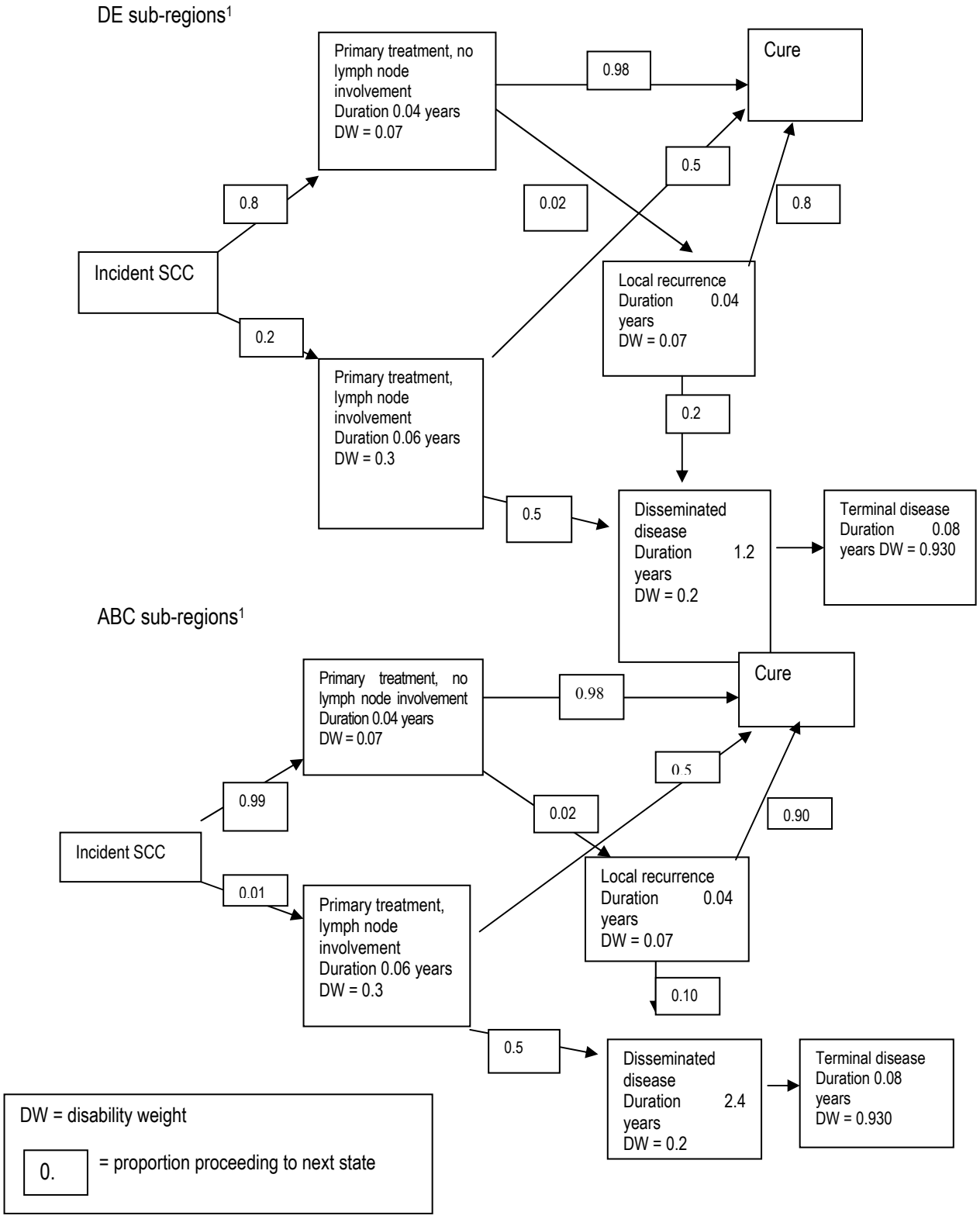
Disease model

Mortality rates were estimated by investigating the relationship between incidence and mortality rates in the Australian setting, for non-melanoma skin cancer (NMSC) (*45*). Weinstock notes that SCC is twelve times more likely to lead to death than BCC (*55*). Using these proportions, the mortality rate for NMSC was split into a rate for SCC and a rate for BCC. This incidence/mortality rate ratio was then applied to the incidence rate estimates for different age groups to define the mortality rate (see Appendix 3). Black populations, even in developed countries have much higher mortality rates from SCC – the disease presents later and tends to be more aggressive. In the series examined by Mora, there was an overall death rate of 18.4% (*58*). Marks (*59*) cites a case fatality rate in lightly pigmented populations, of 7/1000. The mortality to incidence rate ratio in black populations was assumed to be ten times that in white populations, with population groups with intermediate pigmentation having rate ratios between lightly and deeply pigmented populations (i.e. five times that of lightly pigmented populations). Few data are available for mortality rates in DE countries. While mortality rates are likely to be higher in DE countries than in ABC countries, no further adjustments were made to the mortality rates.

Figure 4.1 outlines the flow chart of the disease course for SCC. A, B, C and D,E countries were analyzed separately to take account of differences in stage of presentation and subsequent disease course due to variation in access to health care.

Incidence and mortality for SCC are summarized in Table 4.6 and Table 4.7 respectively. The burden of disease due to SCC in the year 2000 is summarized in Table 4.8 and the upper and lower estimates of disease burden due to SCC are summarized in Tables 4.9 and 4.10.

Figure 4.1 Disease model for SCC



1NB: See Annex 4 for definition of sub-regions

Table 4.6 Incident cases of SCC
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	5	7	46	78	7	73	51	44	47	29	15	55	21	315	793
15-29	16	24	166	349	29	274	179	163	176	91	79	228	102	1 224	3 099
30-44	485	766	3 757	12 172	1 212	7 227	5 830	2 617	2 585	945	3 484	7 337	1 901	26 281	76 599
45-59	1981	3 092	30 641	57 450	5 050	33 637	21 715	27 052	16 095	10 461	14 507	34 823	20 924	164 562	441 990
60-69	2 129	3 038	37 760	63 063	5 706	33 642	23 436	46 550	23 613	17 888	16 721	39 824	32 224	201 972	547 567
70-79	1 829	2 420	56 028	64 320	5 221	32 754	19 116	66 691	25 335	19 611	15 034	35 805	41 085	197548	582 798
80+	291	314	28 590	13 716	844	6 632	2 991	35 846	7 236	7 016	2 387	6 460	17 931	46 679	176 932
TOTAL	6 737	9 661	156 987	211 147	18 069	114 239	73 318	178 963	75 087	56 041	52 228	124 532	114 188	638 580	1 829 777

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	1	2	13	19	2	19	13	14	15	10	4	13	6	83	213
15-29	12	18	121	257	21	196	125	117	134	67	57	156	74	868	2 225
30-44	363	569	5 742	10 165	749	5 646	3 985	4 484	4 010	1 938	2 386	5 639	2 967	35 668	84 312
45-59	1 280	1 992	15 023	36 138	3 410	15 127	14 417	12 000	8 648	4 842	9 472	19 461	9 923	76 573	228 306
60-69	1092	1 648	15 856	31 695	2 866	13 481	11 507	18 663	11 677	8 741	8 569	18 059	13 034	76 837	233 724
70-79	790	1 203	26 444	29 656	2 150	11 912	7 721	34 405	14 877	15 644	6 384	13 982	19 566	84 703	269 438
80+	414	707	37 264	22 427	1 466	7 080	3 830	42 057	9 483	12 487	4 017	8 200	23 684	61 925	235 042
TOTAL	3 953	6 140	100 464	130 357	10 663	53 461	41 597	111 739	48 844	43 730	30 890	65 511	69 254	336 657	1 053 260

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	6	8	60	97	8	92	64	58	62	39	19	68	27	398	1 006
15-29	28	42	287	606	49	470	304	280	310	158	136	384	176	2 092	5 324
30-44	848	1 335	9 499	22 337	1 961	12 873	9 815	7 102	6 595	2 883	5 870	12 976	4 869	61 948	160 911
45-59	3 261	5 085	45 663	93 588	8 460	48 763	36 133	39 052	24 743	15 303	23 979	54 284	30 847	241 135	670 296
60-69	3 221	4 686	53 616	94 758	8 572	47 123	34 943	65 212	35 290	26 629	25 291	57 883	45 259	278 809	781 291
70-79	2 619	3 623	82 472	93 975	7 371	44 666	26 837	101 096	40 212	35 255	21 419	49 787	60 651	282 251	852 235
80+	706	1 021	65 854	36 143	2 310	13 713	6 820	77 903	16 719	19 503	6 404	14 660	41 614	108 604	411 974
TOTAL	10 690	15 800	257 452	341 504	28 732	167 700	114 915	290 702	123 931	99 771	83 118	190 043	183 442	975 237	2 883 037

Table 4.7 Deaths from SCC
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	1	1	1	4	1	1	2	1	1	0	3	7	0	7	29
45-59	23	25	49	128	20	50	60	39	23	15	85	246	30	279	1 072
60-69	42	44	101	233	38	83	106	112	57	43	166	474	78	572	2 149
70-79	41	43	160	272	41	91	104	167	65	47	174	491	106	599	2 402
80+	27	24	384	250	29	82	80	438	88	85	114	390	219	637	2 846
TOTAL	133	136	696	886	128	307	353	757	233	191	543	1 608	434	2 094	8 498

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-59	12	13	19	63	10	17	29	13	10	5	44	107	11	106	459
60-69	15	16	30	83	13	24	36	32	21	15	61	153	22	161	684
70-79	20	21	92	139	19	38	47	109	46	49	81	218	62	314	1 254
80+	27	32	342	279	33	60	64	351	81	104	128	338	198	603	2 639
TOTAL	74	83	483	565	76	139	176	505	157	173	313	815	293	1 184	5 036

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	1	1	1	4	1	1	2	1	1	0	3	7	0	7	29
45-59	35	38	67	191	30	67	89	52	33	20	129	353	41	385	1 531
60-69	57	60	132	316	51	106	142	144	78	58	227	627	101	733	2 833
70-79	61	64	253	410	60	129	152	275	110	97	255	709	168	913	3 656
80+	54	56	726	529	62	142	144	789	169	189	242	727	417	1 240	5 485
TOTAL	208	219	1179	1450	204	446	529	1262	390	364	856	2423	727	3 278	13 534

Table 4.8 Disease burden due to SCC in DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.002	0.000	0.002	0.008
15-29	0.001	0.001	0.001	0.002	0.001	0.001	0.007	0.001	0.001	0.000	0.000	0.009	0.001	0.006	0.032
30-44	0.038	0.052	0.040	0.158	0.062	0.073	0.272	0.026	0.026	0.009	0.087	0.454	0.019	0.298	1.616
45-59	0.520	0.610	1.101	2.778	0.574	1.147	1.994	0.884	0.530	0.345	1.722	6.085	0.686	6.293	25.269
60-69	0.654	0.713	1.580	3.520	0.733	1.307	2.348	1.774	0.897	0.686	2.374	8.008	1.230	8.863	34.687
70-79	0.447	0.482	1.733	2.805	0.574	0.999	1.678	1.852	0.725	0.543	1.680	5.852	1.178	6.507	27.057
80+	0.150	0.136	2.056	1.327	0.177	0.445	0.523	2.326	0.468	0.453	0.600	2.247	1.174	3.569	15.651
TOTAL	1.810	1.993	6.511	10.590	2.122	3.973	6.825	6.863	2.647	2.038	6.465	22.656	4.287	25.538	104.320

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.002
15-29	0.000	0.001	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.000	0.000	0.006	0.000	0.004	0.022
30-44	0.014	0.022	0.030	0.053	0.028	0.029	0.151	0.023	0.021	0.010	0.012	0.214	0.015	0.184	0.806
45-59	0.290	0.344	0.462	1.493	0.342	0.433	1.141	0.335	0.248	0.136	0.944	2.933	0.278	2.583	11.965
60-69	0.277	0.314	0.546	1.442	0.314	0.430	0.987	0.585	0.381	0.275	0.975	3.029	0.410	2.863	12.829
70-79	0.240	0.272	1.091	1.612	0.278	0.465	0.797	1.303	0.558	0.600	0.895	2.831	0.746	3.738	15.427
80+	0.178	0.215	2.040	1.689	0.245	0.375	0.523	2.089	0.491	0.627	0.766	2.286	1.201	3.796	16.521
TOTAL	0.999	1.168	4.169	6.290	1.209	1.734	3.604	4.337	1.700	1.649	3.593	11.300	2.651	13.170	57.573

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.003	0.000	0.002	0.010
15-29	0.001	0.002	0.001	0.003	0.002	0.002	0.012	0.001	0.002	0.001	0.001	0.015	0.001	0.011	0.054
30-44	0.052	0.073	0.070	0.211	0.090	0.103	0.423	0.049	0.047	0.019	0.100	0.667	0.035	0.483	2.422
45-59	0.810	0.954	1.563	4.272	0.916	1.580	3.135	1.219	0.779	0.481	2.667	9.018	0.964	8.876	37.234
60-69	0.931	1.027	2.125	4.962	1.048	1.738	3.335	2.359	1.279	0.962	3.350	11.037	1.639	11.727	47.517
70-79	0.687	0.754	2.824	4.417	0.852	1.464	2.475	3.156	1.283	1.143	2.575	8.683	1.924	10.246	42.484
80+	0.328	0.351	4.096	3.016	0.422	0.820	1.046	4.414	0.959	1.081	1.366	4.534	2.375	7.364	32.172
TOTAL	2.808	3.161	10.680	16.881	3.331	5.707	10.429	11.199	4.348	3.687	10.058	33.956	6.938	38.709	161.892

Table 4.9 Disease burden from SCC attributable to ultraviolet radiation DALYs (000) – upper estimates (by 14 WHO subregions, see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
15-29	0.000	0.000	0.001	0.001	0.000	0.001	0.004	0.001	0.001	0.000	0.000	0.001	0.000	0.004	0.015
30-44	0.003	0.017	0.027	0.099	0.029	0.051	0.156	0.018	0.018	0.007	0.023	0.066	0.013	0.201	0.730
45-59	0.045	0.196	0.755	1.738	0.264	0.798	1.145	0.618	0.371	0.241	0.456	0.890	0.479	4.251	12.249
60-69	0.057	0.229	1.083	2.202	0.337	0.910	1.348	1.241	0.628	0.480	0.628	1.172	0.859	5.988	17.162
70-79	0.039	0.155	1.189	1.755	0.264	0.696	0.964	1.296	0.507	0.380	0.445	0.856	0.823	4.396	13.764
80+	0.013	0.044	1.410	0.830	0.081	0.310	0.300	1.627	0.327	0.317	0.159	0.329	0.821	2.411	8.978
TOTAL	0.158	0.639	4.465	6.625	0.975	2.766	3.918	4.800	1.852	1.427	1.711	3.315	2.996	17.254	52.902

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
15-29	0.000	0.000	0.000	0.001	0.000	0.001	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.011
30-44	0.001	0.007	0.020	0.033	0.013	0.020	0.088	0.016	0.015	0.007	0.003	0.031	0.011	0.124	0.390
45-59	0.025	0.116	0.317	0.936	0.158	0.302	0.665	0.235	0.174	0.095	0.255	0.431	0.195	1.735	5.637
60-69	0.024	0.106	0.374	0.903	0.145	0.300	0.575	0.409	0.267	0.193	0.263	0.445	0.286	1.923	6.214
70-79	0.021	0.092	0.748	1.010	0.128	0.324	0.464	0.912	0.391	0.420	0.241	0.416	0.522	2.511	8.199
80+	0.015	0.073	1.400	1.059	0.113	0.262	0.305	1.461	0.343	0.439	0.207	0.336	0.839	2.549	9.400
TOTAL	0.087	0.395	2.860	3.941	0.558	1.209	2.100	3.033	1.190	1.154	0.970	1.659	1.853	8.845	29.853

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
15-29	0.000	0.001	0.001	0.002	0.001	0.002	0.007	0.001	0.001	0.001	0.000	0.002	0.001	0.007	0.026
30-44	0.004	0.024	0.048	0.132	0.042	0.072	0.244	0.035	0.033	0.014	0.026	0.098	0.024	0.325	1.120
45-59	0.070	0.312	1.072	2.674	0.422	1.100	1.810	0.853	0.545	0.337	0.711	1.321	0.674	5.987	17.886
60-69	0.081	0.335	1.457	3.105	0.482	1.210	1.923	1.650	0.895	0.673	0.891	1.616	1.146	7.911	23.377
70-79	0.060	0.246	1.937	2.764	0.392	1.020	1.428	2.207	0.898	0.800	0.686	1.272	1.345	6.907	21.963
80+	0.029	0.116	2.810	1.888	0.195	0.571	0.605	3.087	0.671	0.757	0.365	0.664	1.660	4.960	18.379
TOTAL	0.244	1.034	7.325	10.566	1.533	3.975	6.018	7.833	3.042	2.581	2.680	4.974	4.849	26.099	82.754

Table 4.10 Disease burden from SCC attributable to ultraviolet radiation DALYs (000) – lower estimates (by 14 WHO subregions, see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003
15-29	0.000	0.000	0.000	0.001	0.000	0.001	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.011
30-44	0.002	0.012	0.020	0.071	0.020	0.037	0.112	0.013	0.013	0.005	0.017	0.047	0.010	0.144	0.521
45-59	0.032	0.139	0.540	1.241	0.188	0.570	0.818	0.442	0.265	0.172	0.326	0.636	0.342	3.037	8.748
60-69	0.040	0.163	0.774	1.573	0.241	0.650	0.963	0.886	0.448	0.343	0.449	0.837	0.614	4.277	12.258
70-79	0.027	0.110	0.849	1.253	0.189	0.497	0.688	0.925	0.362	0.272	0.318	0.612	0.588	3.140	9.830
80+	0.009	0.031	1.007	0.593	0.058	0.221	0.214	1.162	0.234	0.227	0.113	0.235	0.586	1.722	6.413
TOTAL	0.111	0.455	3.189	4.732	0.697	1.976	2.799	3.429	1.323	1.019	1.222	2.368	2.140	12.324	37.784

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
15-29	0.000	0.000	0.000	0.001	0.000	0.001	0.002	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.008
30-44	0.001	0.005	0.015	0.024	0.009	0.015	0.063	0.012	0.011	0.005	0.002	0.022	0.008	0.088	0.279
45-59	0.018	0.083	0.226	0.668	0.113	0.216	0.475	0.168	0.124	0.068	0.182	0.308	0.139	1.239	4.026
60-69	0.017	0.076	0.267	0.645	0.104	0.214	0.411	0.292	0.191	0.138	0.188	0.318	0.205	1.374	4.438
70-79	0.015	0.066	0.535	0.721	0.092	0.232	0.331	0.651	0.279	0.300	0.172	0.297	0.373	1.793	5.856
80+	0.011	0.052	1.000	0.756	0.081	0.187	0.218	1.043	0.245	0.314	0.148	0.240	0.599	1.821	6.714
TOTAL	0.061	0.281	2.043	2.815	0.398	0.863	1.500	2.167	0.850	0.825	0.693	1.185	1.323	6.318	21.322

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
15-29	0.000	0.000	0.001	0.001	0.001	0.001	0.005	0.001	0.001	0.000	0.000	0.002	0.000	0.005	0.018
30-44	0.003	0.017	0.034	0.094	0.030	0.051	0.174	0.025	0.023	0.010	0.019	0.070	0.017	0.232	0.800
45-59	0.050	0.222	0.766	1.910	0.301	0.786	1.293	0.609	0.389	0.240	0.508	0.943	0.481	4.276	12.774
60-69	0.057	0.238	1.041	2.218	0.344	0.864	1.374	1.179	0.639	0.481	0.637	1.155	0.818	5.651	16.696
70-79	0.042	0.175	1.384	1.975	0.280	0.728	1.020	1.577	0.641	0.572	0.490	0.908	0.961	4.934	15.687
80+	0.020	0.083	2.007	1.349	0.139	0.408	0.432	2.205	0.479	0.540	0.261	0.475	1.186	3.543	13.127
TOTAL	0.172	0.737	5.232	7.547	1.095	2.839	4.298	5.595	2.173	1.844	1.914	3.553	3.464	18.642	59.106

4.3 Basal cell carcinoma

Disease incidence

Basal cell carcinomas (BCCs) are the most frequent cancers in a number of countries (*53*). While mortality from these cancers is low, there may be substantial morbidity from disfigurement (they are most often on the skin of the head and neck) and because of their high prevalence they represent a considerable medical expense. Many countries do not record incidence of BCC or only as a part of "non-melanoma skin cancer" (NMSC). Unfortunately, this category, as well as including SCC, can include Kaposi's sarcoma, histiocytoma of the skin and other skin tumours (*55*). This means that even those cancer registries that do record 'non-melanoma skin cancer' cannot be used as a source of incidence/prevalence/mortality data for BCC.

Many BCC are dealt with by a primary care physician and no histological confirmation of the diagnosis may be requested, or the method of removal may result in a specimen that is unsuitable for histological examination. Incidence must often be investigated by epidemiological studies of populations over several years. BCC and SCC are commonly multiple – studies may count number of people with lesions, or number of lesions, so care must be taken when using these data.

NMSC is uncommon in Asians, blacks and Hispanics. Unlike SCC, it appears that BCC in black patients is related to UVR exposure and is clinically and histologically similar to BCC in white patients (*60*). However, while the ratio of BCC to SCC in white populations appears to lie between 4:1 (higher latitudes) and 2.5:1(lower latitudes), SCC is more common than BCC in deeply pigmented populations.

Incidence of BCC was recorded as for SCC. Population level dose response curves were plotted and age-specific incidence derived from these as already outlined for SCC. Much of the epidemiological data on BCC comes from Australia, which has extremely high rates of incident BCC. Thus, efforts were made to also find non-Australian studies to contribute to the incidence rate data.

Basal cell carcinoma is uncommon in people of intermediate pigment and rare in those who are deeply pigmented. Data are scarce, so the data for the lightly pigmented were adjusted with multipliers across all latitudes and age groups as follows: intermediate skin pigmentation – female - 0.21, male - 0.14 (*34*); deeply pigmented – 0.002 (*61, 62*).

Population attributable fraction

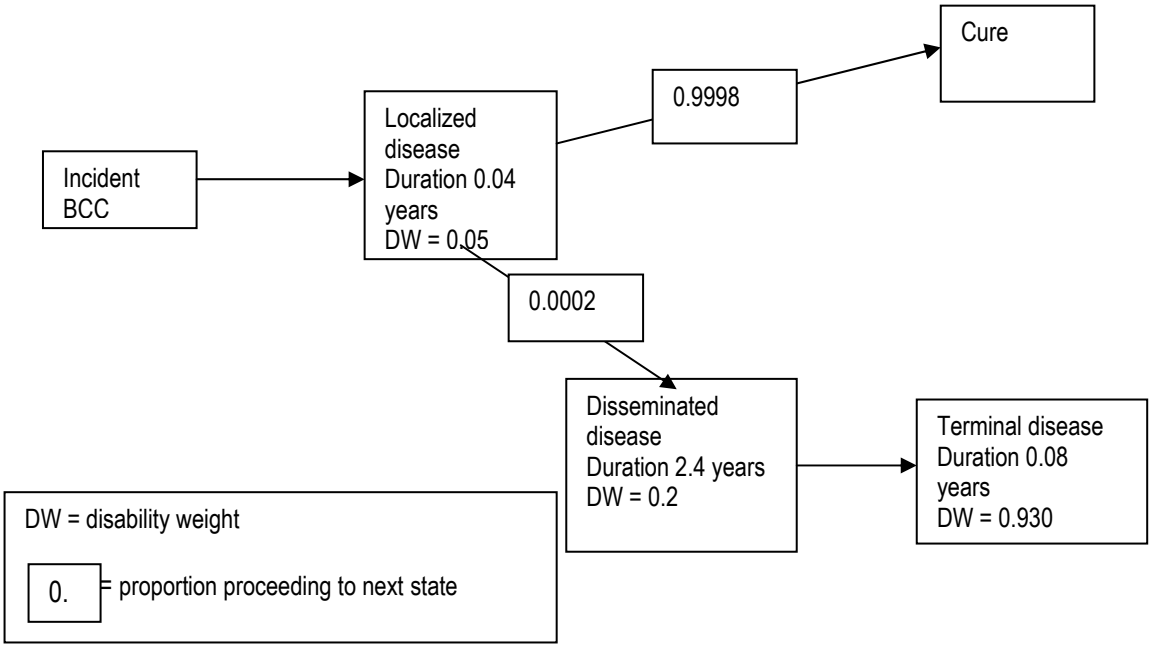
Case-control studies were examined to calculate PAF. Similarly to melanoma, there is little latitudinal gradient of PAF ($p = 0.32$) and the calculated PAF seems quite low (intercept = 0.33). If one applies a similar analysis of PAF based on the difference in incidence in Caucasian and African Americans that Armstrong has done for melanoma (*42*), the PAF would similarly be of the order of 0.9 to 1.00, (see Appendix 3). Basal cell carcinoma, like melanoma, may have a complicated dose-response relationship, which is difficult to examine with case-control studies. A lower estimate of 0.50 and an upper estimate of 0.9 were applied to the calculated burden of disease estimates, (see Appendix 3).

Disease characteristics

Metastasis and mortality due to BCC are very rare. Case fatality rates vary from <1 in 4000 (< 0.025%) (*63*) to 0.05% (1 in 2000) (*64*). Information on mortality rates is scarce, with most references quoting rates for non-melanoma skin cancer, with no distinction between SCC, BCC and other types of skin cancer. Mortality rates were calculated as for SCC, by using a ratio in relation to incidence. The results of this method were compatible with the few

published mortality rates for BCC (*55, 65*). Figure 4.2 summarizes the flow diagram for the disease course for BCC.

Figure 4.2 Disease model for BCC – all regions



Many of those with non-melanoma skin cancer have multiple lesions, particularly at lower latitudes (*66*). Most studies to date have recorded the incidence rate as number of persons with incident disease (and this is used in this assessment). However, this clearly does not truly capture the burden of disease due to non-melanoma skin cancers. A person having multiple BCC removed has a higher burden of disease than a person having one BCC removed – but how much higher? Presumably removal of ten BCC does not attract ten times the disability of having one removed. The epidemiological data are too sparse to include multiple lesions in the current assessment, but future disease models should attempt to include multiple lesions in the analysis. Tables 4.11 and 4.12 summarize the incidence and mortality for BCC; Table 4.13 summarizes the burden of disease due to BCC; Tables 4.14 and 4.15 summarize the burden of disease from BCC that is attributable to UVR exposure in the year 2000 (upper and lower estimates).

Table 4.11 Incident cases of BCC
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	1	2	12	34	4	27	31	8	13	4	9	32	6	86	270
5-14	15	19	184	437	47	371	303	143	187	87	116	407	82	1 347	3 744
15-29	536	737	7 658	19 910	1 918	14 380	10 585	6 684	8 048	3 450	5 844	17 110	4 647	59 103	160 611
30-44	3 474	5 179	32 573	171 459	30 156	92 300	113 117	26 257	22 218	11 158	73 678	134 157	16 338	237 911	969 975
45-59	4 408	6 752	95 771	244 201	33 593	135 982	109 865	95 175	51 293	40 052	89 573	189 944	65 003	520 668	1 682 280
60-69	2 744	3 659	135 758	146 494	11 290	80 687	52 059	194 807	87 079	83 691	41 519	122 279	119 901	682 871	1 764 837
70-79	1 952	2 125	147 879	116 638	8 271	61 366	33 407	199 778	69 107	65 052	29 389	85 091	111 101	493 261	1 424 417
80+	658	600	51 973	49 890	5 848	19 529	13 615	57 557	12 517	10 517	14 216	31 354	31 279	92 499	392 053
TOTAL	13 789	19 072	471 807	749 063	91 128	404 644	332 982	580 409	250 462	214 012	254 344	580 374	348 357	2 087 745	6 398 187

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	5	5	56	111	13	89	79	58	63	40	37	137	25	367	1 084
15-29	292	328	1 824	9 552	1 630	5 141	5 859	1 690	2 189	936	4 442	9 684	1 062	15 069	59 697
30-44	4 157	4 663	34 848	169 306	30 186	63 342	91 958	29 642	24 641	13 758	86 356	156 331	17 397	246 483	973 067
45-59	3 691	4 383	70 526	163 317	22 131	59 447	72 775	73 481	40 864	36 432	72 390	155 993	46 792	347 473	1 169 694
60-69	2 136	2 404	52 561	91 690	11 253	34 914	36 489	81 165	42 115	46 862	40 915	94 066	44 017	242 024	822 610
70-79	1 067	1 115	52 911	52 449	5 091	19 020	15 330	87 303	33 799	46 477	18 378	45 078	39 490	160 913	578 420
80+	553	679	83 878	39 112	2 656	11 741	7 118	105 700	21 570	33 928	9 675	25 983	53 680	133 678	529 950
TOTAL	11 900	13 575	296 604	525 538	72 959	193 694	229 606	379 037	165 242	178 434	232 193	487 272	202 463	1 146 007	4 134 524

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	1	2	12	34	4	27	31	8	13	4	9	32	6	86	270
5-14	20	24	240	547	60	460	383	202	250	127	153	544	107	1 713	4 829
15-29	828	1 064	9 481	29 463	3 548	19 522	16 444	8 373	10 237	4 386	10 286	26 794	5 709	74 173	220 308
30-44	7 631	9 842	67 421	340 765	60 342	155 642	205 074	55 899	46 860	24 916	160 034	290 488	33 735	484 394	1 943 042
45-59	8 099	11 135	166 296	407 518	55 724	195 429	182 639	168 656	92 157	76 484	161963	345 937	111 795	868 141	2 851 974
60-69	4 879	6 063	188 320	238 184	22 543	115 601	88 548	275 971	129 194	130 553	82 434	216 345	163 918	924 895	2 587 447
70-79	3 019	3 239	200 790	169 087	13 362	80 386	48 737	287 081	102 906	111 529	47 767	130 169	150 591	654 173	2 002 837
80+	1 211	1 279	135 851	89 002	8 504	31 270	20 733	163 257	34 087	44 445	23 891	57 337	84 959	226 178	922 004
TOTAL	25 689	32 648	768 410	1 274 600	164 087	598 337	562 589	959 447	415 704	392 445	486 537	1 067 646	550 820	3 233 752	10 532 711

Table 4.12 Deaths from BCC in 2000
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	0	1	3	17	3	9	11	3	2	1	7	13	2	24	97
45-59	1	1	14	36	5	20	16	14	8	6	13	28	10	77	249
60-69	1	1	36	39	3	22	14	52	23	22	11	33	32	182	471
70-79	1	1	87	69	5	36	20	118	41	38	17	50	66	291	841
80+	1	1	68	65	8	25	18	75	16	14	19	41	41	121	511
TOTAL	4	5	209	226	24	113	79	262	90	82	68	165	150	695	2 170

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45-59	1	1	14	32	4	11	14	14	8	7	14	30	9	67	226
60-69	0	0	10	17	2	7	7	15	8	9	8	18	8	46	157
70-79	0	0	18	18	2	7	5	30	13	16	6	16	14	56	203
80+	1	1	77	36	2	11	7	98	20	31	9	24	50	123	489
TOTAL	2	2	120	103	11	36	33	158	50	63	37	88	81	293	1 076

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	0	1	3	17	3	9	11	3	2	1	7	13	2	24	97
45-59	1	2	28	68	9	32	30	28	15	13	27	58	19	144	475
60-69	1	1	46	57	5	28	21	67	32	31	19	51	40	228	628
70-79	2	2	106	87	7	43	25	148	54	55	24	66	79	347	1044
80+	1	1	145	101	10	36	24	173	37	45	27	65	90	244	1001
TOTAL	6	7	328	330	34	148	112	419	140	145	105	253	230	988	3245

Table 4.13 Disease burden due to BCC in DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
5-14	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.008
15-29	0.001	0.002	0.016	0.042	0.004	0.030	0.022	0.014	0.017	0.007	0.012	0.036	0.010	0.124	0.338
30-44	0.016	0.023	0.147	0.777	0.137	0.418	0.513	0.119	0.100	0.050	0.334	0.608	0.074	1.079	4.393
45-59	0.022	0.034	0.477	1.217	0.167	0.680	0.549	0.472	0.256	0.200	0.446	0.946	0.322	2.600	8.388
60-69	0.016	0.021	0.781	0.845	0.065	0.464	0.300	1.120	0.500	0.485	0.240	0.705	0.689	3.932	10.164
70-79	0.015	0.016	1.097	0.872	0.062	0.459	0.251	1.487	0.520	0.495	0.221	0.639	0.832	3.705	10.671
80+	0.006	0.005	0.446	0.433	0.051	0.169	0.120	0.488	0.106	0.089	0.125	0.276	0.267	0.825	3.406
TOTAL	0.075	0.101	2.964	4.186	0.486	2.222	1.756	3.700	1.500	1.327	1.379	3.211	2.193	12.268	37.369

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
15-29	0.001	0.001	0.004	0.020	0.003	0.011	0.012	0.004	0.005	0.002	0.009	0.020	0.002	0.032	0.126
30-44	0.009	0.010	0.073	0.357	0.064	0.133	0.194	0.062	0.054	0.029	0.182	0.329	0.037	0.519	2.051
45-59	0.022	0.027	0.429	0.994	0.135	0.363	0.444	0.445	0.246	0.222	0.440	0.948	0.283	2.121	7.119
60-69	0.011	0.012	0.263	0.460	0.056	0.175	0.183	0.406	0.218	0.236	0.206	0.472	0.220	1.213	4.132
70-79	0.006	0.006	0.303	0.303	0.029	0.110	0.089	0.500	0.209	0.269	0.107	0.261	0.227	0.930	3.351
80+	0.004	0.005	0.595	0.286	0.020	0.086	0.054	0.743	0.156	0.241	0.072	0.195	0.383	0.993	3.833
TOTAL	0.053	0.061	1.667	2.420	0.307	0.879	0.976	2.160	0.888	1.000	1.017	2.227	1.152	5.808	20.614

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
5-14	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.004	0.010
15-29	0.002	0.002	0.020	0.062	0.007	0.041	0.035	0.018	0.022	0.009	0.022	0.056	0.012	0.156	0.464
30-44	0.025	0.033	0.220	1.133	0.200	0.551	0.706	0.181	0.154	0.079	0.516	0.937	0.111	1.598	6.445
45-59	0.044	0.060	0.905	2.211	0.302	1.043	0.992	0.917	0.503	0.422	0.886	1.894	0.604	4.721	15.506
60-69	0.027	0.033	1.044	1.305	0.122	0.640	0.484	1.526	0.719	0.721	0.446	1.178	0.909	5.144	14.296
70-79	0.021	0.022	1.400	1.175	0.091	0.570	0.340	1.987	0.729	0.764	0.328	0.900	1.059	4.635	14.022
80+	0.010	0.010	1.041	0.718	0.071	0.255	0.174	1.231	0.262	0.331	0.198	0.471	0.650	1.818	7.239
TOTAL	0.128	0.162	4.631	6.607	0.794	3.100	2.732	5.860	2.389	2.326	2.396	5.438	3.345	18.076	57.983

Table 4.14 Disease burden from BCC attributable to ultraviolet radiation DALYs (000) – upper estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
5-14	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.007
15-29	0.001	0.001	0.015	0.038	0.004	0.027	0.020	0.013	0.015	0.007	0.011	0.032	0.009	0.112	0.304
30-44	0.014	0.021	0.132	0.699	0.123	0.376	0.461	0.107	0.090	0.045	0.300	0.547	0.066	0.971	3.954
45-59	0.020	0.030	0.429	1.095	0.151	0.612	0.494	0.425	0.231	0.180	0.401	0.852	0.289	2.340	7.549
60-69	0.014	0.019	0.703	0.760	0.059	0.418	0.270	1.008	0.450	0.436	0.216	0.635	0.620	3.539	9.147
70-79	0.013	0.014	0.987	0.785	0.056	0.413	0.226	1.339	0.468	0.445	0.199	0.575	0.749	3.335	9.604
80+	0.005	0.005	0.401	0.389	0.046	0.152	0.108	0.439	0.095	0.080	0.113	0.249	0.240	0.743	3.065
TOTAL	0.068	0.091	2.667	3.768	0.438	1.999	1.580	3.330	1.350	1.194	1.241	2.890	1.974	11.041	33.632

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
15-29	0.001	0.001	0.003	0.018	0.003	0.010	0.011	0.003	0.004	0.002	0.008	0.018	0.002	0.029	0.113
30-44	0.008	0.009	0.066	0.321	0.057	0.120	0.174	0.056	0.048	0.026	0.164	0.296	0.033	0.467	1.846
45-59	0.020	0.024	0.386	0.895	0.121	0.326	0.399	0.400	0.222	0.200	0.396	0.853	0.254	1.909	6.407
60-69	0.010	0.011	0.237	0.414	0.051	0.158	0.165	0.366	0.196	0.212	0.185	0.425	0.198	1.091	3.719
70-79	0.006	0.006	0.273	0.273	0.027	0.099	0.080	0.450	0.188	0.242	0.096	0.235	0.204	0.837	3.016
80+	0.004	0.005	0.536	0.257	0.018	0.077	0.048	0.668	0.140	0.217	0.065	0.176	0.345	0.893	3.450
TOTAL	0.048	0.055	1.500	2.178	0.277	0.791	0.878	1.944	0.799	0.900	0.915	2.004	1.037	5.227	18.553

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
5-14	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.003	0.009
15-29	0.002	0.002	0.018	0.056	0.007	0.037	0.031	0.016	0.019	0.008	0.019	0.051	0.011	0.141	0.417
30-44	0.022	0.030	0.198	1.020	0.180	0.496	0.636	0.163	0.139	0.071	0.464	0.843	0.099	1.438	5.800
45-59	0.040	0.054	0.815	1.990	0.272	0.939	0.893	0.825	0.452	0.380	0.798	1.705	0.544	4.249	13.956
60-69	0.024	0.030	0.939	1.175	0.109	0.576	0.435	1.374	0.647	0.649	0.401	1.060	0.818	4.630	12.866
70-79	0.019	0.020	1.260	1.058	0.082	0.513	0.306	1.788	0.657	0.687	0.295	0.810	0.953	4.171	12.620
80+	0.009	0.009	0.937	0.647	0.064	0.229	0.156	1.107	0.236	0.297	0.178	0.424	0.585	1.636	6.515
TOTAL	0.115	0.146	4.168	5.946	0.714	2.790	2.458	5.274	2.150	2.094	2.156	4.894	3.011	16.268	52.184

Table 4.15 Disease burden from BCC attributable to ultraviolet radiation DALYs (000) – lower estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
15-29	0.001	0.001	0.008	0.021	0.002	0.015	0.011	0.007	0.008	0.004	0.006	0.018	0.005	0.062	0.169
30-44	0.008	0.012	0.073	0.388	0.068	0.209	0.256	0.059	0.050	0.025	0.167	0.304	0.037	0.539	2.197
45-59	0.011	0.017	0.238	0.609	0.084	0.340	0.274	0.236	0.128	0.100	0.223	0.473	0.161	1.300	4.194
60-69	0.008	0.011	0.390	0.422	0.033	0.232	0.150	0.560	0.250	0.242	0.120	0.353	0.344	1.966	5.082
70-79	0.007	0.008	0.548	0.436	0.031	0.230	0.125	0.744	0.260	0.247	0.111	0.319	0.416	1.853	5.336
80+	0.003	0.003	0.223	0.216	0.026	0.084	0.060	0.244	0.053	0.045	0.063	0.138	0.134	0.413	1.703
TOTAL	0.038	0.051	1.482	2.093	0.243	1.111	0.878	1.850	0.750	0.663	0.690	1.605	1.097	6.134	18.685

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
15-29	0.000	0.000	0.002	0.010	0.002	0.005	0.006	0.002	0.002	0.001	0.005	0.010	0.001	0.016	0.063
30-44	0.004	0.005	0.037	0.178	0.032	0.067	0.097	0.031	0.027	0.014	0.091	0.165	0.018	0.260	1.026
45-59	0.011	0.013	0.214	0.497	0.067	0.181	0.222	0.222	0.123	0.111	0.220	0.474	0.141	1.060	3.559
60-69	0.005	0.006	0.132	0.230	0.028	0.088	0.092	0.203	0.109	0.118	0.103	0.236	0.110	0.606	2.066
70-79	0.003	0.003	0.151	0.151	0.015	0.055	0.045	0.250	0.105	0.135	0.053	0.131	0.114	0.465	1.675
80+	0.002	0.003	0.298	0.143	0.010	0.043	0.027	0.371	0.078	0.121	0.036	0.098	0.192	0.496	1.917
TOTAL	0.026	0.030	0.834	1.210	0.154	0.439	0.488	1.080	0.444	0.500	0.508	1.113	0.576	2.904	10.307

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.002	0.005
15-29	0.001	0.001	0.010	0.031	0.004	0.021	0.017	0.009	0.011	0.005	0.011	0.028	0.006	0.078	0.232
30-44	0.012	0.017	0.110	0.567	0.100	0.276	0.353	0.091	0.077	0.040	0.258	0.468	0.055	0.799	3.222
45-59	0.022	0.030	0.453	1.106	0.151	0.521	0.496	0.458	0.251	0.211	0.443	0.947	0.302	2.360	7.753
60-69	0.013	0.017	0.522	0.653	0.061	0.320	0.242	0.763	0.359	0.360	0.223	0.589	0.454	2.572	7.148
70-79	0.010	0.011	0.700	0.588	0.046	0.285	0.170	0.994	0.365	0.382	0.164	0.450	0.530	2.317	7.011
80+	0.005	0.005	0.521	0.359	0.035	0.127	0.087	0.615	0.131	0.165	0.099	0.236	0.325	0.909	3.620
TOTAL	0.064	0.081	2.315	3.303	0.397	1.550	1.366	2.930	1.194	1.163	1.198	2.719	1.673	9.038	28.991

4.4 Chronic sun damage/solar keratoses

Disease incidence

Although we may not like the appearance of our ageing skin, there is no disability in health terms from the wrinkling, actinic lentigines and actinic (solar) keratoses that constitute photoageing. There is however, a disability related to removal of solar keratoses and there is a recognized progression of solar keratoses (SK) to SCC. It appears that SK, dysplasia, SCC-in-situ and invasive SCC are a continuum and it may be difficult to delineate these clinically. Current treatment options include local destruction with cryotherapy, curettage, electrodessication, or topical application of aminolevulinic acid and light.

It is clear that not only is there a latitudinal gradient in the prevalence of persons with solar keratoses, but at lower latitudes, it is more likely that there will be multiple solar keratoses. It is important in evaluating studies to be clear whether they are measuring prevalent lesions, or 'persons with lesions' as some people have a large number of lesions. In the Nambour study (*67*) 10% of the population had more than one lesion, while in South Wales there was a median of 2 solar keratoses in those aged over 60 years (*54*). In the later part of the Nambour study (*68*), 18% of the study population had 11 or more solar keratoses.

A few studies have examined the prevalence of solar keratoses and using these data we have extrapolated to achieve a theoretical distribution of prevalence of solar keratoses by latitude and age (*54, 68-72*). From this the incidence rates for removal of SK and for malignant transformation were estimated.

Population attributable fraction

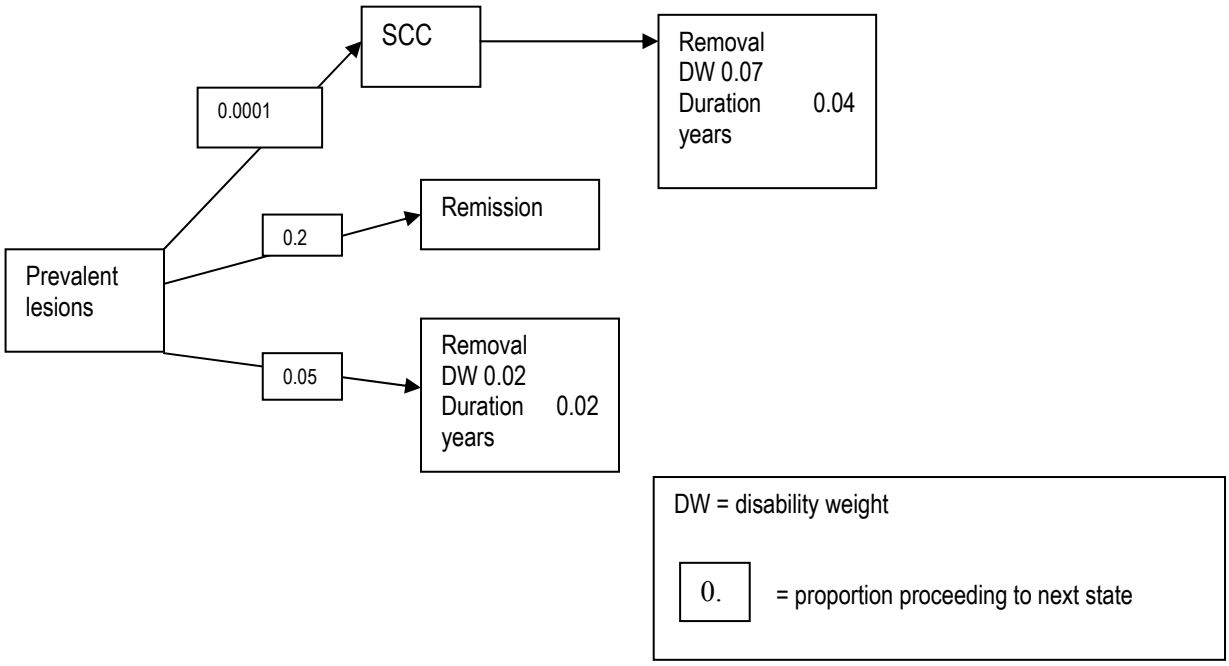
Chronic sun damage to the skin, or photoageing includes those sun-induced changes to the skin that, combined with the changes of intrinsic or chronologic ageing, represent the characteristic signs of ageing skin. Many of the changes in the skin that are evident with ageing are photo-induced (*73*).

Only solar keratoses are assessed in this report and they are considered to be entirely related to UVR exposure. (See appendix 3)

Disease model

From the epidemiological data we have assumed a removal rate of 5% (of those solar keratoses that do not remit) in developed countries, a zero removal rate in under-developed countries, a remission rate of 20% per year, (*54, 74*) and a progression to SCC of 0.01% per year (*75*). Figure 4.3 presents the disease model for solar keratoses.

Figure 4.3 Disease model for solar keratoses



Tables 4.16 to 4.17 summarize the prevalence and burden of disease due to solar keratoses (as part of the photoageing process).

Table 4.16 Prevalent persons with solar keratoses
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	1 270	27 580	358 289	767 805	43 427	554 168	289 306	308 131	336 321	85 589	50 008	7 935	316 817	3 446 324	6 592 970
30-44	6 586	186 617	5 872 608	5 734 145	239 382	4 013 297	1 802 422	6 995 676	4 170 761	2 813 945	390 819	52 517	3 713 439	38 410 568	74 402 782
45-59	5 503	174 078	8 754 162	5 909 085	203 461	4 095 124	1 609 478	10 554 675	4 912 268	3 981 146	311 019	41 899	7 920 583	46 772 556	95 245 037
60-69	2 625	77 791	5 634 194	3 214 432	104 333	2 191 993	836 400	10 548 280	4 246 878	4 113 056	162 098	24 186	5 921 548	27 340 613	64 418 427
70-79	1 303	31 779	4 457 224	1 875 245	55 224	1 212 758	371 928	8 264 776	2 561 876	2 830 309	86 443	11 466	3 838 172	14 031 807	39 630 310
80+	307	5 950	2 029 818	577 161	17 049	326 917	88 401	3 278 006	612 261	684 429	26 926	3 134	1 409 415	3 187 199	12 246 973
TOTAL	17 594	503 794	27 106 294	18 077 874	662 876	12 394 257	4 997 935	39 949 545	16 840 365	14 508 475	1 027 313	141 137	23 119 975	133 189 067	292 536 501

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	3 172	102 062	2 849 348	3 103 000	118 051	2 063 058	919 582	2 743 052	1 821 289	1 090 194	187 503	27 182	2 043 947	20 476 801	3 7548 242
45-59	5 917	188 813	8 969 150	6 339 515	214 578	3 637 145	1 703 897	10 688 037	5 063 708	4 565 229	325 348	44 340	7 973 923	43 680 059	9 3399 659
60-69	2 893	85 008	4 219 774	3 126 162	108 236	1 649 817	735 003	7 053 434	3 060 191	3 240 080	174 741	24 527	4 672 050	20 054 940	4 8206 856
70-79	1 513	46 070	4 541 544	2 202 398	60 398	1 085 944	371 117	7 730 689	2 571 785	3 159 231	100 128	12 096	4 282 375	14 187 061	4 0352 349
80+	429	14 753	3 379 996	878 219	21 604	335 179	99 124	5 085 134	929 380	1 333 264	39 627	3 278	2 603 518	5 235 202	19 958 702
TOTAL	13 924	436 707	23 959 813	15 649 289	522 866	8 771 143	3 828 723	33 300 347	13 446 352	13 388 000	827 347	111 423	21 575 814	103 634 063	239 465 811

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	1 270	27 580	358 289	767 805	43 427	554 168	289 306	308 131	336 321	85 589	50 008	7 935	316 817	3 446 324	6 592 970
30-44	9 758	288 679	8 721 956	8 837 146	357 433	6 076 356	2 722 004	9 738 729	5 992 050	3 904 140	578 321	79 699	5 757 386	58 887 369	111 951 026
45-59	11 420	362 891	17 723 312	12 248 600	418 039	7 732 268	3 313 375	21 242 712	9 975 976	8 546 375	636 367	86 239	15 894 506	90 452 615	188 644 695
60-69	5 518	162 799	9 853 968	6 340 594	212 569	3 841 809	1 571 402	17 601 714	7 307 069	7 353 137	336 840	48 713	10 593 598	47 395 553	112 625 284
70-79	2 816	77 849	8 998 768	4 077 643	115 622	2 298 702	743 046	15 995 466	5 133 660	5 989 540	186 571	23 562	8 120 547	28 218 869	79 982 661
80+	737	20 703	5 409 814	1 455 375	38 653	662 097	187 525	8 363 140	1 541 641	2 017 694	66 553	6 412	4 012 933	8 422 400	32 205 677
TOTAL	31 518	940 501	51 066 107	33 727 164	1 185 742	21 165 400	8 826 658	73 249 892	30 286 717	27 896 475	1854 660	252 561	44 695 788	236 823 130	532 002 313

Table 4.17 Burden of disease due to solar keratoses (=attributable BOD) DALYs (000) by 14 WHO subregions (see Appendix 4

(note that there is no mortality due to solar keratoses and the disease burden is fully attributable to UVR exposure)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.004	0.012	0.000	0.009	0.000	0.002	0.003	0.000	0.001	0.000	0.005	0.055	0.091
30-44	0.000	0.000	0.065	0.093	0.000	0.065	0.001	0.044	0.033	0.023	0.006	0.000	0.056	0.603	0.989
45-59	0.000	0.000	0.131	0.096	0.000	0.067	0.000	0.142	0.074	0.058	0.005	0.000	0.125	0.758	1.456
60-69	0.000	0.000	0.101	0.052	0.000	0.036	0.000	0.165	0.069	0.065	0.003	0.000	0.096	0.450	1.037
70-79	0.000	0.000	0.080	0.031	0.000	0.020	0.000	0.167	0.060	0.061	0.001	0.000	0.065	0.238	0.723
80+	0.000	0.000	0.047	0.009	0.000	0.005	0.000	0.102	0.030	0.025	0.000	0.000	0.026	0.060	0.304
TOTAL	0.000	0.000	0.429	0.294	0.000	0.201	0.001	0.622	0.268	0.232	0.017	0.000	0.374	2.163	4.601

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	0.000	0.000	0.036	0.050	0.000	0.034	0.000	0.020	0.017	0.009	0.003	0.000	0.032	0.325	0.526
45-59	0.000	0.000	0.113	0.103	0.000	0.059	0.000	0.095	0.050	0.047	0.005	0.000	0.123	0.694	1.289
60-69	0.000	0.000	0.091	0.051	0.000	0.027	0.000	0.146	0.065	0.062	0.003	0.000	0.079	0.338	0.862
70-79	0.000	0.000	0.071	0.036	0.000	0.018	0.000	0.116	0.045	0.051	0.002	0.000	0.070	0.233	0.642
80+	0.000	0.000	0.060	0.014	0.000	0.005	0.000	0.109	0.032	0.037	0.001	0.000	0.044	0.090	0.392
TOTAL	0.000	0.000	0.369	0.254	0.000	0.143	0.001	0.487	0.209	0.206	0.013	0.000	0.347	1.681	3.711

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.004	0.012	0.000	0.009	0.000	0.002	0.003	0.000	0.001	0.000	0.005	0.055	0.091
30-44	0.000	0.000	0.100	0.143	0.000	0.099	0.001	0.064	0.049	0.032	0.009	0.000	0.088	0.928	1.513
45-59	0.000	0.000	0.244	0.199	0.000	0.126	0.001	0.237	0.124	0.104	0.010	0.000	0.248	1.453	2.746
60-69	0.000	0.000	0.192	0.103	0.000	0.062	0.000	0.311	0.133	0.127	0.005	0.000	0.175	0.788	1.896
70-79	0.000	0.000	0.151	0.066	0.000	0.037	0.000	0.283	0.105	0.112	0.003	0.000	0.135	0.471	1.363
80+	0.000	0.000	0.107	0.024	0.000	0.011	0.000	0.211	0.062	0.062	0.001	0.000	0.070	0.150	0.698
TOTAL	0.000	0.000	0.798	0.548	0.000	0.344	0.002	1.108	0.477	0.438	0.030	0.000	0.721	3.844	8.311

4.5 Sunburn

Disease incidence

There is a paucity of data on the incidence of sunburn globally. Many studies report incidence over one or two weekends in the summer, (*76-78*) or hospital experience of sunburn (*79*) without relating this to a population incidence.

Characteristically, sunburn is uncommon in the very young, although if it does occur, it may be severe and even life threatening (*80*). The incidence rises through childhood and reaches a peak in adolescence and early adulthood (*81*). Studies vary as to relative incidence by sex (*78, 82*).

Many of the studies examining incidence of sunburn come from Australia and New Zealand and are confined to narrow age groups of later childhood and adolescence. Recent studies report that the incidence of sunburn, particularly amongst the young, continues to be very high. In the United States, 72% of youths 11-18 years reported at least one summer sunburn, and 12% reported at least 5 sunburns (*83*). In the United Kingdom, 48% of parents stated that their child had had at least one sunburn in the previous year (*84*). Even in Sweden, a high latitude country, 55% of respondents reported sunburn in the previous year (*85*). Diffey suggests that sunscreen may often be applied incorrectly, resulting in high doses of UVR exposure as people erroneously assume their skin is protected; doses of UVA may be particularly high if narrow-spectrum sunscreen is used (*86*).

We have used the age distribution outlined by Boldeman et al (*85*) for the Swedish population aged 13-50 years and incidence studies from other parts of the world, to derive a theoretical distribution of sunburn incidence by age and latitude (see Appendix 6).

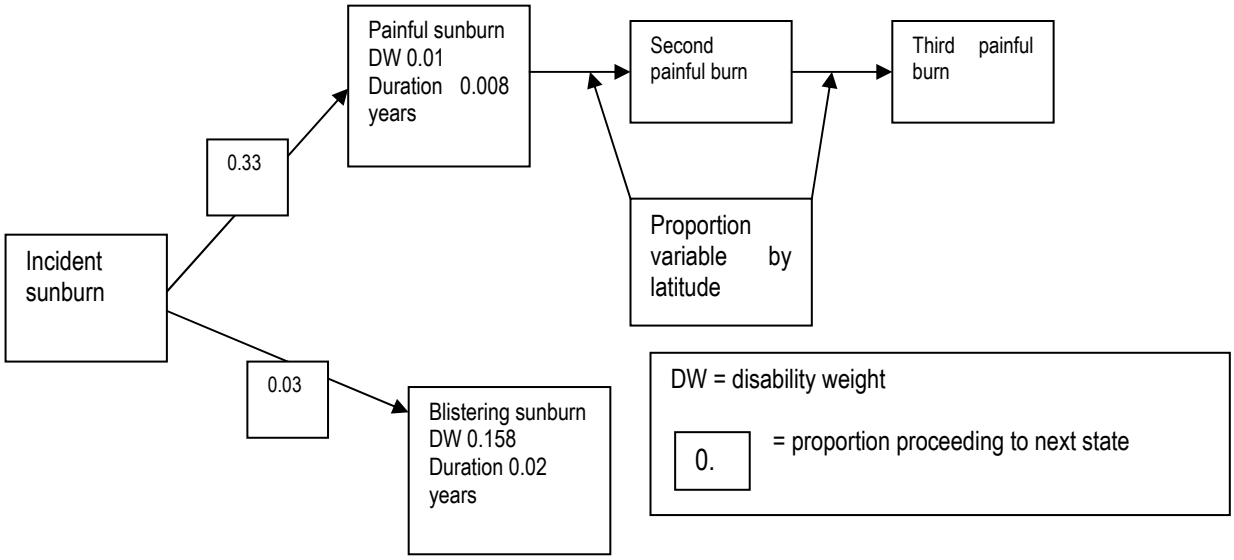
Population attributable fraction

Sunburn is considered totally attributable to UVR exposure, i.e. PAF = 100%

Disease model

Approximately 33% of all recorded sunburns are painful sunburns (*87-89*). Approximately 3% of all burns are severe, blistering burns (*87, 88*). The incidence of a second and third severe burn seems to vary with latitude, from 57% of those with painful sunburn having a second burn and 32% of these having a third burn at the lowest latitudes, to 15% and 8% respectively at higher latitudes. Figure 4.4 shows the disease model used for sunburn.

Figure 4.4 Disease model for sunburn



Sunburn per se is not considered to cause a disability, but there is a disability related to severe and blistering sunburns.

Almost all the available data on sunburn involves white populations. However, Hall et al (*90*) note that 6% of African Americans reported being extremely sensitive to the sun and had suffered severe sunburning, while 9% reported mild burns. This is in contrast to overall rates of any sunburn of 84% for lightly pigmented populations. There is no published detail regarding the depth of pigmentation in those who have suffered severe sunburn, but on the basis of these data (84% lightly pigmented report sunburn, compared to 9% deeply pigmented), and assuming it is applicable to deeply pigmented persons, we have applied a multiplier to the distribution of sunburn incidence in fair-skinned populations of 0.1 for those with deep pigment (9% is approximately 0.1*84%) and 0.5 for those of intermediate pigment (halfway between deeply pigmented and lightly pigmented persons) to obtain an incidence distribution in these populations. We have then applied the same breakdown of painful sunburn and blistering sunburn to this incidence distribution, with duration and disability weights as for lightly pigmented populations.

Tables 4.18 and 4.19 summarize the incidence and burden of disease due to sunburn, but it should be noted that these estimates are highly uncertain due to the paucity of good epidemiological data.

Table 4.18 Incident cases of sunburn 2000
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	854 925	802 746	1 579 535	3 436 242	584 572	1 987 848	3 194 318	1 471 602	1 489 794	735 602	1 851 959	7 919 779	809 178	11 439 715	38 157 815
5-14	3 857 723	3 663 400	10 680 544	19 173 192	2 796 064	12 184 612	15 178 505	11 801 964	10 172 833	7 929 205	9 649 675	44 391 359	4 759 849	74 534 048	230 772 973
15-29	4 169 002	3 651 086	16 800 360	26 230 559	3 240 908	15 719 390	16 892 545	23 906 063	17 668 507	16 065 886	13 956 763	56 725 595	10 056 333	112 428 380	337 511 377
30-44	1 815 561	1 565 226	14 712 885	14 193 593	1 446 684	7 416 760	8 084 110	21 165 584	10 495 391	11 775 258	7 672 841	29 946 165	7 205 341	79 486 508	216 981 907
45-59	753 059	649 617	9290 128	6 769 027	658 861	3 198 697	3 371 934	14 354 750	5 694 382	7 253 988	3 393 441	14 116 708	6 271 210	40 025 310	115 801 112
60-69	69 921	56 107	930 421	644 250	65 242	295 882	298 011	1 963 380	692 758	1 011 341	341 885	1 373 359	796 020	4 016 660	12 555 237
70-79	16 013	11 997	335 190	172 823	16 203	76 463	66 189	646 089	187 562	252 935	81 170	320 034	242 822	962 247	3 387 737
80+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	11 536 203	10 400 179	54 329 062	70 619 686	8 808 534	40 879 652	47 085 612	75 309 432	46 401 228	45 024 215	36 947 735	154 792 997	30 140 753	322 892 868	955 168 156

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	837 728	791 810	1 504 717	3 305 412	562 587	1 903 656	3 052 637	1 392 341	1 432 383	702 512	1 783 665	7 461 028	766 854	10 356 001	35 853 331
5-14	3 793 035	3 651 991	10 192 122	18 509 522	2 705 370	11 665 983	14 558 734	11 182 676	9 767 696	7 614 522	9 334 635	41 544 773	4 526 363	67 561 348	216 608 770
15-29	4 112 907	3 658 879	16 224 249	26 012 735	3 206 347	15 080 051	15 856 575	22 769 368	16 990 212	15 736 970	13 619 714	52 396 696	9 639 269	105 658 235	320 962 207
30-44	1 831 465	1 573 480	14 460 326	14 707 862	1 511 273	6 727 285	7 543 093	20 667 118	10 427 808	12 028 628	7 741 538	27 703 180	7 099 048	75 611 970	209 634 074
45-59	785 228	695 295	9 507 641	7 255 204	693 119	2 817 028	3 351 875	14 453 014	5 908 228	8 326 781	3 606 462	13 490 429	6 313 312	37 665 127	114 868 743
60-69	80 451	67 908	1 027 960	747 381	71 017	292 143	316 736	2 174 969	816 304	1 460 494	389 672	1 436 944	862 444	3 949 701	13 694 124
70-79	19 674	16 504	439 463	226 816	19 155	79 926	76 018	919 439	275 033	548 698	98 022	359 979	321 760	1 155 523	4 556 010
80+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	11 460 487	10 455 867	53 356 477	70 764 931	8 768 869	38 566 071	44 755 667	73 558 925	45 617 664	46 418 605	36 573 709	144 393 028	29 529 049	301 957 904	916 177 253

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	1 692 653	1 594 555	3 084 252	6 741 654	1 147 160	3 891 504	6 246 955	2 863 942	2 922 177	1 438 114	3 635 625	15 380 807	1 576 031	21 795 716	74 011 145
5-14	7 650 758	7 315 391	20 872 666	37 682 714	5 501 434	23 850 595	29 737 238	22 984 640	19 940 529	15 543 727	18 984 310	85 936 131	9 286 212	142 095 396	447 381 741
15-29	8 281 908	7 309 964	33 024 608	52 243 293	6 447 254	30 799 441	32 749 120	46 675 432	34 658 720	31 802 856	27 576 478	109 122 291	19 695 601	218 086 615	658 473 581
30-44	3 647 025	3 138 706	29 173 211	28 901 455	2 957 957	14 144 044	15 627 203	41 832 703	20 923 199	23 803 886	15 414 379	57 649 345	14 304 389	155 098 478	426 615 980
45-59	1 688 658	1 344 912	18 797 769	14 024 231	1 351 980	6 015 725	6 723 808	28 807 764	11 602 610	15 580 769	6 999 903	27 607 137	12 584 522	77 690 437	230 820 225
60-69	150 371	124 015	1 958 381	1 391 631	136 259	588 025	614 747	4 138 349	1 509 062	2 471 835	731 557	2 810 303	1 658 465	7 966 360	26 249 360
70-79	35 687	28 501	774 653	399 638	35 358	156 389	142 207	1 565 528	462 596	801 633	179 192	680 013	564 582	2 117 769	7 943 746
80+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	23 147 061	20 856 045	107 685 540	141 384 617	17 577 402	79 445 723	91 841 278	148 868 358	92 018 892	91 442 819	73 521 444	299 186 026	59 669 803	624 850 772	1 871 495 780

Table 4.19 Burden of disease due to sunburn (attributable BOD) DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.145	0.136	0.268	0.584	0.099	0.338	0.543	0.250	0.253	0.125	0.315	1.345	0.137	1.943	6.481
5-14	0.655	0.612	1.761	3.237	0.467	2.138	2.627	1.797	1.622	1.170	1.611	7.467	0.835	12.941	38.940
15-29	0.733	0.671	2.594	4.562	0.583	2.520	2.794	3.581	2.689	2.335	2.428	9.859	1.580	18.118	55.049
30-44	0.302	0.265	2.253	2.290	0.240	1.154	1.273	3.239	1.597	1.821	1.220	4.807	1.119	12.332	33.914
45-59	0.088	0.076	1.059	0.781	0.077	0.363	0.384	1.677	0.654	0.867	0.390	1.630	0.711	4.536	13.294
60-69	0.010	0.008	0.135	0.093	0.009	0.043	0.043	0.284	0.100	0.146	0.049	0.199	0.115	0.581	1.816
70-79	0.002	0.002	0.048	0.025	0.002	0.011	0.010	0.093	0.027	0.037	0.012	0.046	0.035	0.139	0.490
80+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	1.936	1.770	8.120	11.573	1.478	6.566	7.674	10.922	6.943	6.500	6.024	25.354	4.533	50.591	149.984

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.142	0.134	0.256	0.561	0.096	0.323	0.519	0.236	0.243	0.119	0.303	1.267	0.130	1.759	6.090
5-14	0.643	0.610	1.681	3.125	0.451	2.047	2.519	1.703	1.558	1.124	1.558	6.988	0.794	11.728	36.530
15-29	0.725	0.672	2.505	4.524	0.577	2.417	2.624	3.412	2.586	2.286	2.369	9.106	1.515	17.032	52.350
30-44	0.305	0.266	2.215	2.374	0.251	1.045	1.189	3.162	1.587	1.860	1.231	4.446	1.103	11.734	32.767
45-59	0.092	0.081	1.084	0.837	0.081	0.319	0.383	1.687	0.679	0.995	0.414	1.558	0.716	4.269	13.196
60-69	0.012	0.010	0.149	0.108	0.010	0.042	0.046	0.315	0.118	0.211	0.056	0.208	0.125	0.571	1.981
70-79	0.003	0.002	0.064	0.033	0.003	0.012	0.011	0.133	0.040	0.079	0.014	0.052	0.047	0.167	0.659
80+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	1.922	1.777	7.953	11.563	1.470	6.205	7.290	10.649	6.811	6.675	5.945	23.625	4.429	47.260	143.573

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.288	0.271	0.524	1.145	0.195	0.661	1.061	0.486	0.000	0.244	0.618	2.612	0.268	3.702	12.571
5-14	1.298	1.223	3.442	6.363	0.918	4.184	5.146	3.501	0.000	2.293	3.169	14.456	1.629	24.669	75.471
15-29	1.458	1.343	5.100	9.086	1.160	4.937	5.418	6.993	0.000	4.621	4.797	18.965	3.095	35.150	107.399
30-44	0.606	0.531	4.468	4.664	0.491	2.199	2.462	6.401	0.017	3.681	2.451	9.253	2.222	24.066	66.681
45-59	0.180	0.157	2.144	1.619	0.159	0.683	0.767	3.364	0.050	1.862	0.803	3.188	1.426	8.805	26.490
60-69	0.022	0.018	0.283	0.201	0.020	0.085	0.089	0.599	0.065	0.358	0.106	0.407	0.240	1.152	3.797
70-79	0.005	0.004	0.112	0.058	0.005	0.023	0.021	0.226	0.045	0.116	0.026	0.098	0.082	0.306	1.149
80+	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	3.857	3.547	16.073	23.136	2.948	12.771	14.964	21.571	13.754	13.176	11.969	48.979	8.962	97.851	293.557

4.6 Cortical cataract

Disease incidence

Early studies on cataract used a number of different definitions to define presence of cataract, making comparison of cataract rates in different locations very difficult. However, in later studies there is consistency in the definition of the various types of cataracts, which has led to reliable estimates from a number of parts of the world as to percentage of all cataracts that are cortical cataract, and cataract incidence, prevalence and progression.

While there does seem to be a latitudinal gradient in the proportion of all cataracts that are cortical, with higher proportions of cortical cataract at lower latitudes (*91-95*) the prevalence of cataract does not vary with latitude and, if there is any latitudinal variation, prevalence of cortical cataract increases with increasing latitude.

Population attributable fraction

Population attributable fractions were calculated from case-control studies for cortical cataract, and graphed against latitude (see cortical cataract workbook, Appendix 3). There was a non-significant latitudinal gradient ($p = 0.62$) with an intercept of 0.26, mean = 0.19. A PAF for UVR exposure causing cortical cataract of 0.2 was used in this assessment. This may be low due to recall inaccuracy as already noted, but reflects the efforts made in some cataract studies to accurately quantify the ocular UVR dose.

Disease model

Cataract per se attracts no disability weight – the disability results from loss of vision, from cataract surgery and from the increased mortality associated with visual impairment.

Few studies that have measured cortical cataract have also measured visual loss in those with cortical cataract. It does however, appear likely that cortical cataract is less likely to be associated with visual impairment than other forms of cataract, particularly mixed and nuclear cataract (*91, 96*). In addition, cortical cataract has a weaker relationship with mortality than other forms of cataract and is less likely to result in cataract surgery (*97, 98*).

The Barbados Eye Study (*91*) looking at visual impairment of greater than 20/40 due to cataract, found a prevalence of cortical cataract of 20.4%, over all age groups. In the Tibet Eye Study, also looking at visual impairment of greater than 20/40, a much higher proportion of cataracts were cortical, with little variation in different age groups – around 60% (*92*). In the POLA study, the proportion of those with cortical cataract who were visually impaired due to cataracts was 13-17% with little variation due to age (*94*).

For the purposes of this burden of disease study, the proportion of all cataracts causing visual loss that is due to cortical cataract is taken as 30% (average of above is 31%, range 13% to 60%). Cortical cataracts are likely to cause mild rather than moderate or severe visual loss and thus contribute less to the global burden of disease, based on disease severity, than other forms of cataract. However, mild visual loss is likely to be more prevalent than moderate or severe visual loss, and despite its lower severity, may thus contribute strongly to the total burden of disease due to cataract. We have therefore assumed that 25% of the total burden of disease due to cataract calculated by WHO for 2000 (*99*) is due to cortical cataract. The calculated PAF was applied to the resultant estimated burden of disease due to cortical cataract. Clearly this is only a rough approximation, and further work is needed in this area.

Table 4.20 summarizes the incidence of cataract globally; Table 4.21 summarizes the burden of disease due to all cataracts; Tables 4.22 and 4.23 summarize the burden of disease due to cortical cataract and the burden of disease due to cortical cataract that is attributable to UVR exposure.

Table 4.20 Incident cataracts 2000 (from GBD 2000, (99)) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	902	717	0	158	298	160	62	0	1	0	17	17	0	0	2 331
5-14	3 974	5 274	0	753	906	1 791	1 575	0	47	0	94	475	0	14	14 903
15-29	21 352	30 176	3	4 688	2 229	7 329	8 457	33	410	177	1,071	22 195	3	5 491	103 614
30-44	73 079	92 430	462	18 733	4 052	10 392	12 172	938	1 646	1 669	57 321	154 654	62	50 475	478 086
45-59	102 486	141 795	2 736	48 828	6 549	15 262	18 109	3 731	5 572	6 080	223 906	346 629	490	168 751	1 090 924
60-69	55 616	93 519	4 913	43 829	6 400	14 614	13 911	5 424	8 887	16 407	185 984	264 242	573	209 016	923 334
70-79	47 984	57 781	4 208	37 788	6 897	14 232	9 753	3 832	9 522	15 390	107 600	185 475	509	142 700	643 672
80+	21 988	17 566	3 418	20 343	3 444	7 594	4 395	1 797	4 200	5 121	39 458	76 967	266	39 472	246 029
TOTAL	327 380	439 260	15 740	175 120	30 776	71 375	68 433	15 755	30 285	44 844	615 450	1 050 653	1 904	615 918	3 502 893

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	277	139	0	7	202	350	835	5	0	0	6	8	0	0	1 830
5-14	1 416	1 132	0	40	690	2 709	2 616	26	0	2	59	74	1	13	8 777
15-29	25 441	19 238	21	709	2 122	9 350	8 407	199	8	19	1 255	24 748	9	1 121	92 648
30-44	83 281	115 153	875	8 251	5 922	8 370	14 266	2 131	424	1 036	51 378	202 143	80	34 837	528 147
45-59	112 447	210 370	3 878	67 924	9 574	18 677	21 597	4 709	7 095	5 682	261 318	472 273	534	196 400	1 392 478
60-69	90 460	149 902	5 309	73 539	7 979	19 833	16 225	6 027	13 086	13 001	279 070	356 219	707	240 608	1 271 965
70-79	74 803	96 158	5 792	61 497	11 055	19 894	12 725	5 378	15 879	26 587	167 921	272 985	743	183 990	955 407
80+	36 753	35 973	6 682	36 956	7 901	12 332	6 616	4 064	10 462	18 531	71 926	130 312	541	77 268	456 317
TOTAL	424 878	628 064	22 558	248 923	45 448	91 514	83 288	22 538	46 954	64 858	832 932	1 458 762	2 616	734 237	4 707 569

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	1 179	856	0	165	501	510	897	5	1	0	23	25	0	0	4 161
5-14	5 390	6 406	0	793	1 597	4 500	4 191	26	47	2	154	550	1	27	23 681
15-29	46 793	49 415	25	5 397	4 351	16 678	16 864	232	418	196	2 326	46 943	12	6 612	196 262
30-44	156 360	207 583	1 337	26 984	9 975	18 763	26 438	3 069	2 070	2 705	108 699	356 797	142	85 312	1 006 233
45-59	214 933	352 165	6 614	116 752	16 123	33 939	39 706	8 440	12 667	11 762	485 223	818 902	1 024	365 151	2 483 401
60-69	146 076	243 421	10 222	117 368	14 380	34 447	30 135	11 451	21 973	29 408	465 054	620 461	1 281	449 623	2 195 300
70-79	122 787	153 939	10 000	99 285	17 952	34 126	22 479	9 210	25 401	41 977	275 521	458 459	1 253	326 691	1 599 079
80+	58 741	53 539	10 099	57 299	11 346	19 926	11 011	5 860	14 662	23 652	111 384	207 279	807	116 739	702 346
TOTAL	752 258	1 067 324	38 297	424 042	76 223	162 889	151 721	38 293	77 239	109 702	1 448 383	2 509 415	4 520	1 350 155	8 210 462

Table 4.21 Burden of disease from cataract DALYs (000) (from GBD 2000, (99)) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.258	1.258
30-44	168.658	112.775	2.842	75.309	5.711	48.034	82.343	3.560	3.306	7.452	85.861	120.228	2.196	124.524	842.798
45-59	286.867	221.564	9.752	66.463	24.036	46.037	210.445	2.879	12.239	30.499	154.742	855.753	4.701	292.412	2 218.390
60-69	113.922	144.264	5.568	20.655	25.209	14.339	104.655	1.221	14.700	63.526	82.781	535.272	2.042	248.419	1 376.572
70-79	38.442	54.777	2.744	7.596	12.887	4.750	32.659	0.557	8.297	26.501	32.777	168.754	0.902	80.953	472.596
80+	5.457	7.881	0.596	1.259	2.129	0.602	4.666	0.123	1.288	2.683	5.322	27.020	0.163	10.209	69.398
TOTAL	613.345	541.261	21.502	171.282	69.972	113.762	434.768	8.341	39.830	130.662	361.483	1707.026	10.004	757.776	4 981.014

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	110.430	143.874	1.844	33.892	3.426	51.339	74.738	4.052	5.793	7.144	86.569	370.889	2.671	119.752	1 016.412
45-59	254.008	228.844	10.883	97.833	20.148	33.712	208.835	3.860	22.412	34.199	169.271	941.937	4.849	332.262	2 363.055
60-69	143.472	122.754	5.944	40.193	25.829	9.478	111.749	2.319	19.767	60.794	96.201	481.880	2.222	299.408	1 422.008
70-79	59.004	63.938	3.459	16.749	17.443	3.152	48.003	1.559	10.693	39.577	39.023	242.261	1.068	131.804	677.733
80+	10.034	13.673	1.040	3.074	3.735	0.452	7.364	0.565	2.050	6.607	7.149	44.090	0.361	24.382	124.578
TOTAL	576.948	573.083	23.169	191.741	70.580	98.133	450.690	12.356	60.715	148.321	398.213	2081.056	11.172	907.609	5 603.786

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.258	1.258
30-44	279.088	256.649	4.685	109.201	9.137	99.372	157.081	7.612	9.099	14.596	172.430	491.116	4.868	244.276	1 859.211
45-59	540.875	450.408	20.635	164.296	44.184	79.749	419.280	6.739	34.652	64.698	324.012	1 797.690	9.550	624.674	4 581.445
60-69	257.393	267.018	11.512	60.848	51.037	23.817	216.404	3.540	34.467	124.320	178.983	1 017.152	4.263	547.828	2 798.580
70-79	97.445	118.716	6.203	24.344	30.330	7.903	80.662	2.117	18.990	66.079	71.800	411.014	1.970	212.757	1 150.329
80+	15.491	21.554	1.636	4.333	5.864	1.055	12.031	0.689	3.337	9.290	12.471	71.110	0.525	34.592	193.976
TOTAL	1 190.292	1 114.344	44.671	363.022	140.552	211.895	885.458	20.697	100.545	278.983	759.696	3 788.082	21.176	1 665.385	10 584.799

Table 4.22 Burden of disease due to cortical cataract DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.315	0.315
30-44	42.164	28.194	0.710	18.827	1.428	12.008	20.586	0.890	0.827	1.863	21.465	30.057	0.549	31.131	210.700
45-59	71.717	55.391	2.438	16.616	6.009	11.509	52.611	0.720	3.060	7.625	38.685	213.938	1.175	73.103	554.598
60-69	28.480	36.066	1.392	5.164	6.302	3.585	26.164	0.305	3.675	15.882	20.695	133.818	0.510	62.105	344.143
70-79	9.610	13.694	0.686	1.899	3.222	1.188	8.165	0.139	2.074	6.625	8.194	42.188	0.226	20.238	118.149
80+	1.364	1.970	0.149	0.315	0.532	0.151	1.167	0.031	0.322	0.671	1.330	6.755	0.041	2.552	17.350
TOTAL	153.336	135.315	5.375	42.820	17.493	28.441	108.692	2.085	9.957	32.666	90.371	426.757	2.501	189.444	1245.253

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	27.608	35.969	0.461	8.473	0.856	12.835	18.685	1.013	1.448	1.786	21.642	92.722	0.668	29.938	254.103
45-59	63.502	57.211	2.721	24.458	5.037	8.428	52.209	0.965	5.603	8.550	42.318	235.484	1.212	83.066	590.764
60-69	35.868	30.688	1.486	10.048	6.457	2.369	27.937	0.580	4.942	15.198	24.050	120.470	0.555	74.852	355.502
70-79	14.751	15.985	0.865	4.187	4.361	0.788	12.001	0.390	2.673	9.894	9.756	60.565	0.267	32.951	169.433
80+	2.508	3.418	0.260	0.769	0.934	0.113	1.841	0.141	0.512	1.652	1.787	11.023	0.090	6.096	31.144
TOTAL	144.237	143.271	5.792	47.935	17.645	24.533	112.672	3.089	15.179	37.080	99.553	520.264	2.793	226.902	1 400.946

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.315	0.315
30-44	69.772	64.162	1.171	27.300	2.284	24.843	39.270	1.903	2.275	3.649	43.108	122.779	1.217	61.069	464.803
45-59	135.219	112.602	5.159	41.074	11.046	19.937	104.820	1.685	8.663	16.175	81.003	449.423	2.388	156.169	1 145.361
60-69	64.348	66.754	2.878	15.212	12.759	5.954	54.101	0.885	8.617	31.080	44.746	254.288	1.066	136.957	699.645
70-79	24.361	29.679	1.551	6.086	7.582	1.976	20.165	0.529	4.748	16.520	17.950	102.754	0.493	53.189	287.582
80+	3.873	5.389	0.409	1.083	1.466	0.264	3.008	0.172	0.834	2.322	3.118	17.778	0.131	8.648	48.494
TOTAL	297.573	278.586	11.168	90.756	35.138	52.974	221.364	5.174	25.136	69.746	189.924	947.021	5.294	416.346	2 646.200

Table 4.23 Disease burden from cataract attributable to UVR DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.063
30-44	8.433	5.639	0.142	3.765	0.286	2.402	4.117	0.178	0.165	0.373	4.293	6.011	0.110	6.226	42.140
45-59	14.343	11.078	0.488	3.323	1.202	2.302	10.522	0.144	0.612	1.525	7.737	42.788	0.235	14.621	110.920
60-69	5.696	7.213	0.278	1.033	1.260	0.717	5.233	0.061	0.735	3.176	4.139	26.764	0.102	12.421	68.829
70-79	1.922	2.739	0.137	0.380	0.644	0.238	1.633	0.028	0.415	1.325	1.639	8.438	0.045	4.048	23.630
80+	0.273	0.394	0.030	0.063	0.106	0.030	0.233	0.006	0.064	0.134	0.266	1.351	0.008	0.510	3.470
TOTAL	30.667	27.063	1.075	8.564	3.499	5.688	21.738	0.417	1.991	6.533	18.074	85.351	0.500	37.889	249.053

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	5.522	7.194	0.092	1.695	0.171	2.567	3.737	0.203	0.290	0.357	4.328	18.544	0.134	5.988	50.821
45-59	12.700	11.442	0.544	4.892	1.007	1.686	10.442	0.193	1.121	1.710	8.464	47.097	0.242	16.613	118.153
60-69	7.174	6.138	0.297	2.010	1.291	0.474	5.587	0.116	0.988	3.040	4.810	24.094	0.111	14.970	71.100
70-79	2.950	3.197	0.173	0.837	0.872	0.158	2.400	0.078	0.535	1.979	1.951	12.113	0.053	6.590	33.887
80+	0.502	0.684	0.052	0.154	0.187	0.023	0.368	0.028	0.102	0.330	0.357	2.205	0.018	1.219	6.229
TOTAL	28.847	28.654	1.158	9.587	3.529	4.907	22.534	0.618	3.036	7.416	19.911	104.053	0.559	45.380	280.189

TOTAL

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.063	0.063
30-44	13.954	12.832	0.234	5.460	0.457	4.969	7.854	0.381	0.455	0.730	8.622	24.556	0.243	12.214	92.961
45-59	27.044	22.520	1.032	8.215	2.209	3.987	20.964	0.337	1.733	3.235	16.201	89.885	0.478	31.234	229.072
60-69	12.870	13.351	0.576	3.042	2.552	1.191	10.820	0.177	1.723	6.216	8.949	50.858	0.213	27.391	139.929
70-79	4.872	5.936	0.310	1.217	1.516	0.395	4.033	0.106	0.950	3.304	3.590	20.551	0.099	10.638	57.516
80+	0.775	1.078	0.082	0.217	0.293	0.053	0.602	0.034	0.167	0.464	0.624	3.556	0.026	1.730	9.699
TOTAL	59.515	55.717	2.234	18.151	7.028	10.595	44.273	1.035	5.027	13.949	37.985	189.404	1.059	83.269	529.242

4.7 Pterygium

Disease incidence

There are moderately good descriptive data on incidence and prevalence of pterygium worldwide (*100, 101*). However, there is a large discrepancy in the prevalence of pterygium within a small area, depending on whether one looks at urban or rural populations. Thus, in the Melbourne Visual Impairment project (*102*) the prevalence of pterygium in males, 80-89 years who lived in an urban area was 1.79%, while in those in a rural area it was 31.3%.

Despite Cameron's work on the distribution of pterygium worldwide, initial inspection of prevalence rates by latitude shows a wide range of rates at similar latitudes, with no clear latitudinal gradient and no clear racial differences. However, closer review of the prevalence rates reveals that some of the rates are for total population prevalence, while some are prevalence rates only in older age groups. For example, Wong et al (*103*) cite a prevalence of 6.9% in the Chinese population of Singapore aged 40 or older, Panchapakesan et al (*104*) a rate of 7.3% in the Blue Mountains, NSW population over the age of 49 years and Taylor et al (*105*) a rate of 44% in Aborigines over the age of 30 years in Northwestern Australia.

In order to develop a global distribution of prevalence for pterygium, prevalence rates using only parts of the population were adjusted to the total population using the World Standard Population (*106*) to derive the approximate age-standardised summary prevalence. Prevalence data from within each latitude band were then averaged to provide the representative age-standardised prevalence for each latitude band. Using this as a summary prevalence for the latitude band, and the age and sex distribution outlined in the literature (*102-104, 107*), a theoretical distribution of global pterygium prevalence was developed by back-calculating from the summary prevalence to give age and sex-specific prevalence data for each latitude band.

Population attributable fraction

Case-control studies were examined to calculate the population attributable fraction due to UVR exposure. Unfortunately, a number of these studies failed to measure confounding factors, particularly exposure to particulate matter. Also, Threlfall et al (*108*) showed that there is a difference in the PAF if different methods of sun exposure are used. There is little latitudinal gradient in the PAF for pterygium ($p = 0.35$) with an intercept of 0.33 and mean of 0.42 in studies using averaged annular ocular dose. Using daily ocular dose as the exposure measure (*108*), the PAF is 0.74. These two PAFs were used as the upper (0.74) and lower (0.42) estimates of PAF and were applied to the calculated disease burden due to pterygium. (See Appendix 3)

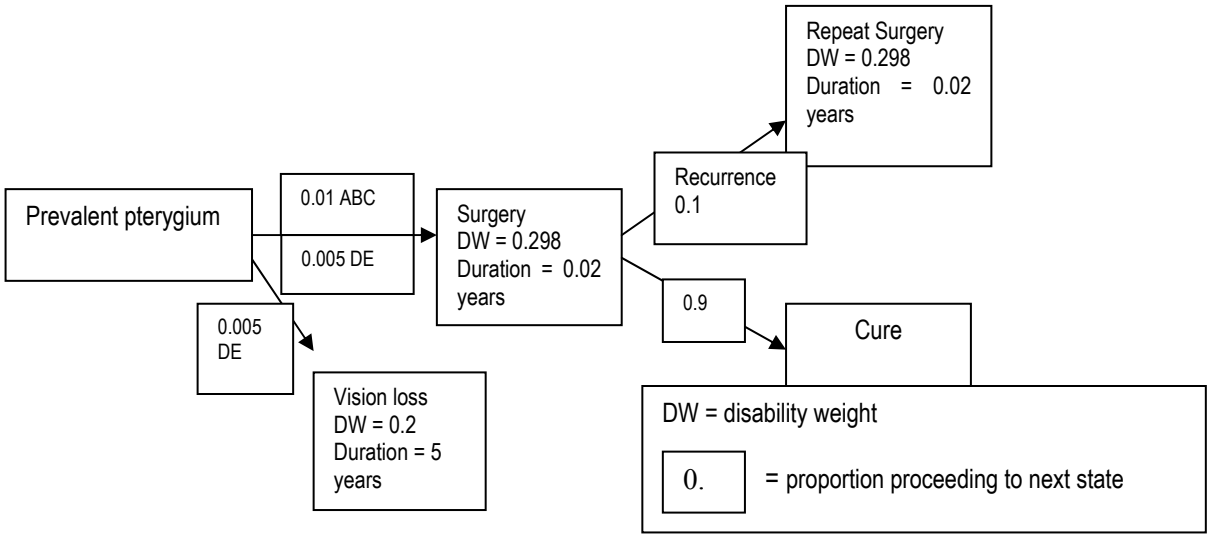
Disease model

Pterygium per se attracts no disability weight, as there is usually no associated vision loss. Only a small proportion of all pterygia are operated on in developed countries and this is likely to be less in under-developed countries. However, the incidence of operations for pterygia may have less to do with the prevalence of pterygia than with the level of ophthalmological service to the area. For example, Wlodarczyk et al have examined the cost of pterygia in Australia (*109*). The lowest rate of pterygium removal is in the Northern Territory and the highest in Queensland – yet these states have similar latitude. This could be explained if the two states had a greatly different age structure (since prevalence of pterygium increases with age) or some other risk factor for pterygium. A more likely explanation is that the Northern Territory has lower access to specialist ophthalmological services.

We have assumed a 1% surgical removal rate for ABC regions (see disease model, Figure 4.5), based on published rates of surgery (*100, 104, 109*). Pterygium surgery is performed in developing countries, probably less for cosmetic reasons and more to avoid loss of vision. In

Nigeria, Ashaye cites pterygium surgery as making up 20% of all ocular surgery (*110*). We have therefore assigned a removal rate of 0.5% of all pterygia, for DE countries (less commonly performed than in ABC countries). However, it is likely that there is a higher prevalence of visual loss due to pterygium in these countries, so that the remaining 0.5% (who are not operated on compared to ABC countries) have a disability related to visual loss.

Figure 4.5 Disease model for pterygium



The results of the burden of disease assessment are presented in Tables 4.24 – 4.26.

Table 4.24 Prevalence (persons) of pterygium 2000
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	166 775	277 920	0	88 990	37 287	7 778	21 707	0	0	0	338 938	72 154	4048	141 723	1 157 320
30-44	1 046 540	1 206 552	1 262 990	1 884 396	285 661	677 931	1 198 860	1 117 598	673 790	402 307	1 546 098	5 328 353	593 128	7 407 246	24 631 450
45-59	2 557 073	2 851 386	3 613 688	4 992 224	753 454	1 714 730	2 706 458	2 958 852	1 432 635	924 702	4 001 299	14 300 823	2 505 757	19 003 819	64 316 900
60-69	1 266 727	1 322 600	1 651 047	2 337 530	400 988	758 656	1 125 710	1 969 401	819 261	701 121	2 146 159	6 968 459	1 423 699	8 763 120	31 654 478
70-79	698 769	726 873	1 742 730	1 609 457	244 151	505 625	698 007	1 934 711	634 107	537 795	1 236 981	4 236 987	1 287 415	5 953 637	22 047 245
80+	146 670	143 065	664 329	444 966	63 866	116 148	158 637	573 809	119 248	84 945	277 535	975 147	408 847	1 168 147	5 345 359
TOTAL	5 882 553	6 528 396	8 934 784	11 357 564	1 785 407	3 780 870	5 909 378	8 554 371	3 679 041	2 650 870	9 547 009	31 881 922	6 222 894	42 437 691	149 152 750

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30-44	534 960	606 786	620 838	979 132	149 631	302 862	559 867	547 290	335 248	205 658	780 817	2 463 047	292 325	3 539 688	11 918 149
45-59	1 368 422	1 520 004	1 898 051	2 690 857	400 315	737 092	1 369 153	1521 881	749 516	537 433	2 128 309	6 873 442	1 303 406	9 249 303	32 347 184
60-69	727 564	772 807	914 133	1 343 395	219 829	368 128	600 659	1103 006	474 894	499 946	1 221 654	3 647 272	770 385	4 383 827	17 047 499
70-79	430 750	471 567	1 145 070	1 036 393	144 598	263 593	400 221	1382 035	454 192	574 416	744 232	2 372 159	851 953	3 624 001	13 895 180
80+	99 679	116 878	648 823	345 616	43 710	66 253	89 280	625 170	115 772	149 481	196 539	603 814	418 396	1 087 915	4 607 326
TOTAL	3 161 375	3 488 042	5 226 915	6 395 393	958 084	1 737 928	3 019 180	5 179 382	2 129 621	1 966 935	5 071 551	15 959 735	3 636 465	21 884 733	79 815 339

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15-29	166 775	277 920	0	88 990	37 287	7 778	21 707	0	0	0	338 938	72 154	4 048	141 723	1 157 320
30-44	1 581 500	1 813 338	1 883 828	2 863 528	435 292	980 794	1 758 727	1 664 888	1 009 038	607 964	2 326 915	7 791 400	885 453	10 946 933	36 549 598
45-59	3 925 495	4 371 390	5 511 739	7 683 081	1 153 770	2 451 822	4 075 611	4 480 733	2 182 150	1 462 136	6 129 607	21 174 265	3 809 163	28 253 122	96 664 084
60-69	1 994 291	2 095 407	2 565 180	3 680 925	620 817	1 126 785	1 726 369	3 072 408	1 294 156	1 201 066	3 367 813	10 615 731	2 194 083	13 146 946	48 701 977
70-79	1 129 519	1 198 441	2 887 800	2 645 851	388 749	769 218	1 098 228	3 316 745	1 088 298	1 112 211	1 981 213	6 609 146	2 139 369	9 577 637	35 942 425
80+	246 349	259 943	1 313 152	790 582	107 576	182 401	247 916	1 198 979	235 020	234 427	474 074	1 578 962	827 243	2 256 061	9 952 685
TOTAL	9 043 929	10 016 438	14 161 699	17 752 957	2 743 491	5 518 798	8 928 558	13 733 752	5 808 662	4 617 805	14 618 560	47 841 657	9 859 359	64 322 423	228 968 088

Table 4.25 Burden of disease from pterygium DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.081	0.135	0.000	0.004	0.018	0.000	0.011	0.000	0.000	0.000	0.014	0.035	0.000	0.006	0.304
30-44	0.520	0.595	0.053	0.079	0.142	0.028	0.605	0.047	0.028	0.017	0.065	2.691	0.025	0.310	5.204
45-59	1.270	1.407	0.151	0.209	0.375	0.072	1.367	0.124	0.060	0.039	0.167	7.222	0.105	0.794	13.359
60-69	0.629	0.652	0.069	0.098	0.199	0.032	0.568	0.082	0.034	0.029	0.090	3.519	0.059	0.366	6.427
70-79	0.347	0.358	0.073	0.067	0.121	0.021	0.352	0.081	0.026	0.022	0.052	2.140	0.054	0.249	3.964
80+	0.073	0.070	0.028	0.019	0.032	0.005	0.080	0.024	0.005	0.004	0.012	0.492	0.017	0.049	0.909
TOTAL	2.919	3.218	0.373	0.475	0.887	0.158	2.983	0.357	0.154	0.111	0.399	16.099	0.260	1.773	30.167

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	0.268	0.300	0.040	0.045	0.074	0.013	0.293	0.027	0.019	0.009	0.033	1.253	0.022	0.238	2.635
45-59	0.684	0.752	0.127	0.126	0.199	0.031	0.715	0.078	0.043	0.022	0.089	3.493	0.102	0.617	7.078
60-69	0.363	0.382	0.060	0.063	0.109	0.015	0.313	0.056	0.026	0.021	0.051	1.852	0.061	0.289	3.662
70-79	0.215	0.233	0.077	0.051	0.072	0.011	0.209	0.070	0.024	0.024	0.031	1.206	0.067	0.244	2.535
80+	0.050	0.058	0.044	0.017	0.022	0.003	0.047	0.032	0.006	0.006	0.008	0.307	0.033	0.073	0.706
TOTAL	1.580	1.725	0.348	0.302	0.476	0.073	1.578	0.263	0.118	0.082	0.212	8.111	0.286	1.461	16.615

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.081	0.135	0.000	0.004	0.018	0.000	0.011	0.000	0.000	0.000	0.014	0.035	0.000	0.006	0.304
30-44	0.788	0.895	0.093	0.124	0.216	0.041	0.899	0.074	0.047	0.025	0.097	3.944	0.047	0.548	7.839
45-59	1.953	2.159	0.278	0.334	0.574	0.102	2.082	0.202	0.103	0.061	0.256	10.715	0.207	1.411	20.437
60-69	0.992	1.034	0.129	0.161	0.309	0.047	0.881	0.138	0.060	0.050	0.141	5.371	0.120	0.655	10.088
70-79	0.563	0.592	0.149	0.118	0.193	0.032	0.562	0.151	0.051	0.046	0.083	3.346	0.121	0.493	6.499
80+	0.123	0.128	0.072	0.036	0.053	0.008	0.127	0.056	0.011	0.010	0.020	0.800	0.050	0.122	1.615
TOTAL	4.499	4.943	0.721	0.776	1.364	0.231	4.562	0.620	0.272	0.193	0.611	24.210	0.546	3.235	46.783

Table 4.26 Disease burden from pterygium attributable to UVR DALYs (000) – upper estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.060	0.100	0.000	0.003	0.013	0.000	0.008	0.000	0.000	0.000	0.010	0.026	0.000	0.004	0.225
30-44	0.385	0.440	0.039	0.058	0.105	0.021	0.448	0.035	0.021	0.012	0.048	1.991	0.018	0.229	3.851
45-59	0.939	1.041	0.112	0.154	0.277	0.053	1.011	0.091	0.044	0.029	0.124	5.344	0.077	0.588	9.886
60-69	0.465	0.483	0.051	0.072	0.148	0.023	0.420	0.061	0.025	0.022	0.066	2.604	0.044	0.271	4.756
70-79	0.257	0.265	0.054	0.050	0.090	0.016	0.261	0.060	0.020	0.017	0.038	1.583	0.040	0.184	2.934
80+	0.054	0.052	0.021	0.014	0.023	0.004	0.059	0.018	0.004	0.003	0.009	0.364	0.013	0.036	0.673
TOTAL	2.160	2.382	0.276	0.351	0.657	0.117	2.208	0.265	0.114	0.082	0.295	11.913	0.192	1.312	22.325

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	0.198	0.222	0.030	0.034	0.055	0.009	0.217	0.020	0.014	0.006	0.024	0.927	0.017	0.176	1.950
45-59	0.506	0.556	0.094	0.093	0.147	0.023	0.529	0.058	0.032	0.017	0.066	2.585	0.075	0.457	5.238
60-69	0.269	0.283	0.045	0.047	0.081	0.011	0.232	0.041	0.019	0.015	0.038	1.370	0.045	0.214	2.710
70-79	0.159	0.173	0.057	0.037	0.053	0.008	0.155	0.052	0.018	0.018	0.023	0.892	0.050	0.181	1.876
80+	0.037	0.043	0.032	0.013	0.016	0.002	0.035	0.023	0.005	0.005	0.006	0.227	0.025	0.054	0.522
TOTAL	1.169	1.276	0.257	0.223	0.353	0.054	1.168	0.194	0.088	0.061	0.157	6.002	0.211	1.081	12.296

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.060	0.100	0.000	0.003	0.013	0.000	0.008	0.000	0.000	0.000	0.010	0.026	0.000	0.004	0.225
30-44	0.583	0.663	0.069	0.092	0.160	0.030	0.665	0.055	0.035	0.019	0.072	2.919	0.035	0.405	5.801
45-59	1.445	1.598	0.206	0.247	0.424	0.076	1.541	0.149	0.076	0.045	0.190	7.929	0.153	1.044	15.124
60-69	0.734	0.765	0.096	0.119	0.229	0.035	0.652	0.102	0.045	0.037	0.104	3.974	0.089	0.485	7.465
70-79	0.416	0.438	0.111	0.087	0.143	0.024	0.416	0.112	0.038	0.034	0.061	2.476	0.090	0.365	4.810
80+	0.091	0.095	0.053	0.026	0.040	0.006	0.094	0.041	0.008	0.007	0.015	0.592	0.037	0.090	1.195
TOTAL	3.329	3.658	0.534	0.575	1.009	0.171	3.376	0.459	0.201	0.143	0.452	17.916	0.404	2.394	34.621

Table 4.27 Disease burden from pterygium attributable to UVR DALYs (000) – lower estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.034	0.057	0.000	0.002	0.008	0.000	0.004	0.000	0.000	0.000	0.006	0.015	0.000	0.002	0.128
30-44	0.218	0.250	0.022	0.033	0.060	0.012	0.254	0.020	0.012	0.007	0.027	1.130	0.010	0.130	2.186
45-59	0.533	0.591	0.063	0.088	0.157	0.030	0.574	0.052	0.025	0.016	0.070	3.033	0.044	0.334	5.611
60-69	0.264	0.274	0.029	0.041	0.084	0.013	0.239	0.035	0.014	0.012	0.038	1.478	0.025	0.154	2.699
70-79	0.146	0.151	0.031	0.028	0.051	0.009	0.148	0.034	0.011	0.009	0.022	0.899	0.023	0.104	1.665
80+	0.031	0.030	0.012	0.008	0.013	0.002	0.034	0.010	0.002	0.001	0.005	0.207	0.007	0.021	0.382
TOTAL	1.226	1.352	0.157	0.199	0.373	0.066	1.253	0.150	0.065	0.047	0.168	6.762	0.109	0.745	12.670

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30-44	0.112	0.126	0.017	0.019	0.031	0.005	0.123	0.011	0.008	0.004	0.014	0.526	0.009	0.100	1.107
45-59	0.287	0.316	0.053	0.053	0.084	0.013	0.301	0.033	0.018	0.009	0.037	1.467	0.043	0.259	2.973
60-69	0.153	0.160	0.025	0.026	0.046	0.006	0.132	0.023	0.011	0.009	0.021	0.778	0.025	0.121	1.538
70-79	0.091	0.098	0.032	0.021	0.030	0.005	0.088	0.029	0.010	0.010	0.013	0.507	0.028	0.102	1.065
80+	0.021	0.024	0.018	0.007	0.009	0.001	0.020	0.013	0.003	0.003	0.003	0.129	0.014	0.031	0.296
TOTAL	0.664	0.724	0.146	0.127	0.200	0.031	0.663	0.110	0.050	0.035	0.089	3.407	0.120	0.614	6.979

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15-29	0.034	0.057	0.000	0.002	0.008	0.000	0.004	0.000	0.000	0.000	0.006	0.015	0.000	0.002	0.128
30-44	0.331	0.376	0.039	0.052	0.091	0.017	0.378	0.031	0.020	0.011	0.041	1.656	0.020	0.230	3.292
45-59	0.820	0.907	0.117	0.140	0.241	0.043	0.874	0.085	0.043	0.026	0.108	4.500	0.087	0.593	8.584
60-69	0.417	0.434	0.054	0.068	0.130	0.020	0.370	0.058	0.025	0.021	0.059	2.256	0.050	0.275	4.237
70-79	0.236	0.248	0.063	0.050	0.081	0.014	0.236	0.063	0.021	0.020	0.035	1.405	0.051	0.207	2.730
80+	0.052	0.054	0.030	0.015	0.022	0.003	0.053	0.023	0.005	0.004	0.008	0.336	0.021	0.051	0.678
TOTAL	1.890	2.076	0.303	0.326	0.573	0.097	1.916	0.260	0.114	0.081	0.257	10.168	0.229	1.359	19.650

4.8 Carcinoma of the cornea and conjunctiva

Disease incidence

Age-standardized incidence rates for eye cancers are available for a number of countries (*30*). In addition, the proportion of eye cancers that are histologically proven SCCC is given. Using this information it is possible to obtain approximate age-standardized incidence rates for SCCC globally. Using the literature to establish an age breakdown of the disease (*111, 112*), and using the Segi World Standard Population (*106*), age-specific incidence rates were back calculated (using an Excel spreadsheet and repeated iterations of possible values, to achieve age-specific incidence rates that were compatible with both the final age-standardized rate and the population distribution of the disease in that region).

It is clear that this is predominantly a rare disease of the elderly, except in sub-Saharan Africa, where the mean age at presentation is 35 years (compared to 60.4 years in Mexico City) (*112, 113*). For this reason, the same male to female ratios and age distribution of disease were applied to all regions, except AFR E for which a younger age distribution was applied.

Population attributable fraction

Squamous cell carcinomas of the cornea and conjunctiva (SCCC) are rare tumours, particularly in white populations. There appears to be a continuum from simple dysplasia to carcinoma in situ to invasive squamous cell carcinoma involving the conjunctiva as well as the cornea (*114*).

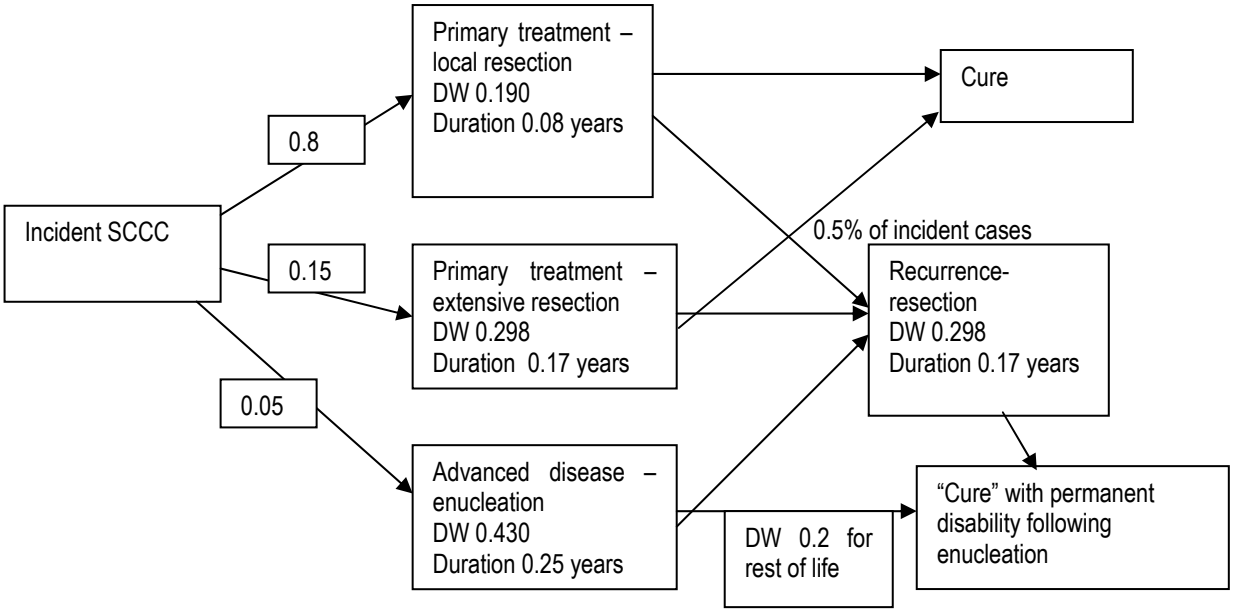
The incidence of this tumour has greatly increased in recent years associated with HIV infection. The proportion of SCCC that is attributable to AIDS (PAF for AIDS for SCCC) has been calculated to be 0.66 (*112*). Sun (*115*) found links between SCCC and ultraviolet radiation exposure of a similar magnitude to SCC of the eyelid. The PAF calculated from the single relevant study by Lee et al (using as a UV exposure measure cumulative exposure at ≤ 30° latitude for ≥ 50 years), was 0.62, based on an odds ratio of 3.9 (1.0-14.8) (*114*). We have used the same PAF as for SCC in lightly pigmented populations (lower estimate 0.5, upper estimate 0.7), and applied this to all pigment groups. This assumes that the protective effect of pigmentation present for SCC of the skin is not present when considering disease of the cornea and conjunctiva.

Disease model

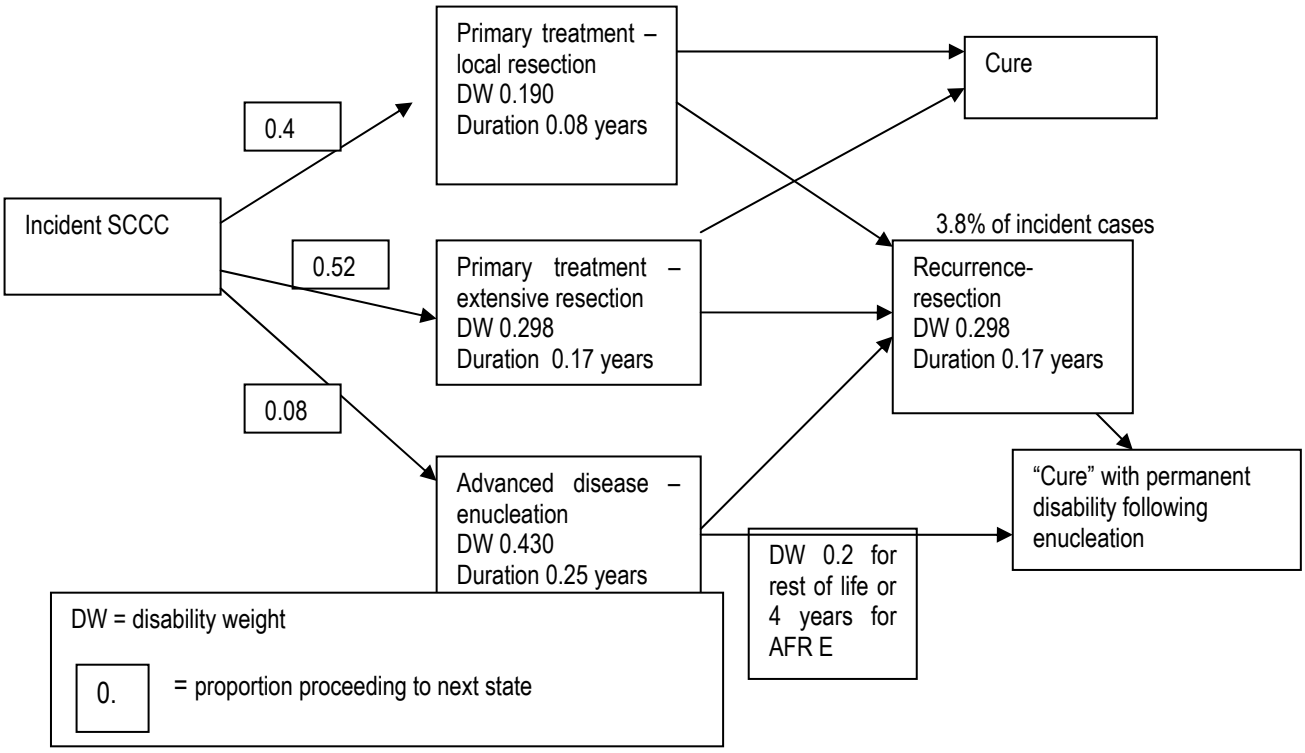
There appears to be no mortality associated with SCCC itself. Treatment is by local resection for localized disease; more extensive resection or enucleation is performed for more extensive disease.

The flow chart of the disease history is outlined in Figure 4.6.

Figure 4.6 Disease model for SCCC - ABC regions



Disease model of SCCC for DE regions



The results of the burden of disease assessment for SCCC for the year 2000 are presented in Tables 4.28 to 4.31.

Table 4.28 Incident cases of SCCC (2000)
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	2	341	0	4	1	0	1	0	0	0	3	6	0	3	361
15-29	10	1 209	6	35	7	9	18	4	4	1	29	92	5	72	1 501
30-44	46	976	30	106	17	24	51	22	15	8	100	281	20	276	1 972
45-59	60	325	69	153	24	40	71	47	25	14	132	412	65	502	1 939
60-69	30	65	41	73	12	19	34	44	20	14	65	210	43	268	938
70-79	16	17	38	48	7	12	18	38	13	10	39	110	33	169	568
80+	5	5	21	17	2	4	5	21	4	3	11	34	14	43	189
TOTAL	170	2 937	206	436	70	107	197	176	81	50	378	1 144	181	1 332	7 465

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	2	282	0	2	1	0	1	0	0	0	3	5	0	2	298
15-29	10	555	4	27	6	6	10	3	3	1	24	51	3	52	755
30-44	25	498	21	78	14	16	30	15	10	6	90	132	15	202	1 152
45-59	48	219	54	124	19	25	56	35	19	12	118	273	49	364	1 415
60-69	23	56	39	65	10	16	29	42	19	18	63	154	42	226	802
70-79	14	15	43	48	7	11	18	47	16	18	41	93	40	166	577
80+	4	5	34	20	3	3	5	38	7	11	14	29	24	62	259
TOTAL	126	1 630	196	363	58	77	148	179	74	65	353	738	174	1 075	5 256

BOTHSEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	3	623	0	6	2	0	2	0	0	0	6	11	0	4	657
15-29	20	1764	10	62	12	15	27	7	8	2	54	143	9	125	2 258
30-44	71	1473	51	184	31	40	80	37	25	14	190	414	36	478	3 124
45-59	108	543	123	277	43	65	127	82	44	26	249	685	114	866	3 352
60-69	53	121	80	137	22	34	63	87	39	32	128	364	85	493	1 738
70-79	31	32	82	95	14	23	36	85	29	28	80	203	74	334	1 146
80+	9	10	55	37	5	7	10	58	11	14	25	63	38	106	448
TOTAL	297	4 567	402	799	129	184	345	355	155	115	731	1 883	355	2 407	12 724

Table 4.29 Burden of disease from SCCC DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
5-14	0.001	0.035	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.003	0.000	0.001	0.044
15-29	0.005	0.123	0.002	0.010	0.003	0.003	0.009	0.001	0.001	0.000	0.009	0.044	0.002	0.022	0.234
30-44	0.020	0.099	0.008	0.028	0.007	0.006	0.022	0.006	0.004	0.002	0.027	0.121	0.005	0.074	0.429
45-59	0.021	0.033	0.015	0.033	0.008	0.009	0.025	0.010	0.005	0.003	0.029	0.143	0.014	0.109	0.457
60-69	0.008	0.007	0.007	0.012	0.003	0.003	0.009	0.007	0.003	0.002	0.010	0.054	0.007	0.043	0.175
70-79	0.003	0.002	0.004	0.005	0.001	0.001	0.003	0.004	0.001	0.001	0.004	0.020	0.004	0.019	0.072
80+	0.001	0.001	0.002	0.001	0.000	0.000	0.001	0.002	0.000	0.000	0.001	0.004	0.001	0.003	0.017
TOTAL	0.058	0.299	0.037	0.092	0.024	0.022	0.068	0.030	0.016	0.009	0.081	0.390	0.033	0.270	1.428

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
5-14	0.001	0.029	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.003	0.000	0.001	0.036
15-29	0.005	0.056	0.001	0.008	0.003	0.002	0.005	0.001	0.001	0.000	0.007	0.025	0.001	0.016	0.131
30-44	0.011	0.051	0.006	0.021	0.006	0.004	0.013	0.004	0.003	0.002	0.025	0.058	0.004	0.055	0.263
45-59	0.018	0.022	0.012	0.028	0.007	0.006	0.021	0.008	0.004	0.003	0.027	0.100	0.011	0.084	0.351
60-69	0.007	0.006	0.007	0.011	0.003	0.003	0.008	0.008	0.003	0.003	0.011	0.044	0.007	0.040	0.161
70-79	0.003	0.002	0.006	0.006	0.001	0.001	0.004	0.006	0.002	0.002	0.005	0.019	0.005	0.021	0.083
80+	0.001	0.001	0.003	0.002	0.000	0.000	0.001	0.003	0.001	0.001	0.001	0.004	0.002	0.005	0.025
TOTAL	0.044	0.166	0.035	0.078	0.021	0.016	0.051	0.029	0.014	0.011	0.078	0.253	0.031	0.222	1.049

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0
5-14	0.002	0.063	0.000	0.002	0.001	0.000	0.001	0.000	0.000	0.000	0.002	0.005	0.000	0.001	0.077
15-29	0.010	0.180	0.003	0.019	0.006	0.004	0.013	0.002	0.002	0.001	0.016	0.069	0.003	0.038	0.366
30-44	0.031	0.150	0.014	0.050	0.013	0.011	0.035	0.010	0.007	0.004	0.051	0.179	0.010	0.129	0.694
45-59	0.039	0.055	0.027	0.062	0.015	0.014	0.045	0.018	0.010	0.006	0.056	0.244	0.025	0.192	0.808
60-69	0.014	0.012	0.014	0.023	0.006	0.006	0.017	0.015	0.007	0.005	0.022	0.099	0.014	0.083	0.337
70-79	0.006	0.003	0.010	0.012	0.003	0.003	0.007	0.010	0.003	0.003	0.010	0.039	0.009	0.040	0.158
80+	0.001	0.001	0.004	0.003	0.001	0.001	0.001	0.005	0.001	0.001	0.002	0.008	0.003	0.008	0.04
TOTAL	0.103	0.465	0.072	0.169	0.045	0.039	0.119	0.060	0.030	0.020	0.158	0.643	0.064	0.492	2.478

Table 4.30 Disease burden from SCCC attributable to UVR DALYs (000) – upper estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.025	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.001	0.031
15-29	0.004	0.086	0.001	0.007	0.002	0.002	0.006	0.001	0.001	0.000	0.006	0.031	0.001	0.015	0.164
30-44	0.014	0.069	0.006	0.020	0.005	0.004	0.015	0.004	0.003	0.001	0.019	0.085	0.004	0.052	0.300
45-59	0.015	0.023	0.011	0.023	0.006	0.006	0.018	0.007	0.004	0.002	0.020	0.100	0.010	0.076	0.320
60-69	0.006	0.005	0.005	0.008	0.002	0.002	0.006	0.005	0.002	0.001	0.007	0.038	0.005	0.030	0.123
70-79	0.002	0.001	0.003	0.004	0.001	0.001	0.002	0.003	0.001	0.001	0.003	0.014	0.003	0.013	0.050
80+	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.003	0.001	0.002	0.012
TOTAL	0.041	0.209	0.026	0.064	0.017	0.015	0.048	0.021	0.011	0.006	0.057	0.273	0.023	0.189	1.000

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.020	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.001	0.025
15-29	0.004	0.039	0.001	0.006	0.002	0.001	0.004	0.001	0.001	0.000	0.005	0.018	0.001	0.011	0.092
30-44	0.008	0.036	0.004	0.015	0.004	0.003	0.009	0.003	0.002	0.001	0.018	0.041	0.003	0.039	0.184
45-59	0.013	0.015	0.008	0.020	0.005	0.004	0.015	0.006	0.003	0.002	0.019	0.070	0.008	0.059	0.246
60-69	0.005	0.004	0.005	0.008	0.002	0.002	0.006	0.006	0.002	0.002	0.008	0.031	0.005	0.028	0.113
70-79	0.002	0.001	0.004	0.004	0.001	0.001	0.003	0.004	0.001	0.001	0.004	0.013	0.004	0.015	0.058
80+	0.001	0.001	0.002	0.001	0.000	0.000	0.001	0.002	0.001	0.001	0.001	0.003	0.001	0.004	0.018
TOTAL	0.031	0.116	0.025	0.055	0.015	0.011	0.036	0.020	0.010	0.008	0.055	0.177	0.022	0.155	0.735

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.045	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.004	0.000	0.001	0.056
15-29	0.007	0.125	0.002	0.013	0.004	0.004	0.010	0.001	0.001	0.000	0.011	0.048	0.002	0.027	0.256
30-44	0.022	0.105	0.010	0.034	0.009	0.007	0.025	0.007	0.005	0.003	0.036	0.125	0.006	0.090	0.484
45-59	0.027	0.039	0.019	0.043	0.011	0.011	0.032	0.013	0.006	0.004	0.039	0.170	0.018	0.135	0.566
60-69	0.011	0.009	0.010	0.016	0.004	0.004	0.012	0.011	0.004	0.004	0.015	0.069	0.010	0.058	0.235
70-79	0.004	0.003	0.007	0.008	0.001	0.001	0.005	0.007	0.002	0.002	0.006	0.027	0.006	0.028	0.109
80+	0.001	0.001	0.004	0.002	0.000	0.000	0.001	0.004	0.001	0.001	0.001	0.006	0.002	0.006	0.029
TOTAL	0.071	0.326	0.050	0.119	0.032	0.027	0.083	0.041	0.021	0.014	0.111	0.450	0.045	0.344	1.736

Table 4.31 Disease burden from SCCC attributable to UVR DALYs (000) – lower estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.018	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.002	0.000	0.001	0.022
15-29	0.003	0.062	0.001	0.005	0.002	0.002	0.005	0.001	0.001	0.000	0.005	0.022	0.001	0.011	0.117
30-44	0.010	0.050	0.004	0.014	0.004	0.003	0.011	0.003	0.002	0.001	0.014	0.061	0.003	0.037	0.215
45-59	0.011	0.017	0.008	0.017	0.004	0.005	0.013	0.005	0.003	0.002	0.015	0.072	0.007	0.055	0.229
60-69	0.004	0.004	0.004	0.006	0.002	0.002	0.005	0.004	0.002	0.001	0.005	0.027	0.004	0.022	0.088
70-79	0.002	0.001	0.002	0.003	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.010	0.002	0.010	0.036
80+	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.002	0.001	0.002	0.009
TOTAL	0.029	0.150	0.019	0.046	0.012	0.011	0.034	0.015	0.008	0.005	0.041	0.195	0.017	0.135	0.716

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.015	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.000	0.001	0.018
15-29	0.003	0.028	0.001	0.004	0.002	0.001	0.003	0.001	0.001	0.000	0.004	0.013	0.001	0.008	0.066
30-44	0.006	0.026	0.003	0.011	0.003	0.002	0.007	0.002	0.002	0.001	0.013	0.029	0.002	0.028	0.132
45-59	0.009	0.011	0.006	0.014	0.004	0.003	0.011	0.004	0.002	0.002	0.014	0.050	0.006	0.042	0.176
60-69	0.004	0.003	0.004	0.006	0.002	0.002	0.004	0.004	0.002	0.002	0.006	0.022	0.004	0.020	0.081
70-79	0.002	0.001	0.003	0.003	0.001	0.001	0.002	0.003	0.001	0.001	0.003	0.010	0.003	0.011	0.042
80+	0.001	0.001	0.002	0.001	0.000	0.000	0.001	0.002	0.001	0.001	0.001	0.002	0.001	0.003	0.013
TOTAL	0.022	0.083	0.018	0.039	0.011	0.008	0.026	0.015	0.007	0.006	0.039	0.127	0.016	0.111	0.528

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.001	0.032	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.001	0.003	0.000	0.001	0.040
15-29	0.005	0.090	0.002	0.009	0.003	0.003	0.007	0.001	0.001	0.000	0.008	0.035	0.002	0.019	0.183
30-44	0.016	0.075	0.007	0.025	0.007	0.005	0.018	0.005	0.004	0.002	0.026	0.090	0.005	0.065	0.346
45-59	0.020	0.028	0.014	0.031	0.008	0.008	0.023	0.009	0.005	0.003	0.028	0.122	0.013	0.097	0.404
60-69	0.008	0.007	0.007	0.012	0.003	0.003	0.009	0.008	0.003	0.003	0.011	0.049	0.007	0.042	0.168
70-79	0.003	0.002	0.005	0.006	0.001	0.001	0.004	0.005	0.002	0.002	0.005	0.020	0.005	0.020	0.078
80+	0.001	0.001	0.003	0.002	0.000	0.000	0.001	0.003	0.001	0.001	0.001	0.004	0.002	0.004	0.021
TOTAL	0.051	0.233	0.036	0.085	0.023	0.019	0.060	0.030	0.015	0.010	0.080	0.322	0.032	0.246	1.244

4.9 Reactivation of herpes labialis

Disease incidence

In developing a plausible global distribution of history of recurrent herpes, it is clear that there are racial differences as well as age differences. Some studies are not population-based and different studies use different definitions of "a history of recurrent herpes", making comparison difficult.

In white populations there appears to be a weak latitudinal gradient, with lower prevalence in Swedish populations (*116*) than in southern Wisconsin (*117*) or Germany (*118*) as well as a peak of prevalence (history of recurrence in the last two years) in late adolescence and early adulthood. 52% of those with a positive history of recurrent herpes had disease onset prior to 10 years of age (*117*). In a study examining prevalence of a history of reactivation of herpes labialis (RHL) in Asian dental outpatients there was a higher incidence in Chiang Mai (latitude 18^{o} 48′ N) than in Kuala Lumpur (latitude 3^{o} 08′ N) by a factor of three. However, the number of affected individuals was too small to draw any conclusions about incidence or latitudinal gradients (*119*).

The few studies done in African, Asian and South American populations indicate that there is a lower prevalence of RHL in Asian populations, but that African populations have similar rates to European populations. Thus, the distribution of RHL is taken to be the same in lightly pigmented populations as for deeply pigmented populations but with a multiplier of 0.4 times the prevalence for Asian populations. The method used to calculate the global incidence is outlined in Appendix 6.

Population attributable fraction

There are few quantitative data either on the prevalence of recurrent herpes labialis or the factors that precipitate lesions. We do know that 80-90% of the adult population has antibodies to herpes simplex virus type 1, the causative organism for herpes labialis (*120*). Of these, around one third suffer from recurrent disease. Recurrences are precipitated by emotional stress, illness, sunlight, trauma and a variety of other anecdotal factors. Analysis of data from Young et al gives several different odds ratios for a relationship with UVR exposure, depending on the exposure measure used (*117*). (See Appendix 3). However, this is a cross-sectional study and recalled exposure may be inaccurate, with resultant underestimation of the odds ratios and thus the PAF. A PAF of 0.25 is used as the lower estimate and 0.5 as the upper estimate of the population attributable fraction.

Disease model

Recurrence rates of lesions were averaged from a number of studies (*116, 117, 121-123*). In the model used, 48.6% of people with a history of recurrent herpes labialis had one recurrence per year, 35.1% have two recurrences per year, and 16% have four or more recurrences per year. The duration of an episode was 0.014 years, disability weight 0.005. The results of the burden of disease assessment are outlined in Tables 4.32 to 4.35.

Table 4.32 Incident herpes labialis 2000
by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	7 512 354	9 621 294	2 842 909	5 448 982	969 018	3 224 926	4 303 089	2 581 515	2 344 701	1 646 880	25 93 751	10 177 772	1 239 659	19 419 936	73 926 787
15-29	15 328 480	19 376 664	8 011 907	15 046 699	2 287 586	7 772 992	9 178 835	9 129 483	7 166 187	5 650 674	78 29 730	26 255 789	4 764 667	55 129 528	192 929 221
30-44	8 129 705	10 167 267	10 678 287	10 947 228	1 286 996	5 330 339	5 957 231	12 987 218	6 612 431	7 032 971	54 67 105	18 540 622	5 080 145	56 077 651	164 295 196
45-59	3 929 823	4 673 399	8 151 937	6 043 202	657 290	2 719 617	2 905 648	10 872 786	4 365 555	5 339 151	26 94 888	10 210 786	5 217 266	33 379 625	101 160 973
60-69	1 357 976	1 517 789	2 841 169	2 089 461	239 633	902 255	938 737	4 902 177	1 800 396	2 336 636	9 92 214	3 629 725	2 368 126	12 030 873	37 947 166
70-79	509 385	574 746	1 902 027	1 009 155	100 806	433 807	375 997	2 971 305	894 071	1 065 668	3 95 649	1 525 311	1 345 214	5 368 114	18 471 254
80+	103 004	111 411	659 151	251 366	25 380	88 952	75 710	851 486	159 745	169 765	89 869	321 825	380 455	936 236	4 224 356
TOTAL	36 870 727	46 042 572	35 087 386	40 836 093	5 566 707	20 472 887	23 735 248	44 295 970	23 343 086	23 241 744	20 063 205	70 661 830	20 395 532	182 341 964	592 954 951

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	7 446 089	9 580 522	2 712 846	5 260 542	939 156	3 087 818	4 144 070	2446 053	2252 273	1 581 506	2 509 106	9 524 210	1 178 649	17 609 063	70 271 903
15-29	15 360 398	19 369 863	7 734 762	14 915 705	2 270 323	7 454 797	8 706 145	8700 403	6891 743	5 533 818	7 641 505	24 245 483	4 566 550	51 826 057	185 217 553
30-44	8 335 458	10 227 711	10 495 667	11 337 671	1 357 443	4 819 259	5625 509	12687 394	6571 515	7 184 281	5 517 043	17 145 839	5 006 412	53 316 734	159 627 936
45-59	4 208 233	4 977 081	8 346 126	6 475 304	708 590	2 383 663	2 938392	10953 563	4525 010	6 128 424	2 863 995	9 760 765	5 251 690	31 389 323	100 910 158
60-69	1 559 473	1 780 333	3 143 354	2 423 329	265 752	888 793	10 05 920	5445 277	2111 932	3 367 170	1 131 093	3 798 508	2 565 177	11 815 329	41 301 441
70-79	628 469	749 644	2 494 766	1 324 374	120 200	453 108	4 30 336	4225 344	1299 265	2 300 590	478 305	1 712 560	1 781 970	6 432 059	24 430 991
80+	143 448	184 035	1 294 359	409 067	35 342	102 019	87 626	1889 286	324 171	626 188	129 302	404 997	780 410	1 734 515	8 144 765
TOTAL	37 681 569	46 869 188	36 221 880	42 145 993	5 696 807	19 189 458	22 937 997	46347 321	23975 909	26 721 976	20 270 350	66 592 363	21 130 859	174 123 079	589 904 749

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-14	14 958 443	19 201 816	5 555 755	10 709 524	1 908 174	6 312 744	8 447 159	5 027 567	4 596 974	3 228 386	5 102 857	19 701 982	2 418 308	37 028 999	144 198 689
15-29	30 688 878	38 746 527	15 746 669	29 962 404	4 557 909	15 227 789	17 884 981	17 829 886	14 057 930	11 184 492	15 471 235	50 501 273	9 331 217	106 955 586	378 146 775
30-44	16 465 163	20 394 978	21 173 954	22 284 899	2 644 439	10 149 597	11 582 740	25 674 612	13 183 946	14 217 251	10 984 148	35 686 460	10 086 558	109 394 385	323 923 130
45-59	8 138 056	9 650 480	16 498 062	12 518 506	1 365 879	5 103 280	5 844 040	21 826 350	8 890 565	11 467 575	5 558 883	19 971 551	10 468 956	64 768 948	202 071 131
60-69	2 917 450	3 298 122	5 984 523	4 512 790	505 385	1 791 048	1 944 657	10 347 453	3 912 328	5 703 805	2 123 307	7 428 233	4 933 303	23 846 202	79 248 606
70-79	1 137 854	1 324 390	4 396 792	2 333 529	221 006	886 915	806 333	7 196 650	2 193 336	3 366 257	873 954	3 237 871	3 127 184	11 800 173	42 902 244
80+	246 452	295 446	1 953 510	660 433	60 722	190 971	163 335	2 740 772	483 916	795 953	219 170	726 822	1 160 865	2 670 751	12 369 119
TOTAL	74 552 296	92 911 760	71 309 266	82 982 086	11 263 514	39 662 345	46 673 245	90 643 290	47 318 994	49 963 720	40 333 555	137 254 193	41 526 390	356 465 044	1 182 859 698

Table 4.33 Burden of disease from RHL DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.873	1.118	0.330	0.633	0.113	0.375	0.500	0.300	0.272	0.191	0.301	1.182	0.144	2.256	8.587
15-29	1.780	2.251	0.931	1.748	0.266	0.903	1.066	1.060	0.832	0.656	0.909	3.050	0.553	6.403	22.409
30-44	0.944	1.181	1.240	1.272	0.149	0.619	0.692	1.508	0.768	0.817	0.635	2.154	0.590	6.513	19.083
45-59	0.456	0.543	0.947	0.702	0.076	0.316	0.337	1.263	0.507	0.620	0.313	1.186	0.606	3.877	11.750
60-69	0.158	0.176	0.330	0.243	0.028	0.105	0.109	0.569	0.209	0.271	0.115	0.422	0.275	1.397	4.408
70-79	0.059	0.067	0.221	0.117	0.012	0.050	0.044	0.345	0.104	0.124	0.046	0.177	0.156	0.624	2.145
80+	0.012	0.013	0.077	0.029	0.003	0.010	0.009	0.099	0.019	0.020	0.010	0.037	0.044	0.109	0.491
TOTAL	4.283	5.348	4.075	4.743	0.647	2.378	2.757	5.145	2.711	2.700	2.330	8.207	2.369	21.179	68.872

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.855	1.100	0.311	0.604	0.108	0.355	0.476	0.281	0.259	0.182	0.288	1.093	0.135	2.022	8.068
15-29	1.763	2.224	0.888	1.712	0.261	0.856	1.000	0.999	0.791	0.635	0.877	2.784	0.524	5.950	21.264
30-44	0.957	1.174	1.205	1.302	0.156	0.553	0.646	1.457	0.754	0.825	0.633	1.968	0.575	6.121	18.327
45-59	0.483	0.571	0.958	0.743	0.081	0.274	0.337	1.258	0.520	0.704	0.329	1.121	0.603	3.604	11.585
60-69	0.179	0.204	0.361	0.278	0.031	0.102	0.115	0.625	0.242	0.387	0.130	0.436	0.295	1.356	4.742
70-79	0.072	0.086	0.286	0.152	0.014	0.052	0.049	0.485	0.149	0.264	0.055	0.197	0.205	0.738	2.805
80+	0.016	0.021	0.149	0.047	0.004	0.012	0.010	0.217	0.037	0.072	0.015	0.046	0.090	0.199	0.935
TOTAL	4.326	5.381	4.159	4.839	0.654	2.203	2.633	5.321	2.753	3.068	2.327	7.645	2.426	19.991	67.726

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	1.727	2.217	0.642	1.237	0.220	0.729	0.976	0.581	0.531	0.373	0.589	2.276	0.279	4.277	16.654
15-29	3.544	4.474	1.819	3.460	0.526	1.759	2.066	2.059	1.624	1.292	1.787	5.833	1.078	12.353	43.673
30-44	1.901	2.355	2.445	2.573	0.305	1.172	1.338	2.965	1.523	1.642	1.268	4.122	1.165	12.635	37.410
45-59	0.940	1.114	1.905	1.445	0.158	0.590	0.675	2.520	1.027	1.324	0.642	2.307	1.209	7.481	23.335
60-69	0.337	0.381	0.691	0.521	0.058	0.207	0.225	1.195	0.452	0.658	0.245	0.858	0.570	2.754	9.149
70-79	0.131	0.153	0.507	0.269	0.026	0.102	0.093	0.830	0.253	0.388	0.101	0.374	0.361	1.362	4.950
80+	0.028	0.034	0.225	0.076	0.007	0.022	0.019	0.316	0.056	0.092	0.025	0.084	0.134	0.308	1.426
TOTAL	8.609	10.729	8.234	9.582	1.301	4.581	5.390	10.466	5.464	5.767	4.658	15.853	4.795	41.170	136.598

Table 4.34 Disease burden from RHL attributable to UVR DALYs (000) – upper estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.436	0.559	0.165	0.316	0.056	0.187	0.250	0.150	0.136	0.096	0.151	0.591	0.072	1.128	4.293
15-29	0.890	1.125	0.465	0.874	0.133	0.451	0.533	0.530	0.416	0.328	0.455	1.525	0.277	3.202	11.204
30-44	0.472	0.590	0.620	0.636	0.075	0.310	0.346	0.754	0.384	0.408	0.318	1.077	0.295	3.257	9.542
45-59	0.228	0.271	0.473	0.351	0.038	0.158	0.169	0.631	0.254	0.310	0.157	0.593	0.303	1.939	5.875
60-69	0.079	0.088	0.165	0.121	0.014	0.052	0.055	0.285	0.105	0.136	0.058	0.211	0.138	0.699	2.204
70-79	0.030	0.033	0.110	0.059	0.006	0.025	0.022	0.173	0.052	0.062	0.023	0.089	0.078	0.312	1.073
80+	0.006	0.006	0.038	0.015	0.001	0.005	0.004	0.049	0.009	0.010	0.005	0.019	0.022	0.054	0.245
TOTAL	2.141	2.674	2.038	2.372	0.323	1.189	1.378	2.573	1.356	1.350	1.165	4.104	1.184	10.590	34.436

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.427	0.550	0.156	0.302	0.054	0.177	0.238	0.140	0.129	0.091	0.144	0.547	0.068	1.011	4.034
15-29	0.882	1.112	0.444	0.856	0.130	0.428	0.500	0.499	0.396	0.318	0.439	1.392	0.262	2.975	10.632
30-44	0.478	0.587	0.602	0.651	0.078	0.277	0.323	0.728	0.377	0.412	0.317	0.984	0.287	3.061	9.163
45-59	0.242	0.286	0.479	0.372	0.041	0.137	0.169	0.629	0.260	0.352	0.164	0.560	0.301	1.802	5.793
60-69	0.090	0.102	0.180	0.139	0.015	0.051	0.058	0.313	0.121	0.193	0.065	0.218	0.147	0.678	2.371
70-79	0.036	0.043	0.143	0.076	0.007	0.026	0.025	0.243	0.075	0.132	0.027	0.098	0.102	0.369	1.402
80+	0.008	0.011	0.074	0.023	0.002	0.006	0.005	0.108	0.019	0.036	0.007	0.023	0.045	0.100	0.468
TOTAL	2.163	2.690	2.079	2.419	0.327	1.102	1.317	2.661	1.376	1.534	1.164	3.823	1.213	9.995	33.863

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.864	1.109	0.321	0.618	0.110	0.365	0.488	0.290	0.265	0.186	0.295	1.138	0.140	2.139	8.327
15-29	1.772	2.237	0.909	1.730	0.263	0.879	1.033	1.030	0.812	0.646	0.893	2.917	0.539	6.177	21.837
30-44	0.951	1.178	1.223	1.287	0.153	0.586	0.669	1.483	0.761	0.821	0.634	2.061	0.582	6.317	18.705
45-59	0.470	0.557	0.953	0.723	0.079	0.295	0.337	1.260	0.513	0.662	0.321	1.153	0.604	3.740	11.668
60-69	0.168	0.190	0.345	0.260	0.029	0.103	0.112	0.597	0.226	0.329	0.123	0.429	0.285	1.377	4.575
70-79	0.066	0.076	0.254	0.135	0.013	0.051	0.047	0.415	0.127	0.194	0.050	0.187	0.180	0.681	2.475
80+	0.014	0.017	0.113	0.038	0.004	0.011	0.009	0.158	0.028	0.046	0.013	0.042	0.067	0.154	0.713
TOTAL	4.304	5.364	4.117	4.791	0.650	2.291	2.695	5.233	2.732	2.884	2.329	7.926	2.397	20.585	68.299

Table 4.35 Disease burden from RHL attributable to UVR DALYs (000) – lower estimates by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.218	0.279	0.083	0.158	0.028	0.094	0.125	0.075	0.068	0.048	0.075	0.296	0.036	0.564	2.147
15-29	0.445	0.563	0.233	0.437	0.066	0.226	0.267	0.265	0.208	0.164	0.227	0.762	0.138	1.601	5.602
30-44	0.236	0.295	0.310	0.318	0.037	0.155	0.173	0.377	0.192	0.204	0.159	0.538	0.148	1.628	4.771
45-59	0.114	0.136	0.237	0.175	0.019	0.079	0.084	0.316	0.127	0.155	0.078	0.296	0.151	0.969	2.937
60-69	0.039	0.044	0.083	0.061	0.007	0.026	0.027	0.142	0.052	0.068	0.029	0.105	0.069	0.349	1.102
70-79	0.015	0.017	0.055	0.029	0.003	0.013	0.011	0.086	0.026	0.031	0.011	0.044	0.039	0.156	0.536
80+	0.003	0.003	0.019	0.007	0.001	0.003	0.002	0.025	0.005	0.005	0.003	0.009	0.011	0.027	0.123
TOTAL	1.071	1.337	1.019	1.186	0.162	0.594	0.689	1.286	0.678	0.675	0.583	2.052	0.592	5.295	17.218

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.214	0.275	0.078	0.151	0.027	0.089	0.119	0.070	0.065	0.045	0.072	0.273	0.034	0.505	2.017
15-29	0.441	0.556	0.222	0.428	0.065	0.214	0.250	0.250	0.198	0.159	0.219	0.696	0.131	1.488	5.316
30-44	0.239	0.294	0.301	0.325	0.039	0.138	0.161	0.364	0.189	0.206	0.158	0.492	0.144	1.530	4.582
45-59	0.121	0.143	0.240	0.186	0.020	0.068	0.084	0.314	0.130	0.176	0.082	0.280	0.151	0.901	2.896
60-69	0.045	0.051	0.090	0.070	0.008	0.026	0.029	0.156	0.061	0.097	0.032	0.109	0.074	0.339	1.185
70-79	0.018	0.022	0.072	0.038	0.003	0.013	0.012	0.121	0.037	0.066	0.014	0.049	0.051	0.185	0.701
80+	0.004	0.005	0.037	0.012	0.001	0.003	0.003	0.054	0.009	0.018	0.004	0.012	0.022	0.050	0.234
TOTAL	1.082	1.345	1.040	1.210	0.164	0.551	0.658	1.330	0.688	0.767	0.582	1.911	0.606	4.998	16.931

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5-14	0.432	0.554	0.160	0.309	0.055	0.182	0.244	0.145	0.133	0.093	0.147	0.569	0.070	1.069	4.164
15-29	0.886	1.119	0.455	0.865	0.132	0.440	0.516	0.515	0.406	0.323	0.447	1.458	0.269	3.088	10.918
30-44	0.475	0.589	0.611	0.643	0.076	0.293	0.334	0.741	0.381	0.410	0.317	1.030	0.291	3.159	9.352
45-59	0.235	0.279	0.476	0.361	0.039	0.147	0.169	0.630	0.257	0.331	0.160	0.577	0.302	1.870	5.834
60-69	0.084	0.095	0.173	0.130	0.015	0.052	0.056	0.299	0.113	0.164	0.061	0.214	0.142	0.688	2.287
70-79	0.033	0.038	0.127	0.067	0.006	0.026	0.023	0.208	0.063	0.097	0.025	0.093	0.090	0.340	1.238
80+	0.007	0.009	0.056	0.019	0.002	0.006	0.005	0.079	0.014	0.023	0.006	0.021	0.033	0.077	0.356
TOTAL	2.152	2.682	2.059	2.395	0.325	1.145	1.348	2.617	1.366	1.442	1.164	3.963	1.199	10.292	34.150

5. Potential disease burden caused by complete removal of UVR exposure

The previous chapter described the burden of disease due to excessive UVR exposure. That disease burden may be completely avoidable if personal UVR exposure was reduced to levels appropriate to an individual's skin type, given the local ambient UVR. This appropriate level is not "no UVR exposure", but the minimum exposure required to maintain vitamin D adequacy. This chapter presents an estimate of the potential burden of disease that would be incurred if, globally, there was zero UVR exposure (taking account only of these diseases that have strong, proven causal association with low UVR exposure). Notably if the association between a number of other diseases thought to possibly associated with low UVR exposure, eg cancers of the breast, colon and prostate, is proven, this potential burden of disease will be much greater.

The beneficial effect of UVR in preventing rickets in young children and osteomalacia in adults has been documented since the early 19th century (*21*). More recently the importance of UVR in maintaining vitamin D levels to prevent osteoporosis in older adults has been noted (*124*).

Vitamin D levels can also be maintained by supplementation of food. However, it is estimated that approximately 80-100 % of vitamin D is derived from the action of sunlight on the skin (*125*).

In order to evaluate the beneficial effects of UVR in preventing rickets, osteomalacia and osteoporosis, we assume a baseline exposure of no UVR exposure and examine the associated amount of disease that would occur in this situation – this is the amount of disease avoided by having adequate exposure to UVR. Jabonski and Chaplin (*1*) have defined three bands of ambient UVR which correspond to areas in which there is sufficient UVR to produce vitamin D throughout the year (latitude 30^{o}N to 30^{o}S), sufficient to produce vitamin D in some seasons only (30^{o} to 50^{o}) and insufficient to produce adequate vitamin D from UVR alone at any time of the year (50^{o} to 70^{o}).

It is likely that there is an inverse relationship between these zones and the amount of dietary intake of vitamin D. For example, in the zone where there is insufficient sunlight year round to produce sufficient vitamin D, it is likely that people who inhabit this zone have adapted to the lack of sunlight-derived vitamin D by increasing dietary vitamin D sources – fish, cod liver oil. This provides a way of separating out the contribution of diet and sunlight to the maintenance of vitamin D levels in different regions. In confirmation of this, in an examination of vitamin D intake and serum levels in Arab, Danish and ethnic Danish Moslems in Denmark, Glerup et al found that Arab women had low dietary vitamin D intake (1.04ug/day), while Danish women ingested 7.49ug/day (unveiled) and 13.53 ug/day (veiled) (*125*).

Using Jabonski and Chaplin's zones, studies were sought in which individuals had 'no' sunlight exposure – veiled women, institutionalized individuals, children who, for cultural reasons are kept wrapped up. By looking at the incidence of rickets, osteomalacia and osteoporosis in these populations, it should be possible to estimate the burden of disease avoided by sunlight exposure.

Vitamin D deficiency itself does not attract a disability weight. Thus only preventive effects on frank rickets, osteomalacia and osteoporosis have been considered in this analysis.

Clearly, this is only the tip of the iceberg of even the bone-related disorders related to vitamin D deficiency. It takes no account of minor derangements in structure and consequently of function that are sub-clinical – knock knees or bowed knees, with subsequent loss of function, possible decreased participation in physical activities and possible osteoarthritis at a later age. There is no account taken of the difficulty and morbidity associated with childbirth when pelvic malformation is the consequence of unrecognized rickets.

In addition, researchers are beginning to suspect that vitamin D has far more wide-ranging effects on the immune system (various malignancies and auto-immune disorders may be increased with vitamin D deficiency), the cardiovascular system, the muscle part of the musculoskeletal system and psychiatric disorders. Shaw et al (*2*) outline effects of maternal vitamin D deficiency on the developing fetal brain, congenital cataracts, postnatal head and linear growth.

Vitamin D status is assessed by measuring blood levels of 25-hydroxy vitamin D (25(OH)D). Unfortunately, there is little standardization in methods for measuring 25(OH)D with different methods giving vastly different results (*24*). Similarly, quoted reference ranges vary greatly. The "normal" range depends on the dietary and sun exposure habits of the reference group and may have little relationship to clinical disease. Lips has proposed stages of vitamin D deficiency based on adverse health outcomes (*24*), which are presented in Table 5.1.

Table 5.1 Proposal for staging of vitamin D deficiency[1]

Severity of deficiency	25(OH) D [nmol/l]	25(OH)D [ng/ml]	Bone histology
Mild	25-50	10-20	Normal or high turnover
Moderate	12.5-25	5-10	High turnover
Severe	<12.5	<5	Incipient or overt osteomalacia

[1] Serum levels of vitamin D are measured as 25 hydroxy vitamin D, 25(OH) D
Source: Lips et al, 2001(*24*)

We have used a serum level of 10nmol/l as the level likely to be associated with frank disease, or a clinical diagnosis of rickets or osteomalacia. Studies from Africa indicate that rickets is still a not uncommon disease with a high case fatality rate (31%) and high morbidity (*126*). It is associated with increased risk of pneumonia and congestive cardiac failure, in addition to the skeletal effects.

Case fatality due to vitamin D deficiency of 30% in DE regions and 5% in ABC regions has been assumed. Duration of rickets is taken as one year in children 0-4 years, with onset of disease at 12 months of age.

Twenty per cent of veiled ethnic Danish Moslems had serum 25(OH) D levels of less than 10nmol/l, a level at which one could expect signs of osteomalacia, bone pain, muscle weakness etc (*125*). Thus in the highest latitude band, where dietary substitutes have been found to compensate for lack of UV induced vitamin D, we have taken a figure of 20% of the population as suffering from rickets, osteomalacia or osteoporosis under a scenario of no UV exposure. Gloth et al, looking at vitamin D deficiency in the elderly found that 48% of a sunlight deprived group in Baltimore (latitude 39^{o} N) had 25(OH) D levels less than 25nmol/l (*127*). There was an equal male to female ratio and no racial differences in the levels of 25(OH) D. Indeed, recent research indicates that skin colour does not affect the amount of vitamin D that can be generated; it just takes longer sun exposure to generate a certain level of circulating vitamin D (six times as long for deeply pigmented skin, compared to lightly pigmented skin) (*19*). In Lebanon (latitude 34^{o}), 61.8% of veiled women had 25(OH) D levels less than 5ng/ml (12.5nmol/l) (*128*). Using these data, 61.8% of people in the 30-50 degree

band would be expected to have clinically low vitamin D levels. The prevalence of vitamin D deficiency from the Baltimore study was not used in these calculations as USA is one of only a few countries that have vitamin D supplementation of foods. The figure of 48% is thus likely to underestimate the prevalence of vitamin D deficiency in populations at a similar latitude who do not have dietary supplementation with vitamin D.

On the basis of data presented in Jablonski and Chaplin (*1*), it is likely that the entire population of the central zone of adequate UV year round (30°N to 30°S) has developed few dietary substitutes for sunlight-induced production of vitamin D. However, more coastal populations may have higher dietary intake of vitamin D and thus be less affected by low levels of UVR (*129*). Thus, the incidence of vitamin D deficiency diseases is estimated at 85% for populations in this band under a scenario of no UV exposure.

Using these figures as the incidence of severe vitamin D deficiency, and applying a disability weight of 0.3 for rickets in the 0-4 age group, 0.2 in the 5-59 age group for adolescent rickets and then osteomalacia, and 0.1 in the older age groups for the effects of osteoporosis (see Appendix 3), the beneficial effects of UVB exposure were calculated.

The effect of dietary supplementation can be seen by examining the rates of disease avoided in AMR A (where there is dietary supplementation of vitamin D) with other regions of similar latitude and population. We have applied incidence rates for vitamin D deficiency to AMR A of 20%, assuming that dietary intake is similar to that of high latitude countries. Note that Gloth's results from Baltimore are consistent with this figure – 48% had vitamin D levels less than 25nmol/l, but a much smaller fraction would have had levels <10nmol/l (the definition of vitamin D deficiency used here). Incident cases of vitamin D deficiency and the burden of disease avoided by having adequate UVR exposure are presented in Table 5.2 and 5.3.

Table 5.2 Incident cases of vitamin D deficiency 2000 under a scenario of zero UVR exposure by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	20 298 939	24 355 501	2 211 114	18 759 318	4 063 195	6 797 361	18 677 283	4 890 825	5 061 358	2 140 675	12 300 533	59 645 237	2 564 009	45 662 839	227 428 185
5-14	32 802 301	39 515 271	4 754 818	37 008 446	7 448 261	14 131 633	31 509 011	10 752 113	10 567 325	5 593 303	24 592 452	116 355 865	5 194 311	100 226 537	440 451 647
15-29	33 409 842	39 294 480	6 589 386	49 957 726	8 759 572	16 854 779	33 476 980	18 635 462	15 619 181	9 042 631	36 400 222	147 802 974	9 886 841	138 894 466	564 624 540
30-44	18 861 972	21 860 239	7 675 552	36 154 552	5 241 108	11 074 940	21 884 763	21 360 177	12 107 818	8 615 505	27 053 236	105 487 336	9 638 511	129 254 113	436 269 820
45-59	9 768 725	10 867 422	5 866 056	20 472 819	2 888 841	5 988 034	11 169 981	17 257 800	7 656 788	6 329 230	14 585 374	60 595 161	10 088 979	77 897 175	261 432 384
60-69	3 512 523	3 702 027	2 236 435	7 316 618	1 095 917	2 028 389	3 761 986	8 867 525	3 580 226	3 211 614	5 639 821	22 608 065	4 873 112	29 895 708	102 329 966
70-79	1 557 871	1 634 161	1 610 215	3 869 245	544 230	1 025 188	1 690 424	5 916 592	1 917 520	1 638 138	2 674 354	10 549 902	2 975 110	14 267 110	51 870 060
80+	356 899	352 892	696 710	1 176 359	153 470	264 249	434 138	2 099 665	421 469	343 241	660 199	2 681 658	1 063 402	3 155 097	13 859 449
Total	120 569 072	141 581 992	31 640 286	174 715 082	30 194 594	58 164 573	122 604 566	89 780 159	56 931 684	36 914 336	123 906 191	525 726 198	46 284 275	539 253 044	2 098 266 052

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	1 9958 983	24 015 716	2 106 033	18 034 772	3 910 836	6 511 682	17 885 065	4 626 648	4 865 738	2 043 794	11 846 561	56 191 876	2 429 672	41 567 402	215 994 777
5-14	3 2468 873	39 351 661	4 537 357	35 710 671	7 210 320	13 532 897	30 265 194	10 189 719	10 151 433	5 370 572	23 790 738	108 894 954	4 938 055	91 307 572	417 720 015
15-29	3 3390 309	39 288 722	6 362 945	49 600 733	8 674 715	16 144 827	31 481 583	17 784 196	15 019 121	8 842 589	35 529 989	136 514 368	9 476 104	130 982 674	539 092 875
30-44	1 9292549	21 997 941	7 544 505	37 584 209	5 495 634	9 740 163	20 429 403	20 901 324	12 043 855	8 805 864	27 310 942	97 581 124	9 503 143	123 614 040	421 844 695
45-59	10 426 378	11 583 563	6 004 607	21 934 227	3 073 490	5 002 687	11 082 439	17 464 041	7 914 042	7 254 731	15 508 706	57 912 826	10 150 278	73 975 134	259 287 149
60-69	4 037 673	4 354 247	2 471 282	8 426 092	1 202 495	1 961 256	4 002 276	9 932 110	4 166 523	4 567 847	6 423 707	23 630 340	5 275 000	29 807 534	110 258 380
70-79	1 921 344	2 132 941	2 109 575	4 986 076	644 836	1 066 358	1 938 966	8 428 964	2 733 931	3 449 787	3 222 200	11 818 414	3 934 606	17 350 697	65 738 697
80+	490 299	589 187	1 364 304	1 847 301	213 308	303 779	488 611	4 628 243	825 380	1 209 793	944 602	3 365 342	2 176 841	5 891 422	24 338 411
Total	121 986 407	143 313 979	32 500 607	178 124 081	30 425 634	54 263 649	117 573 537	93 955 246	57 720 022	41 544 978	124 577 444	495 909 244	47 883 698	514 496 474	2 054 274 999

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	40 257 922	48 371 217	4 317 147	36 794 089	7 974 031	13 309 043	36 562 348	9 517 473	9 927 095	4 184 468	24 147 093	115 837 113	4 993 680	87 230 240	443 422 962
5-14	65 271 174	78 866 932	9 292 175	72 719 116	14 658 581	27 664 531	61 774 205	20 941 832	20 718 758	10 963 875	48 383 190	225 250 819	10 132 365	191 534 109	858 171 662
15-29	66 800 151	78 583 202	12 952 331	99 558 459	17 434 287	32 999 606	64 958 563	36 419 658	30 638 301	17 885 221	71 930 210	284 317 342	19 362 945	269 877 140	1 103 717 416
30-44	38 154 521	43 858 180	15 220 056	73 738 761	10 736 742	20 815 103	42 314 166	42 261 501	24 151 672	17 421 369	54 364 178	203 068 460	19 141 654	252 868 153	858 114 515
45-59	20 195 102	22 450 985	11 870 663	42 407 046	5 962 332	10 990 720	22 252 420	34 721 841	15 570 830	13 583 961	30 094 079	118 507 988	20 239 257	151 872 308	520 719 533
60-69	7 550 195	8 056 274	4 707 717	15 742 710	2 298 412	3 989 645	7 764 262	18 799 635	7 746 749	7 779 461	12 063 528	46 238 405	10 148 112	59 703 242	212 588 346
70-79	3 479 215	3 767 102	3 719 790	8 855 322	1 189 067	2 091 546	3 629 390	14 345 557	4 651 451	5 087 925	5 896 555	22 368 317	6 909 716	31 617 806	117 608 757
80+	847 198	942 079	2 061 014	3 023 660	366 778	568 029	922 749	6 727 908	1 246 849	1 553 034	1 604 802	6 046 999	3 240 243	9 046 519	38 197 860
Total	242 555 479	284 895 971	64 140 893	352 839 163	60 620 229	112 428 222	240 178 103	183 735 404	114 651 706	78 459 314	248 483 635	1 021 635 442	94 167 974	1 053 749 518	4 152 541 051

Table 5.3 Potential disease burden due to complete removal of UVR exposure, DALYs (000) by 14 WHO subregions (see Appendix 4)

MALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	185 718	222 974	3 652	30 984	37 162	11 227	170 691	8 078	8 360	3 536	20 316	545 056	4 235	75 419	1 327 408
5-14	29 829	355 090	472	3 673	6 603	1 403	28 126	1 067	1 049	555	2 441	99 659	516	9 948	220 931
15-29	3 316	3 900	654	4 958	869	1 673	3 323	1 850	1 550	898	3 613	14 670	981	13 786	56 041
30-44	1 872	2 170	762	3 588	520	1 099	2 172	2 120	1 202	855	2 685	10 470	957	12 829	43 301
45-59	970	1 079	582	2 032	287	594	1 109	1 713	760	628	1 448	6 014	1 001	7 732	25 948
60-69	174	184	111	363	54	101	187	440	178	159	280	1 122	242	1 484	5 078
70-79	1 538	1 606	224	542	538	144	1 674	826	270	233	377	10 339	418	2 007	20 736
80+	207	205	69	117	87	26	249	206	41	34	66	1 529	105	320	3 262
TOTAL	223 626	267 706	6 526	46 259	46 122	16 267	207 530	16 299	13 410	6 897	31 226	688 860	8 453	123 524	1 702 706

FEMALE

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	183 958	221 487	3 502	29 216	36 033	10 224	164 662	7 336	7 652	3 282	19 798	517 299	3 825	65 900	1 274 174
5-14	29 743	35 661	450	2 451	6 433	453	27 202	460	371	327	2 500	94 083	183	3 909	204 226
15-29	3 314	3 900	632	3 353	861	533	3 125	776	558	546	3 734	13 550	340	5 329	40 550
30-44	1 915	2 183	749	2 523	545	319	2 028	928	453	556	2 870	9 685	352	4 710	29 816
45-59	1 035	1 150	596	1 439	305	164	1 100	780	311	455	1 630	5 748	360	2 749	17 821
60-69	200	216	123	270	60	32	199	218	81	145	338	1 173	91	549	3 694
70-79	2 182	2 406	322	680	733	130	2 212	1 057	343	472	510	13 306	477	2 135	26 965
80+	320	382	141	162	135	22	320	350	62	104	104	2 163	155	444	4 865
TOTAL	222 667	267 385	6 515	40 096	45 105	11 878	200 847	11 904	9 831	5 887	31 484	657 007	5 783	85 724	1 602 111

BOTH SEXES

AGE	AFR D	AFR E	AMR A	AMR B	AMR D	EMR B	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR D	WPR A	WPR B	TOTAL
0-4	369 677	444 461	7 154	60 200	73 194	21 451	335 354	15 414	16 011	6 818	40 115	1 062 355	8 060	141 319	2 601 581
5-14	59 572	71 250	922	6 125	13 036	1 855	55 327	1 528	1 420	882	4 941	193 743	699	13 856	425 157
15-29	6 630	7 800	1 286	8 312	1 730	2 206	6 447	2 626	2 108	1 444	7 347	28 220	1 321	19 115	96 591
30-44	3 787	4 353	1 511	6 112	1 066	1 418	4 200	3 048	1 654	1 411	5 555	20 155	1 308	17 539	73 117
45-59	2 004	2 228	1 178	3 471	592	759	2 209	2 492	1 071	1 083	3 077	11 762	1 361	10 480	43 769
60-69	375	400	234	633	114	133	385	658	259	304	617	2 295	333	2 033	8 772
70-79	3 720	4 012	546	1 222	1 271	274	3 886	1 883	613	704	887	23 645	895	4 142	47 701
80+	527	587	210	279	223	48	569	556	104	137	171	3 692	260	764	8 127
TOTAL	446 293	535 091	13 040	86 354	91 227	28 144	408 377	28 204	23 240	12 784	62 711	1 345 867	14 236	209 248	3 304 816

6. Sources of error or uncertainty

There are three major sources of uncertainty in the estimates:

1. Lack of data on a global basis for incidence and mortality estimates, disease course and disability weights.
2. Modification of the exposure-response curves due to sun-seeking behaviour or cultural influences on clothing. The "dose-response relationships" derived for non-melanoma skin cancers are averaged over regions with similar ambient UVR – despite possibly wide-ranging differences in actual exposure due to behavioural or cultural influences. Thus, the estimates are likely to be too low for sun-loving populations in Australia, and too high for culturally sun-avoidant populations in the Middle East and Asia. More accurate country-level data is required to improve these uncertainties.
3. Crudeness of the adjustment for skin pigmentation. Only rough estimates assigning populations to three levels of skin pigmentation were possible in this analysis. A single study from Tasmania has examined the distribution of skin pigmentation using spectrophotometric readings (*130*). In order to accurately adjust for skin pigmentation both the population distribution and the effect on the incidence of disease needs to be known in more detail.

To account for the effect of uncertainty or the use of aggregate information despite variation between individuals and populations, results have been expressed in terms of lower and upper estimates. This is, however, only an approximate estimate of the uncertainty, and more accurate estimates would require that additional evidence becomes available.

7. Conclusion

The full results of the burden of disease assessment are presented in Appendix 7 (including results with and without sunburn and RHL, for which the estimates are highly uncertain). Table 7.1 presents a summary of these results.

Table 7.1 Burden of disease due to excessive UVR exposure, DALYs (000) and deaths

	DALYs (000)		Deaths	
Disease	Upper estimate	Lower estimate	Upper estimate	Lower estimate
CMM	621.2	345.1	58 645	32 581
SCC of skin	82.7	59.1	9 474	6 767
BCC of skin	52.1	29.0	2 921	1 623
Solar keratoses	8.3	8.3	0	0
Sunburn	293.6	293.6	0	0
Cortical cataract	529.2	529.2	0	0
Pterygium	34.6	19.7	0	0
SCCC	1.7	1.2	0	0
RHL	68.3	34.1	0	0
Total	1691.9	1319.4	71 039	40 970
Total (excluding sunburn and RHL)	1330.1	991.7	71 039	40 970

CMM: Cutaneous malignant melanoma; SCC: Squamous cell carcinoma; BCC: Basal cell carcinoma; SCCC: Squamous cell carcinomas of the cornea and conjunctiva; RHL: Reactivation of herpes labialis

Thus approximately 1.5 million DALYs and 60 000[6] lives were lost in 2000 due to excessive UVR exposure. While the loss of these 1.5 million DALYs could have been avoided through appropriate UVR exposure (minimum required to maintain vitamin D adequacy), under a scenario of zero UVR exposure 3 304 million DALYs would have been lost due to vitamin D deficiency diseases – rickets, osteomalacia and osteoporosis.

In this first assessment of the burden of disease resulting from excess exposure to ultraviolet radiation it has become clear that more research is needed in this area. Throughout the study, approximations have had to be made to fill knowledge gaps, not just from the developing parts of the globe. This study has highlighted gaps in our knowledge and areas in which further research is needed.

A detailed analysis of a large number of epidemiological studies has been undertaken to arrive at the estimates of burden of disease. The results indicate a relatively modest burden of disease from ultraviolet radiation, but highlight the important benefits from having adequate UVR to maintain vitamin D levels. It should however be noted that only selected disease outcomes have been included here, due to limited evidence or lack of globally available data. It may be that with additional evidence the estimations can become more comprehensive and the true burden will be much higher. Also indirect effects, which could not be included in this analysis, may have wide-ranging consequences on health.

All of the diseases caused by excessive ultraviolet radiation occur in adulthood and old age. They are a result of prolonged and excessive exposure to UVR or the result of a long latent period between exposure and disease. The calculation of the global burden of disease in

[6] The mid-point between the lower and upper estimate was 56 000 deaths, but the authors believe that the upper estimate was closer to reality, and therefore rounded up towards the upper estimate

DALYs favours diseases that affect the young, particularly causing mortality in the young (since this contributes the most years of life lost). In addition, several of the diseases related to UVR are of short duration or attract a low disability weight, despite being of very high prevalence.

Of note in the results is the relatively high (but most uncertain) burden of disease associated with reactivation of herpes labialis and sunburn – two highly prevalent, but relatively minor diseases. Cortical cataract is a significant cause of suffering through loss of vision.

Advocating a position of no UVR exposure is clearly not recommended, given the beneficial effect of UVR. In addition, it is important to moderate the extent of UVR-avoidance depending on the population. It would be deleterious to health to promote high degrees of sun avoidance in populations already at risk of vitamin D deficiency disorders – the deeply pigmented or otherwise sun protected populations.

8. Future directions

At the recent ICNIRP/WHO meeting in Munich (October 2005), which considered the risks and benefits of UVR exposure, the overwhelming consensus was that further research was required in many areas. To improve the precision of these burden of disease estimates and to develop more precise assessment of uncertainty using a comparative risk assessment framework we require information on the following:

What is the counterfactual distribution of minimum disease burden?

If the minimum disease burden occurs at the level of UVR exposure where vitamin D sufficiency is maintained but diseases of over-exposure do not occur, then that level of UVR exposure must be defined. In order for this to occur, further research is needed to clarify what is meant by "vitamin D sufficiency". While musculoskeletal health appears to be preserved at vitamin D levels greater than 50nmol/L, secretion of parathyroid hormone is suppressed and bone density maintained at vitamin D levels of at least 75-80nmol/L, leading to a recommendation of a lower limit of normal of 80nmol/L (*23*). However, it is not yet clear whether this level is sufficient to provide protection from autoimmune diseases or implicated cancers. Further research will be required to establish vitamin D insufficiency as a risk factor for these diseases and then to establish the level of vitamin D considered "sufficient". Similarly there should be clarification of whether there are critical ages where sufficiency is important (*131*).

Once a level of sufficiency is determined, research is then required to better understand the amount and wavelength of UVR to achieve and maintain that level. Based on current research findings, this will vary by:

- Age (*21*)
- Skin type (*132*)
- Location (*21*)
- Typical dietary intake of vitamin D

With these data, a counterfactual exposure distribution could be defined which would be one of theoretical minimum risk, providing a feasible, plausible and almost certainly cost-effective minimum risk.

What is the actual exposure distribution of the populations under consideration?

Better data are required to allow assessment of the actual exposure distribution of populations, taking into account ambient UVR, sun-seeking or avoiding behaviour, clothing habits, and use of sun protective devices (sunscreen, sunglasses, hats etc). Again, this would need to be determined in relation to age, sex and skin type. This measurement would ideally be in physical units, e.g. SED, rather than natural units, e.g. sunburns.

Diseases under consideration

This report outlines nine diseases for which there is sufficient evidence of an association with excessive UVR exposure and three diseases for which there is sufficient evidence of an association with inadequate UVR exposure.

Further data are now required to clarify the relationship between excessive UVR exposure and acute macular degeneration, nuclear and posterior subcapsular cataract and ocular melanoma. Similarly we require more evidence about the apparently complex association between UVR exposure and melanoma onset and progression (whereby excessive UVR exposure is associated with increased risk of developing melanoma, but decreased risk of progression (*133*)).

There are a large number of diseases possibly associated with insufficient UVR exposure – cancers of the colon, breast, prostate, ovary and others; autoimmune diseases such as multiple sclerosis, type 1 diabetes and rheumatoid arthritis; cardiovascular diseases such as hypertension, acute stroke and coronary artery disease; endocrine disorders such as type 2 diabetes; psychiatric disorders and disorders of mood; lymphomas including both Hodgkin and non-Hodgkin lymphoma.

Much more research will be required to elucidate the role of UVR exposure in the onset and progression of these disorders and to control for confounding from, for example, a lowered risk from being outdoors for other reasons, such as exercise. Further work is also required on the effect of solar UVR on vaccine efficacy and risk of infectious diseases.

Not only do we need to establish whether there is indeed a causal association between UVR exposure and these illnesses, but dose-response relationships should be clarified – such relationships will be complicated by the need to include time-varying exposure and perhaps critical periods of exposure.

In summary, to complete a more rigorous assessment using the comparative quantification of health risks (CQHR) framework we require attention to the following features of that methodology (*4*):

1. The burden of disease due to the observed exposure distribution in a population is compared with the burden from a hypothetical distribution, rather than a single reference level, such as non-exposed.

We have little information on either the hypothetical or the observed exposure distribution; what information we do have on the latter typically comes from fair skinned populations living in developed countries. These data may not be generalisable to the global community.

2. Multiple stages in the causal network of interactions among risk factors and disease outcome are considered, including the joint effects of changes in multiple risk factors.

Our understanding of the causal network of interactions both among risk factors and disease outcome are rudimentary. To a certain extent using the PAF derived from multiple regression analysis with adjustment for other factors allows consideration of the pure effect of this exposure. But more work is required for diseases such as cancers, autoimmune diseases and even for example the role of physical activity over the lifetime and bone density in investigating the effect of vitamin D on bone health.

3. The health loss due to a risk factor is calculated as a time-indexed stream of disease burden due to a time-indexed "stream" of exposure.

More sophisticated disease models and the interaction of disease diagnosis with exposure patterns (eg lower sun exposure following a diagnosis of skin cancer), will be required to better describe the time-indexed stream of disease burden.

Murray et al (*4*) describe using a structural model to calculate the burden of disease due to a risk factor. To examine the health effects of UVR exposure, such a model should include changing stratospheric (increasing ground level UVR) and tropospheric (decreasing ground level UVR) ozone levels, human skin pigmentation, diet, levels of physical activity, quality of health care and sun exposure behaviour. The lack of adequate data on the global distribution of the several of these parameters suggests that further research is required before such models can be of value. Modeling time-varying exposure for the diseases of UVR over-exposure may be challenging for diseases such as BCC or melanoma where high intermittent sun exposure in early life confers increased risk which may not decline over time, but accumulated exposure may be partially protective.

There is a growing body of work seeking to understand the differential effects of UVA versus UVB exposure on human health. Since it is ambient UVB that varies most with ozone depletion and with

low zenith angle, and UVB is important to the induction of vitamin D synthesis, separating the health effects of different wavelengths will be crucial to predictive models.

This first global burden of disease assessment of the risks of UVR exposure has highlighted the gaps in our knowledge of the effects of this ubiquitous exposure. A great deal of further research is required across several fields to improve the precision of the estimates and to broaden the scope of the assessment.

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Annexes

Annex 1 Literature Review

In this section, all relevant studies analysed by our literature review are taken into consideration for examining the strength of evidence for a quantitative relationship between UVR and each disease. These studies are summarised in Tables A.1.1 – A.1.8 (at the end of this annex).

1 Effects on immunity and infection

1.1 Suppression of cell-mediated immunity

There is increasing evidence that UVR in sunlight has both local and systemic effects on cell-mediated immunity (*1, 2*). Locally an important effect of UVR is to turn off immune responses to abnormal cells that in turn allow the development of skin cancers (*3*). However, systemic effects on the cell mediated immune system, principally through suppression of the T helper cell type 1(Th-1) immune response, have been demonstrated, particularly as relates to turning off of the immune response to "self" which may be related to the development of autoimmune disorders (*4*). Effects on the immune system, particularly in relation to the development of autoimmune disorders are reviewed by Ponsonby et al (2005) (*2*) and Cantorna (2004) (*5*).

1.1.1 Multiple sclerosis (MS)

There is a well-established, though not ubiquitous, positive latitudinal gradient in incidence of multiple sclerosis (*6*) (*7*). McMichael and Hall proposed that the systemic immunosuppression associated with UVR exposure may dampen the autoimmune process leading to multiple sclerosis by specific suppression of the Th-1 immune response (*8*). Freedman et al reported a reduction in MS mortality risk with high residential or occupational sunlight exposure (*9*) and van der Mei demonstrated a decreased risk for MS with higher sun exposure, particularly during winter, at the ages of 6-15 years (*10*). Recent studies have provided evidence of a protective effect of vitamin D supplementation for the development of multiple sclerosis (*11*) and an inverse association between multiple sclerosis and skin cancer (*12*) i.e. persons with multiple sclerosis were less likely to have skin cancers, suggesting lower sun exposure, than those who did not have multiple sclerosis. Active research is continuing in this area, but the evidence for a causal association with UVR exposure is currently insufficient to include a protective effect on MS incidence in this burden of disease analysis.

1.1.2 Type 1 Diabetes

There is a wide variation in the incidence of type 1 diabetes across Europe that is not explainable in terms of climate, temperature or genetics (*13, 14*). In Australia there is a weak positive latitudinal gradient in prevalence of type 1 diabetes (*15*). Many studies describe a seasonality of disease onset (*16, 17*) (*18*). In the Eurodiab case-control study, recalled vitamin D supplementation was associated with decreased risk for the development of type 1 diabetes (*19*). Stene et al report increased risk of type 1 diabetes in children who were not supplemented with cod-liver oil (a potent source of vitamin D) antenatally (*20*). These findings are further supported by the prospective study reported by Hypponen et al, where regular vitamin D supplementation in infancy was associated with decreased risk of type 1 diabetes in a birth cohort (*21*). As in the work on MS, there are biologically plausible mechanisms to explain a protective effect of UV-induced immunosuppression in this autoimmune disease. However, the work in human populations is in its infancy and type 1 diabetes has not been included in this analysis of burden of disease.

1.1.3 Rheumatoid arthritis

As in type 1 diabetes and MS, there is a biologically plausible role for both UVR exposure and vitamin D as selective Th-1 immunosuppressants in this autoimmune disorder. Cantorna was able to largely prevent the onset of rheumatoid arthritis in mice by administration of vitamin D compounds (*22*) and recent evidence from the Iowa Women's Health Study has indicated that greater intake of vitamin D is inversely associated with risk of developing rheumatoid arthritis (RR 0.67, 95% CI 0.44 – 1.00 for highest vs lowest tertile of vitamin D intake) (*23*). However, further corroborating evidence is required before a causal association can be inferred.

1.1.4 Other autoimmune disorders

UVR exposure has been implicated in the onset and progression of SLE (*24*) and worsens the skin manifestations of this disease (*25*). Experimental studies suggest that vitamin D insufficiency is associated with increased risk of inflammatory bowel disease (*26*). Several human studies have shown an association between vitamin D insufficiency and inflammatory bowel diseases (ulcerative colitis and Crohn's disease) (reviewed in

(*27*)). Further human studies are required to better delineate the role of vitamin D/UVR exposure in disease onset and/or progression.

1.2 Increased susceptibility to infection

There is ample experimental evidence from animal models that exposure to UVR increases susceptibility to a range of infections – Listeria, Schistosoma, Trichinella, and Cytomegalovirus (reviewed in (*28*)). There is biological evidence at least in these animal models of an effect of UVR on immunity at the cellular and the molecular level (*4*). However, there is little evidence of clinically important effects on humans apart from in the reactivation of latent herpes labialis (*29*). There is evidence of increased incidence of viral warts in immunosuppressed patients exposed to UVR (*30*), but although animal models of UVR-induced immunosuppression have raised questions about the effects of UVR on the development or progression of AIDS in HIV positive subjects, human studies have not shown an effect of UVR exposure on HIV progression (*31*). In summary, while there is convincing biological evidence that UVR may have effects on immunity and susceptibility to infection in humans, there is little hard evidence other than in the reactivation of latent herpes labialis.

1.3 Impairment of prophylactic immunization

UVR exposure has been shown to cause local and systemic immune suppression in animal and human studies (*1*). Impairment of contact hypersensitivity to chemicals (nickel, DNCB and diphenylcyclopropenone) has been demonstrated in humans by pretreatment with UVR (*32*). This raises the question of the effect of UVR on the development of an immune response to prophylactic immunization. Sleijffers et al examined the influence of pre-exposure with UVR to the effectiveness of vaccination with hepatitis B. In this cohort study, 97 subjects were irradiated and 94 acted as controls. Pre exposure to UVB induced suppression of NK activity and contact hypersensitivity, but there was no suppression of the antibody response or the cellular immune response to hepatitis B (*33*). A review of the evidence indicates that while there are effects of UVR on response to vaccination, there is no evidence that these are of clinical significance (*34*). Notably, since UVR-induced immunosuppression affects primarily cellular (Th-1) immune responses, further examination is required of the effects of UVR exposure on prophylactic immunization of Th-1 inducing vaccines, e.g. BCG.

1.4 Activation of latent virus infections

1.4.1 Herpes labialis

In animal models and in humans, there is strong circumstantial evidence for the reactivation of herpes virus by exposure to sunlight (*35, 36*). There are few quantitative data on the links between UVR and reactivation of herpes labialis, but sufficient to make a first estimate. Further research will be required before these estimates can be defined with more accuracy.

1.4.2 Papilloma virus

As noted above, there is evidence of increased incidence of viral warts caused by papilloma virus in immunosuppressed patients exposed to sunlight (*37*). Renal transplant recipients exposed to sunlight have an increased risk of development of SCC, which may have human papilloma virus associated with them (*30*). However, there is no evidence to date of an effect of sunlight on papilloma virus infection in humans in the absence of immunosuppression and it is therefore not included in this analysis.

2. Effects on the eyes

2.1 Acute photokeratitis and photoconjunctivitis

There is copious experimental and epidemiological support for a causative role of UVR in the development of acute photokeratitis and photoconjunctivitis (*38-40*). Acute exposure to UVR in settings of high reflectance, such as surroundings covered by snow, is a common cause of photokeratitis (snow blindness) (*41*), with laboratory studies suggesting a mean threshold of UVB for photokeratitis of 3500Jm^{-2} (reviewed in (*41*)).

Occupational exposure to welder's arcs or to metal halide lamps (*42*) can induce photokeratitis in the unprotected eye. UVB blocking contact lenses are able to prevent photokeratitis in laboratory animals (*43*).

2.2 Climatic droplet keratopathy (CDK)

Also called spheroidal degeneration, this is a usually bilateral condition of major significance in certain parts of the world, reducing vision to blindness levels in older people (*41*). It is more common in areas where snowfall persists late into summer as well as in areas of sand and desert at other latitudes. This geographical pattern provides circumstantial evidence of a link with chronic solar exposure, as these surfaces are those of highest UVR reflectance. EHC 160 (*41*) concluded that there was strong evidence that climatic droplet keratopathy is due to environmental factors, but damage by particulate matter could not be excluded. Since 1994 there have been few original research reports on the association between UVR and CDK. Reviews of the association variously conclude that there is insufficient evidence of a causal link (*44*) or very strong evidence (*43*). Cullen accepts the causal association between CDK and chronic UVR exposure as proven (*45*), based on the early studies of Johnson (*46*) and Taylor ((*47*) and provides a biologically plausible explanation for the link, but fails to address the possibly confounding role of damage due to particulate matter. CDK has been used as a proxy for solar damage for the assessment of the association between UVR exposure and cataract (*48*). Animal studies do show biological changes in the cornea exposed to UVR (*43*) but it is not clear that such changes progress to CDK. Reflected UVR (eg from snow, white sand or water) may be more important than direct sunlight (*49*).

Thus although there is circumstantial (geographic) evidence of a causal contribution UVR exposure to the development of CDK and some epidemiological evidence (*46, 47*), the evidence seems insufficient at this time to conclude a causal relationship of CDK with UVR.

2.3 Pterygium

EHC 160 concluded that there was insufficient evidence to link pterygium to UVR – any associations may be due to confounding of observed associations by exposure to particulate matter (*41*). Mackenzie et al demonstrated a RR of 17.2 for pterygium associated with spending most of the time outdoors in childhood (*50*). There is a negative latitudinal gradient for pterygium but it is also common in arctic and sub arctic environments (*51*). Threlfall et al examined associations between pterygia and UV exposure in a case control study with 150 cases who had had surgical removal of pterygium. Using a complex estimate of daily ocular solar radiation dose (calculated from climatic data, time spent outdoors not under shade and the use of hats and spectacles), there was a strong link between pterygia and UVR exposure (OR = 6.8, 95% CI 2.6-19.7 for the highest quarter of exposure) (*52*). The strongest associations were found when adjustment was made for the use of hats and sunglasses, and preliminary analysis of possible confounders such as particulate matter suggested that these had only a weak effect. McCarty et al reported on the epidemiology of pterygium in Victoria, Australia. The independent risk factors for pterygium in this large case control study were age, male sex, rural residence and lifetime ocular exposure (OR = 1.63, 95% CI 1.18-2.25) (*53*). The attributable risk of sunlight and pterygium was 43.6% (*54*). Recent studies with pterygium epithelial cells provide biological support for the causal role of UVB in pterygium development (*55*).

In the studies reviewed in EHC 160, it was not possible to exclude exposure to particulate matter as a confounder of the association between UVR exposure and development of pterygia. However, both of the recent epidemiological studies reviewed above found an independent association with ocular UVR exposure, after adjustment for exposure to particulate matter. Threlfall et al's finding of a dose-response relationship between ocular UVR exposure and presence of pterygium provides further evidence of a causal association between UVR exposure and development of pterygium.

2.4 Pinguecula

Pingueculae are fibro-fatty degenerative changes of the interpalpebral conjunctiva. They share similar pathological changes to those of actinic elastosis of the skin, suggesting that sunlight may be a causative element. However, there is limited epidemiological evidence for an association with UVR. In the Chesapeake Bay watermen study, Taylor et al showed a weak association with UVA and UVB exposure (*47*). Earlier work by Johnson et al found a correlation between pinguecula and severity of CDK in Labrador (*46*), and Norn reported a geographical variation in pinguecula with higher prevalence in Arabs living near the Red Sea than in Eskimos from Greenland or Caucasians in Copenhagen (*56-58*). More recently, Nakaishi et al reported a significant association between occupational motorcycle driving and the prevalence of pinguecula, lending support to a causation related to exposure to particulate matter (*59*). Tang et al demonstrated an association between pinguecula and cumulative occupational sunlight exposure, but there was no control for confounding by exposure to particulate matter (*60*). The evidence thus far is limited and further studies will be required to

clarify the role of UVR in the development of pinguecula, particularly to separate the effects of exposure to UVR and to particulate matter.

2.5 Squamous cell carcinoma of the cornea and conjunctiva

These conditions usually present in the interpalpebral fissure (*61*), an area likely to be exposed to UVR. These corneal neoplasms are rare but are markedly more common in patients with Xeroderma pigmentosa, a recessively inherited syndrome characterized by sunlight sensitivity and a defect in DNA repair of UV-induced damage (*61*). Lee et al reported a case-control study in Australia examining the risk factors for the development of ocular surface epithelial dysplasia, a spectrum of diseases of which cancer of the cornea and conjunctiva is the most serious (*62*). Increased risk of SCCC was found with fair skin (OR = 5.4 95% CI 1.1 – 25.6), propensity to sunburn (OR = 3.8, 95% CI 0.7 – 19.7), history of previous skin cancers removed (OR = 15.0, 95%CI 2.0 – 113.6) and outdoor living in the first 6 years of life at less than 30 degrees from the equator (OR = 7.5, 95% CI 1.8-30.6). The case numbers in the study were necessarily small, hence the wide confidence intervals. There is geographical support for causation by UVR, with a clear latitudinal gradient in incidence (*63*). Guex – Grosier et al reported three cases of corneal intra-epithelial neoplasia in individuals who wore soft contact lenses and had exposure to high intensity UVR (*64*). Kusewitt et al were able to induce corneal tumours in almost 100% of grey short-tailed South American opossums exposed three times weekly to UVR for periods of a year or more (*65*). The evidence is compelling for a causal relationship between UVR and cancer of the cornea and conjunctiva, and some quantitative information is available. These outcomes were therefore included in this analysis.

2.6 Lens opacity (cataract)

The three major types of cataract are cortical, nuclear and posterior subcapsular, but many cataracts are of a mixed type. While the distinction between the types is not always clearly made in (particularly older) epidemiological studies, the etiology of the different cataract types may be quite different and they are here considered separately.

2.6.1 Nuclear cataract

EHC 160 assessed the evidence for nuclear cataract as showing no association between nuclear cataract and UVR exposure (*41*). Hammond et al studied genetic and environmental factors in the occurrence of nuclear cataracts in monozygotic and dizygotic twins and concluded that there was a strong genetic component to nuclear cataract – genetic factors explained 48% of the variance, age 38 % and unique environmental effects, 14% (*66*). Of the studied environmental effects, smoking was thought to have the greatest contribution. A recent Australian study suggests that there is an increased risk of nuclear cataract with high occupational sun exposure at ages 20-29 years (OR = 5.24, 95% CI 2.19-12.6) (*67*). A similar pattern was not seen for sun exposure at other ages. This somewhat unusual age-pattern of exposure will require further investigation before UVR exposure can be considered as causal for the development of nuclear cataract.

2.6.2 Posterior subcapsular cataract (PSC)

The conclusion of the EHC 160 review was that there was inadequate evidence available to link PSC cataract in humans to chronic UVB exposure, although there was sufficient evidence of a link between PSC cataract and UVB exposure in animals.

Using a measure of sun exposure based on residential history and recalled amount of time in the sun (little, moderate or much), Collman et al found an association of sunlight exposure and posterior subcapsular cataract that was similar in strength to that between cortical cataract and sunlight exposure (OR= 1.52, 95% CI 0.28-5.44 for the highest exposure) (*68*).

Despite high ocular UVR exposure in the Chesapeake Bay watermen study, there were too few PSC cataracts to analyse associations with UVR exposure (*69*). In a group likely to have similar high ocular exposure, Hong Kong fishermen, the number of PSC cataracts was again very low compared with nuclear or cortical cataract (*70*). If there was an association between excess UVR exposure and PSC cataracts one might expect that populations such as these, that are likely to have high ocular UVR exposure might have a high prevalence of PSC cataract, but the reverse is apparent.

The India –US Case-control Study on age-related cataract showed a decreased risk of all types of cataract with increased lifetime cloud cover (and by inference, decreased UVR exposure) at the place of residence (OR = 0.78, 95% CI 0.68-0.9) (*71*).

In the Italian-American Cataract Study, UVR exposure was assessed by occupational exposure, use of a hat in the summertime and leisure activities in the sunlight. Analysis of the results revealed a decreased risk of PSC cataract with increasing occupational exposure and leisure time exposure to sunlight, but a positive association with the use of a hat in summer (*72*). The latter observation of increased risk of PSC cataract with the wearing of a hat in summer was thought to be explainable if wearing a hat in summer was a proxy for increased exposure. However, the lack of a positive association of PSC cataract with the other measures of UVR exposure is perhaps stronger evidence against a causative relationship of PSC cataract with UVR exposure.

There was no association between occupational exposure to sunlight and PSC cataract in the Lens Opacities Case-Control study (*73*). In the Beaver Dam Eye study, a measure of average annual ambient UVB light exposure was constructed for each individual based on years of residence in a region weighted by the total ambient UVB light present in that area, as a ratio of the level of such light present for one year in Wisconsin (*74*). There was no association of UVR exposure as measured by this method with PSC cataract in either sex.

Rosmini et al created a summary sunlight index as the measure of sunlight exposure and found no association between any PSC cataract and the sunlight score (*75*). Notably, the number of PSC cataracts was small compared to nuclear or cortical cataracts, but there was a dose-response relationship between the sunlight index and mixed cortical and PSC cataracts.

A positive association between PSC cataract and UVB exposure is reported by Taylor et al (*76*) using a derived measure of personal ocular UVB exposure in a case-control study undertaken in the same area as the Chesapeake Bay Watermen study.

In the Salisbury Eye Evaluation Project, West et al examined relationships between annual ocular UVB doses and cataract in white and African-American populations in Maryland. There was no association between UVB exposure and PSC cataract in either race (*77*).

This lack of association was supported in the Melbourne Visual Impairment Study. While cortical cataract showed a significant association with increased average annual ocular UVB exposure, PSC cataract was associated with increased age, rural location, and use of thiazide diuretics, vitamin E intake and myopia (*78*).

Finally, the POLA study, undertaken in Sete, southern France found no significant association between PSC and average annual ambient solar radiation exposure, while confirming the positive relationship of UVB exposure to cortical cataract (*79*). Professional exposure to sunlight was associated with an excess risk of PSC cataract (OR = 1.75, 95% CI 1.10-2.80).

While some studies have suggested a positive association between PSC cataract and UVB exposure using a number of different measures of UVB exposure, the weight of the evidence (particularly more recently) suggests that PSC cataract is not associated with increased UVB exposure, and PSC has not been included in this burden of disease analysis.

2.6.3 Cortical cataract

In the 1994 WHO review (*41*), most studies indicated some association between cortical cataract and UVR exposure. Taylor et al studied Chesapeake Bay watermen and found a relative risk for presence of cortical cataract for the highest sun exposure category that was three times that for the lowest exposure category (*69*). Subsequent data from the Beaver Eye study suggested that the increased risk might be confined to men (*74*). West et al reported results from a large nested case control study in Maryland in which a detailed model of sun exposure was used to assess sun exposure since age 30, with adjustment for wearing of hats and glasses, average UVR and cloud cover (*77*). There was a higher prevalence of cortical opacity with higher UVR exposure (OR (highest quartile of UV exposure cf. lowest) = 1.57, 95% CI 1.04 – 2.38). Smoking, education and alcohol use were not significantly related to cortical opacity. The association of UVR with cortical cataract was further supported by the findings of McCarty et al in the Visual Impairment study in Victoria, Australia (*78*). There was a statistically significant increased risk of cortical cataract (OR = 1.44, 95% CI 1.21 – 1.73). Further studies of the association between UVR exposure and cortical cataract are summarized in the accompanying tables.

Recent research focuses on the biological processes involved, including the effects of timing and of repeated exposure (*80*), age of exposure (*81*), the role of UVA in cataract genesis (*82*), and protective mechanisms (*83*).

The evidence of an association between presence of cortical cataract and past ocular UVR exposure is largely consistent across a number of well-conducted, large studies. Cortical cataract is included in this analysis.

2.7 Ocular melanoma

EHC 160 reviewed a number of epidemiologic and geographic studies on the risk factors for uveal melanoma and concluded that there was insufficient evidence of a causal association with excessive UVR exposure. In particular, there was no convincing latitudinal gradient for uveal melanoma in the US, Canada or Australia and inconsistent findings relating place of birth to uveal melanoma. There was no statistically significant association between ocular melanoma and a personal history of skin cancer.

In a comparison of age-standardized mortality rates for cancers of the eye and those for cutaneous malignant melanoma (CMM) in England and Wales, Dolin et al found that while rates for CMM increased three-fold from 1950/54 to1985/89 those of uveal melanoma stayed relatively constant (*84*). Holly et al demonstrated an increased risk of uveal melanoma in occupational groups who had intense exposure to ultraviolet light (OR3.0; 1.2-7.8), welding exposure (OR = 2.2; 95% CI 1.3-3.5) and asbestos exposure (OR = 2.4, 95% CI 1.5-3.9) (*85*).

In Queensland, Australia, Pane and Hirst found that risk factors in for ocular melanoma included personal history of cutaneous melanoma (OR = 2.42. 95% CI 0.88-6.62), other skin cancers (OR = 1.52, 95% CI 0.99-2.35), and family history of ocular melanoma (OR = 6.89, 95% CI 0.7-67.38) (*86*). Protective factors included olive or black skin, brown iris colour, high resistance to sunburn and wearing prescription sunglasses. Sunglass wearing and cumulative lifetime ocular UVB exposure were not associated with ocular melanoma.

A recent case-control study in France examined occupational exposure to UVR, both solar and artificial (*87*). While there was an increased risk of ocular melanoma in occupational groups exposed to artificial UVR, there was no increased risk in outdoor occupational groups. Interestingly, this study showed a dose-response relationship with job duration among welders, and an increased risk among male cooks, and female metal workers and material handling operators. This raises the question of whether it is the exposure to UVR in welders that is the causal exposure or something else in the welding process.

Another recent large case-control study from Australia found that eye color was the strongest independent predictor of choroidal and ciliary body melanoma (*88*). Risk was greater for grey, hazel, and blue eyes than brown eyes, and was also increased with decreasing ability to tan, increasing numbers of nevi on the back and with squinting as a child. Such findings strengthen the case for a genetic risk but are consistent with some causal effect of UVR. This study also examined sun exposure and uveal melanomas. Their findings suggest an association of choroid and ciliary body melanoma with occupational sun exposure (mainly in men), with less convincing results of an association with total exposure and no evidence of association with ambient solar irradiance.

In a recent meta-analysis of the evidence, risk of ocular melanoma was increased with exposure to welding (OR = 2.05, 95% CI 1.20 – 3.51) but not with measures of outdoor leisure time (OR = 0.86, 95% CI 0.71 – 1.04), or latitude of birth (OR = 1.08, 95% CI 0.67 – 1.74) (*89*). Occupational sunlight exposure had a borderline non-significant association with the development of uveal melanoma (OR = 1.37, 95% CI 0.96 – 1.61).

In the opinion of the working group, at this stage there is insufficient evidence of a causal relationship with excessive ambient UVR exposure to include ocular melanoma in this analysis.

2.8 Acute solar retinopathy

Also known as phototoxic retinopathy or eclipse retinopathy, acute solar retinopathy has been recognized as a cause of acute loss of vision for many years. It is usually described following sun-gazing or looking at the sun during a solar eclipse, but there have been increasing reports of a similar burn to the retina related to lengthy exposure to light from an operating microscope during eye surgery (*90*). There is such a strong temporal relationship between the intense solar exposure and the retinopathy that we can conclude a causal relationship between the two. Most cases of acute solar retinopathy recover their vision loss over weeks or months, but a few will go on to permanent visual impairment, usually a central scotoma (*91-93*). Despite strong evidence of a causal association with UVR exposure, acute solar retinopathy was not included in this analysis, as it is a sporadic disorder, for which there are insufficient global incidence data from which to derive burden of disease estimates.

2.9 Macular degeneration

There is circumstantial evidence of a link between excess UVR exposure and acute macular degeneration (AMD). For example, Young noted that AMD occurs in the precise region of the eye that would be preferentially damaged by bright light and that both ocular melanin and cataractous lens appear to protect the retina against AMD (*94*).

Bressler's review of the associations between AMD and UVR exposure concluded that the evidence was limited and inconsistent, while there was evidence of positive associations between AMD and cigarette smoking and between AMD and cardiovascular disease (*95*). In a recent examination of the links between ocular UVR exposure and AMD, Loeffler et al examined the association between AMD and other ocular changes possibly induced by UVR, pinguecula and scleral plaque (*96*). There was a significant association between scleral plaque and AMD (and no significant association between pinguecula and AMD). This provides some support for a causative role of exposure to solar radiation in the development of AMD, provided one accepts that solar radiation has a causative role in the development of scleral plaque.

In a comprehensive review of the literature on AMD in 2001, Penfold et al cite the risk factors for AMD, in order of importance, as age and then smoking, with hypertension implicated in causation of the wet form (*97*). Ultraviolet radiation as a causative factor is not considered.

The evidence linking excess ocular UVR exposure to AMD appears tenuous. It seems likely that smoking and cardiovascular disease are important causative factors, with more research required on the associations with UVR exposure and micronutrient levels. While not included in this burden of disease analysis, causative links between excess UV exposure and AMD should be further evaluated in future burden of disease assessments.

3. Effects on the skin

3.1 Cutaneous Malignant Melanoma

There is little doubt from the epidemiologic literature that UVR has a causative relationship with development of malignant melanoma. Evidence includes: - a positive association between melanoma incidence and residence at lower latitudes; a decreased risk of melanoma in those who migrated in childhood, from an area of low UVR to an area of high UVR (compared to those born in the area of high UVR and still resident there); a body site distribution which mirrors those areas of the body usually exposed to sunlight; a correlation with freckling and development of melanocytic naevi; a correlation with other evidence of solar skin damage (wrinkling, solar keratoses); the very low incidence of melanoma in people with black skin, and an increased risk (OR of the order of 1.5) with a history of intermittent sun exposure and sunburn (reviewed in (*41, 98*). Cutaneous malignant melanoma is included in this analysis of the global burden of disease due to ultraviolet radiation.

3.2 Cancer of the lip

This disorder includes cancer of the vermilion border of the lip and the adjacent mucous membrane, but excludes cancer of skin adjacent to the lip. There is some evidence for UVR exposure as a causal risk factor for this disease, including: most occur on the lower lip which has a higher sun exposure than the upper lip; incidence is higher in men than women and higher in white populations than in black or Asian populations; incidence is lower in migrants from areas of low UVR to areas of high UVR (compared to those born in the area of high UVR) and higher in rural than urban dwellers and in those with outdoor occupations.

There is an increased risk of cancer of the lip following SCC of the skin (*99*) and actinic cheilosis may progress to SCC of the lip, similar to the association between solar keratoses and SCC (*100*).

Few epidemiological studies have adequately controlled for confounding by tobacco or alcohol which are known risk factors for oral cancers. Furthermore, a recent review suggested that cancer of the lip has a complex causation due to the interaction of a number of factors (*101*).Further research is required before there is sufficient evidence of a causal role for ultraviolet radiation in causation of cancer of the lip and before the risk attributed to UVR exposure can be determined.

3.3 Squamous cell carcinoma of the skin

There is convincing epidemiologic and biological evidence of a causal association of UV exposure (particularly occupational exposure) to development of squamous cell carcinoma of the skin (SCC) and it was thus included in this analysis. The evidence includes: increased risk in those with light complexion and increased sensitivity

of the skin to sunburn (*102*); increased incidence in patients with Xeroderma pigmentosa, particularly on sun exposed areas; high incidence in African albinos (*103*); site distribution corresponding to the areas of greatest sun exposure; increased risk related to total lifetime sun exposure, but particularly occupational sun exposure; regular use of broad spectrum sunscreen can decrease the incidence of SCC; association with solar keratoses (common benign precursors of SCC and thought to be a result of sun damage), freckling and loss of skin elasticity; evidence of mutation in TP53 gene (tumour suppressant) in response to UVR; development of SCC in neonatal foreskins (grafted onto mice) following chronic exposure to UVR (*104-109*).

3.4 Basal cell carcinoma of the skin

In many studies SCC and basal cell carcinoma of the skin (BCC) are considered together as non-melanocytic skin cancers. While the causal relationship of UVR to BCC is also firmly established (and BCC is thus included in this analysis), the causative pattern of UVR exposure seems to be quite different to that of SCC. Risk of BCC is significantly increased in subjects with a history of sunburn (*110*) or other evidence of skin damage – loss of skin elasticity (as measured by microtopography) freckling and solar keratoses (*102*).

The risk of BCC increases with increasing occupational exposure but particularly with increasing non-occupational or "intermittent" exposure to the sun (*111*). There is a lower risk of BCC in those who migrate to an area of high solar irradiance from an area of low solar irradiance (compared to those born in the area of high solar irradiance) particularly if migration is after the first 10 years of life (*108*). BCC is more common on those body sites that are exposed intermittently to the sun, rather than sites such as the back of the hand that are constantly exposed (*108*). A large fraction of BCCs carry mutations in the p 53 suppressor gene which are typical of UVB damage (*112*). Other mutations, particularly in the PTCH gene, with consequent activation of the proliferative SHH pathway, are observed in murine BCC and in patients with xeroderma pigmentosa and are typical of UVB induced damage (*112, 113*). There is some evidence that use of sun protection devices reduces the risk of BCC (*114*).

3.5 Sunburn

The extent of reddening of the skin (erythema) following exposure to a particular dose of ultraviolet radiation is dependent on skin sensitivity (*115*), wavelength of exposure (250-290 nm being the most erythemogenic) (*41*) and skin pigmentation (fair skin burns more easily than dark) (*116*). Erythema occurs 3-5 hours after UV exposure, reaches a maximum between 8 and 24 hours and then fades over 3 days (*41*). In its most severe form, erythema is followed by inflammation, blistering and peeling of the skin. Histologically, sunburn is associated with vasodilation of the capillary vessels within the papillary dermis, dyskeratotic keratinocytes (sunburn cells), perivenular edema, and presence of dermal neutrophils (*41*). Blisters show elevated levels of prostaglandins, while keratinocytes exposed to UV release cytokines and TNF alpha, potent mediators of inflammation (*41*). There is evidence of DNA damage at suberythemal as well as erythemal doses of UVR (*117*). Sunburn is clearly caused by UVR exposure – although generally mild, it can be severe and is extremely common. Although global incidence data are limited, a first estimate has been made in this analysis of the global burden of disease due to sunburn.

3.6 Chronic sun damage (photo-ageing)

Age related changes in skin are a combination of chronological ageing and photoageing, due to UV exposure (*118*). There are unique alterations in the dermal extracellular matrix as well as an accumulation of DNA mutations related to photoageing that distinguish this from chronological ageing (*119*). Wrinkling, freckling, benign melanocytic nevi, solar (actinic) keratoses and senile (solar) lentigines have been associated with chronic UVR exposure (*120*). It is likely that much of the photodamage induced in skin is UVA-mediated (*121*). Kambayashi et al induced wrinkle formation in hairless mice on exposure to chronic low dose UVA and UVB with fine wrinkling present after 4 weeks exposure (*122*). Contrary to earlier studies that had shown changes in dermal elastin and collagen, this study indicated wrinkling as a consequence of impaired keratinization. There is an increased prevalence of both freckles and solar lentigines in those with highly sun sensitive skin and an increased risk of NMSC (*41*).

Benign melanocytic nevi (moles) are common in white populations and rare in more deeply pigmented populations (*123*) and are associated with an increased risk of malignant melanoma. They occur more commonly on sun-exposed body sites, and are less common in migrants who have spent their childhood in an area of low UV intensity, compared to those who have spent their childhood in an area of high UV intensity (*124*).

UVR exposure is clearly causative of photo-ageing and an initial assessment is made of the burden of disease, largely associated with the treatment of the results of chronic photo-damage to the skin, ie solar keratoses.

3.7 Photodermatoses

This term encompasses a range of skin diseases, whose common element is an abnormal sensitivity to exposure to UVR, particularly UVA. The group includes solar urticaria, photoallergic contact dermatitis, actinic prurigo, polymorphic light eruption and hydroa vacciniforme.

Solar urticaria is an uncommon disorder that occurs worldwide with preponderance in women. Clinically, sun exposure leads to itching, burning, erythema and whealing. Symptoms usually commence in young adulthood, and are short lived once UV exposure is terminated. Urticaria is most marked on exposure of skin not normally exposed to the sun. It is clear that the urticaria is the result of an antigen-antibody reaction, with the antigen produced in the skin after solar irradiation (*125, 126*).

Photoallergic contact dermatitis is a rare condition consisting of an itchy rash with signs of a chronic eczematous eruption on sun-exposed skin. It is reported in association with sunscreen use (PABA containing), use of some fragrances, and use of therapeutic drugs, particularly some phenothiazines, and some antibiotics (*127, 128*).

Actinic prurigo is a rare, familial photodermatosis seen especially in American Indians. Genetically, it is thought to have a simple dominant inheritance with incomplete penetrance (*129*). In predisposed subjects, exposure to UVR may result in excessive release of the pro-inflammatory TNF-alpha from keratinocytes (*130*). Clinically, patients with actinic prurigo experience severe pruritis and develop a dermatosis consisting of erythematous weeping areas, vesicles, papules, nodules and plaques on the face and exposed areas, after exposure to UVR. Typically, there is an exacerbation of symptoms in early spring and improvement at the end of autumn, but symptoms may persist during winter. Onset is usually before puberty and spontaneous resolution may occur in adolescence.

Polymorphic light eruption (PLE) is extremely common, occurring in approximately 15 % of the Caucasian population in the UK, principally women aged 20-30 years. Clinically there is an acute onset of transient itchy, non-scarring erythematous papules and plaques on sun-exposed sites developing hours to days after sun exposure. The eruption differs from acitinic prurigo morphologically and in time course, PLE being much more short-lived, typically resolving over several days. It is usually mild but can be incapacitating and require treatment with systemic steroids. Familial clustering of PLE is reported – Millard et al found 84% to 87% heritability in their twin study (*131*).

Hydroa vacciniforme (HV) is a rare photodermatosis with onset in childhood. Patients develop an itchy, stinging, erythematous rash 15 min to 24 hours after sun exposure, in sun exposed areas – the malar areas, bridge of the nose, lips, ears and the dorsa of the hands and forearms. This rash progresses to tender papules, followed by vesiculation, then crust formation, with healing in 1-6 weeks with residual fine varioliform scars. The disease usually remits in adolescence but may persist into adult life. Severe attacks can cause a systemic illness with fever and malaise, and eye involvement is reported. Severe scarring can lead to contractures of the fingers and deformities of the ears and nose (*132*). The estimated prevalence is 0.34 cases per 100,000 with an approximately equal sex ratio (*133*). The pathogenesis of HV is unknown.

Although photodermatoses are clearly associated with exposure to sunlight, they are not included in this analysis as this group of disorders represents an idiosyncratic reaction to normal levels of sun exposure, rather than a disease of excess or insufficient sun exposure. In addition, there are insufficient global data to include photodermatoses in this analysis.

3.8 Psoriasis

Sunlight has been used in the treatment of psoriasis for many years, but the role of UVR in psoriasis causation is not clear. There is a strong genetic component to psoriasis and a complete absence in varied races – Australian aborigines, Eskimos, Native American Indians, and some South American Indians. There is evidence of a geographic variation in the prevalence of psoriasis, but it is not a simple variation with latitude. While Ferrandiz (*134*) demonstrated a gradient between the south and central regions of Spain, the numbers involved were small and contrast with the study by Finzi in Italy that failed to show a variation by region (*135*). There is a substantial difference in prevalence between East Africa and West Africa which is not related to latitude, although it may be related to humidity, which is low in East Africa but high in West Africa (*136*).

While there are substantial geographic variations in psoriasis prevalence, there does not appear to be a gradient related to UV radiation. While UV radiation is an important therapeutic tool in the treatment of psoriasis, it is not clear that there is a causative relationship between UVR (or lack of it) and psoriasis and it will not be considered further in this project.

4 Health effects possibly mediated by vitamin D

4.1 Vitamin D production

4.1.1 Rickets, osteomalacia and osteoporosis

First described in the mid-1600s, rickets was not linked to lack of sunlight until 1822 and to vitamin D deficiency in 1922. Subsequent supplementation of the diet with vitamin D led to rickets becoming a rare syndrome. During the 1970's the adult version of rickets, osteomalacia, resurfaced in Indian immigrants to the United Kingdom – a result of the combination of darker skin and more clothing than European counterparts and less sunlight than their country-of-origin (*137*). Recently, reports from many diverse parts of the world have found that vitamin D deficiency or insufficiency are common in all age groups and population sub-groups (*138-144*). Immigrants to higher latitude countries who are veiled or have dark skin pigmentation and their children are at particular risk and may suffer frank rickets or osteomalacia or have sub-clinical vitamin D deficiency (*138*). Furthermore there are similar reports even where ambient UVR is high, as in Australia (*145*).

In elderly people, there is a decreased ability of the skin to produce vitamin D from a given dose of UVR – add to this, limited sun exposure (particularly those in institutions) due to decreased mobility, and the assiduous use of sunscreens recommended to decrease the risk of skin cancers on sun-damaged skin and the scene is set for vitamin D deficiency (*143, 146-148*). In a vicious cycle, lack of vitamin D may worsen osteoporosis, a risk factor for fractures in older people, further decreasing mobility and opportunities for sun exposure to increase vitamin D levels. Vitamin D deficiency causes secondary hyperparathyroidism, which may precipitate or exacerbate osteoporosis (*149*). It can result in muscle weakness and pain (*139*) (*150*), and has been implicated in the causation of a number of immune disorders (*2*) and cancers (*151*). The evidence of a protective effect of UVR through the avoidance of vitamin D deficiency is clear-cut. Any assessment of the global burden of disease must take into account that a certain amount of UVR is necessary to avoid the burden of disease related to vitamin D deficiency.

4.1.2 Tuberculosis

Sunlight and cod liver oil were early treatments for tuberculosis (TB), sometimes with excellent results, particularly for cutaneous TB (*152, 153*). Interest in the relationship between vitamin D and susceptibility to TB has resurfaced as more recent work has shown the importance of vitamin D as a modulator of macrophage function and in the process of cell mediated immunity (*154-156*). In vitro studies have shown a direct relationship between vitamin D metabolites and intracellular tuberculosis – these metabolites can enhance the ability of monocytes to restrict the growth of intracellular TB (*157, 158*). Alveolar macrophages in tuberculous patients can produce large quantities of the active 1,25 (OH) vitamin D and this may be important in restricting the growth of mycobacteriae (*159*). Vitamin D deficiency is common in patients with treated and untreated tuberculosis - whether this is cause or effect cannot be deduced from cross-sectional studies (*160*).

Tuberculosis notification has an unusual seasonality for a respiratory disease, with a summer peak (classically, respiratory diseases have a winter peak and a summer trough) (*161*). It is postulated that this may be related to a winter trough of vitamin D levels with consequent impairment of cell-mediated immunity and susceptibility to reactivation of latent mycobacterial infection. Wilkinson et al found an association between low levels of vitamin D and risk of tuberculosis in a population of Gujarati Asians in West London (*162*). There was a high prevalence of vitamin D deficiency in both TB and control groups, but the lowest levels were found in patients with active TB (OR = 2.9, 95% CI 1.3-6.5 for 25(OH)D deficiency, and OR = 9.9, 95% CI 1.3-76.2 for undetectable 25 (OH) D). However, the sample size was small and this was a cross sectional study, so that we must await further evidence of a temporal relationship between lowered vitamin D and TB.

There is a biologically plausible mode of action for vitamin D deficiency to enhance susceptibility to tuberculosis, through its effects on macrophages and cell-mediated immunity. While the possibility that vitamin D deficiency can enhance susceptibility to TB is of great global importance – particularly as relates to a beneficial effect of UVR on suppressing TB - there is insufficient causal evidence at this stage to include it in this analysis of burden of disease.

4.2 Cancers

4.2.1 Non- Hodgkins lymphoma

Cartwright (1994), in reviewing the rise in incidence in non-Hodgkins lymphoma (NHL) worldwide, hypothesized that this rise may be related to increased exposure to sunlight, citing biological and epidemiological evidence (*163, 164*).

Adami et al examined the association of skin cancers with NHL and chronic lymphocytic leukemia (CLL) in an effort to further elucidate the association of NHL with UV exposure (*165*). There was an increased risk of SCC in cases with pre-existing NHL or CLL (both NHL and SCC increased with chronic immunosuppression). Those with pre-existing SCC had an increased risk of developing NHL or CLL, which decreased over time. The authors concluded that this association was supportive of a link between increasing NHL and increasing sun exposure. However it is possible that the increased risk of NHL or CLL in patients with SCC simply reflects an increased risk of SCC in patients who actually already have subclinical NHL or CLL – particularly in view of the diminishing association over time. Newton notes that preliminary US data suggest decreasing incidence of NHL with increasing exposure to UVR, but there is no account taken of possible confounding by SES or occupation (*166*).

Bentham et al examined the incidence of NHL in England and Wales and its relationship to solar UVR in an ecological study (with a model using data on latitude and cloud cover). They found a clear trend of increasing incidence of NHL with increasing estimated UVR (RR = 1.27, 95% CI 1.24-1.29 for the highest UVR compared to the lowest). After adjustment for social class and employment in agriculture this rose to RR = 1.34, 95% CI 1.32–1.37 (*167*). This study has limitations common to ecologic studies with failure to link NHL and UVR exposure at the individual level.

Freedman et al examined mortality from NHL in relation to sunlight exposure as assessed by place of residence and occupation. Again, this is ecological data rather than individual, with the inherent problems of not reflecting individual exposures and cancer experience. Additionally, data are based on place of residence and occupation as reflected on the death certificate. Either or both of these may not reflect true lifetime sun exposure. They found no positive association between mortality from NHL and their measures of exposure to UVR (*168*). Douglas et al failed to show seasonality in the presentation of NHL (*169*).

Two recent case control studies show a protective effect from higher UVR exposure (*170, 171*). In both of these studies, sun exposure in childhood or early adulthood appeared particularly important to this protective effect (OR = 0.7, 95% CI 0.6-0.9 for sunbathing four times a week or more at age 20 vs. never sunbathing, and risk of NHL) (*170*). While there are no data on the risk of NHL actually associated with low vitamin D levels, vitamin D insufficiency is proposed as a biologically plausible intermediate in view of in vitro and animal experimental findings of the anti-proliferative and tumour suppressive properties of vitamin D (*172*). Thus, low UVR exposure causes low vitamin D levels which in turn are hypothesized to increase the risk of NHL development.

In summary, there is conflicting evidence on the association between UVR exposure and development of NHL.

4.2.2 Prostate cancer

In recent years there has been an explosion of interest in the possible beneficial effects of vitamin D. A number of tissues, including prostatic tissue, contain vitamin D receptors and vitamin D has an antiproliferative effect on human prostatic cancer cells (*173*). There is growing, but not yet conclusive, epidemiological evidence of a role of low vitamin D levels as a risk factor for the development and progression of prostate cancer.

Ecological and individual level studies indicate a protective effect of higher levels of ambient UVR (for prostate cancer mortality (*174*) or a personal history of UVR exposure (for prostate cancer incidence (*175-177*)). Further, interaction between sun exposure and skin pigmentation genotypes has been reported (*178*). In a case control study of sun exposure, genes and prostate cancer, tyrosinase codon 192 variants (TYR A2/A2 homozygotes) were at reduced risk of prostate cancer (OR = 0.44, 95% CI 0.21 – 0.94). Stratification of cases and controls by quartiles of exposure, revealed that the protective effect of TYR A2A2 (OR = 0.055, 95%CI 0.008 – 0.37) was particularly strong in subjects who had received the greatest sun exposure (*178*).

There is mixed support for an association between prostate cancer risk and vitamin D levels. In a nested case control study in Finland, Ahonen et al examined links between vitamin D deficiency and prostate cancer (*179*). Non-localized cancers in younger men (40-51 years) were associated with the lowest mean level of vitamin D (OR 6.3, 95% CI 1.3 – 30.5). In these younger men, low vitamin D (less than 40nmol/L) was associated with an

increased risk of prostate cancer compared to those with vitamin D levels above the mean (adj OR 3.5, 95% CI 1.7 – 7.0). There was no statistically significant increased risk in older men. However two cohort studies show no association between vitamin D levels and subsequent prostate cancer risk (*180, 181*). In a longitudinal Nordic study, vitamin D levels higher or lower than the middle range (serum 25OHD 40-59 nmol/L) were associated with increased risk of prostate cancer, with evidence of dose-response in both directions (*172*). Thus the role of vitamin D in prostate cancer remains unclear.

Other risk factors for prostate cancer that may be related to vitamin D include black race, age and residence in northern latitudes (as well as a multitude of other possibilities including diet, genetics and intrauterine effects) (*173*).

The work on prostate cancer and UVR exposure/vitamin D is in its early stages and there is insufficient evidence of a causal link.

4.2.3 Breast cancer

The etiology of breast cancer is clearly multifactorial with dietary factors, drugs, reproductive status, pesticides and environmental carcinogens, and physical activity, all implicated.

Ecological evidence suggests lower breast cancer incidence and mortality in higher ambient UVR settings (*182, 183*) or where vitamin D levels are likely to be highest at diagnosis (*184*). In the NHANES I cohort study, John et al found a reduction in breast cancer risk associated with greater sunlight exposure or dietary vitamin D (*185*). There was a significant protective effect from self-reported frequent or occasional recreational sun exposure, compared to "rare or never" sun exposure (OR = 0.66, 95% CI 0.44 – 0.99, p for trend 0.08), but a non-significant protective effect using objective measures of sun exposure (e.g. actinic damage) (OR = 0.80, 95% CI 0.48-1.29). Vitamin D intake of ≥200IU was associated with a non-significant protective effect (OR = 0.86, 95%CI 0.61-1.20). In the Nurses' Health Study, total vitamin D intake (>500 IU/day vs. ≤ 150 IU/day) was associated with a lower risk of breast cancer in premenopausal women (RR = 0.72, 95% CI 0.55 – 0.94) (*186*).

While there is some evidence developing linking increased breast cancer risk with low vitamin D/UVR exposure, this is insufficient at present to allow an assessment of causality, and breast cancer has not been included in this analysis

4.2.4 Colon cancer

Ecological studies suggest a protective effect on risk of colorectal cancer from higher ambient UVR (*187, 188*). Several individual level studies indicate a protective effect of higher vitamin D (25(OH)D) blood levels (*189-191*) or dietary vitamin D (*192*) on the development of colorectal cancer or colorectal adenomas (*193-195*), although in some studies this effect was apparent only in males (*196*). Other studies suggest that the apparent protective effect of vitamin D is mediated via a protective effect of increased calcium on colorectal cancer (*197, 198*) or postulate an interaction between calcium and vitamin D (*199*). One large incident case-control study (n = 1993 cases) found that self-reported dietary calcium intake in the previous two years was associated with a significant protective effect on colon cancer risk. There was, however, no statistically significant association with either self-reported sunshine exposure or dietary vitamin D intake in the previous two years (*197*).

While the evidence of a protective effect of vitamin D adequacy or higher levels of sun exposure for colorectal cancer is largely, considerable uncertainty remains with some large, well-conducted studies showing no association.

4.2.5 Other cancers

Grant's ecologic study suggests that a number of other cancers may have an association with ambient levels of UVB: ovary, bladder, esophageal, kidney, lung, pancreatic, rectal, stomach and corpus uteri (*188*). There is some supportive evidence from other ecologic (*200*) and individual-level (*201*) studies. Freedman et al found that mortality from ovarian cancer was negatively associated with high ambient solar radiation (OR = 0.84, 95% CI 0.81 – 0.88 for the highest vs lowest category).

Based on ecologic data, Grant estimated that the annual number of premature deaths from cancer in the United States, due to lower UVB exposures (based on mortality data from 1970-1994) was 21,700 (95% CI 20,400 – 23,400) (*188*). Furthermore, Grant et al estimate that, in the United States, the annual economic cost of cancer that is attributable to insufficient UVB doses is 10-15 billion dollars (*202*). While the use of ecologic data to

infer causality and to estimate exposure-outcome associations at a personal level may be questionable, the calculations illustrate the possible magnitude of adverse health effects associated with insufficient sun exposure/vitamin D levels.

4.3 Cardiovascular effects

4.3.1 Hypertension

Geographic and temporal patterns in mean systolic and diastolic blood pressures are consistent with an association with inverse association with ambient UVR: mean systolic and diastolic blood pressure rises linearly with increasing distance from the equator; blood pressure is higher in winter than summer; coloured people living in the US and the UK have higher prevalence of hypertension than those of European origin and within the African-American community greater skin pigmentation is associated with higher blood pressure (*203, 204*). While dietary, social and intrinsic racial differences have been invoked to explain these variations, Rostand has proposed that these patterns may be explainable on the basis of lowered vitamin D and consequent elevation of parathyroid hormone (PTH) secretion as one moves further from the equator (*203*). Elevated blood pressure may be mediated through effects of PTH on vessel wall thickening, effects of vitamin D on proliferation of quiescent vascular smooth muscle, or through effects on calcium metabolism (*203*). Consistent with this hypothesis, Krause et al reported decreases in blood pressure and parathyroid hormone levels following UVB irradiation (*205*).

In a recent review, Zittermann et al note several plausible biological pathways (with supporting evidence) through which vitamin D might be protective for cardiovascular disease (*204*), either directly via effects on vascular smooth muscle cells (which express vitamin D receptors) and insulin resistance or indirectly via effects on PTH levels.

4.3.2 Coronary Heart Disease

There is a seasonal pattern of coronary heart disease (CHD) with a winter peak and a summer trough that applies both to incidence and mortality (*206*) (*204*). There is a strong correlation between death from ischaemic heart disease (IHD) and latitude (r = 0.58 (males)) which mirrors the strong negative correlation of latitude and serum 25(OH)D levels (r = -0.68) (reviewed in (*204*)). Residence in a lower ambient UVR region was associated with increased risk of a major IHD event, in a large prospective study (*207*) and of cardiovascular risk factors (*208*). Several studies have shown lower levels of vitamin D metabolites in subjects with CHD (*206*).

4.3.3. Stroke

Vitamin D deficiency is prevalent in the elderly, particularly those in institutional care or with lowered mobility that affects their ability to be outside (*143, 209, 210*). Sato et al have documented abnormal bone metabolism in long-term survivors of stroke, with lowered vitamin D levels and increased risk of osteoporosis and hip fractures (*211*). This situation appears to occur as a consequence of stroke, but Poole et al recently demonstrated reduced vitamin D in a majority of patients with acute stroke and suggest vitamin D as a risk marker for stroke (*212*).

While a role for vitamin D/UVR exposure in risk of cardiovascular disease has high population-level importance, further investigation is required, including better control for confounders, eg to separate out seasonal effects due to UVR/vitamin D from other seasonal variations such as temperature.

4.4 Metabolic effects

Several recent studies indicate an association between hypovitaminosis D and insulin secretion (*213*) (*214*) or insulin resistance (*215*), and thus risk of type 2 diabetes and the metabolic syndrome (*213*). Further evidence for a role of vitamin D adequacy in appropriate insulin secretion comes from genetic studies, where there is a gene dosage effect for different VDR genotype alleles and estimated insulin secretion (*216*).

5 Medication reactions

A number of cosmetics and medications have the potential to be photosensitizers, i.e. exposure to sunlight leads to a cutaneous reaction with rash, erythema, itching, scaling and edema. Offending compounds include some perfumes, body lotions, tetracyclines, phenothiazines, sulphonylureas, tricyclic antidepressants, non-steroidal anti-inflammatory drugs, sulphonamides and cyclamate (an artificial sweetener) (*217*). Such reactions may be photoallergic or phototoxic. While such reactions may cause a significant burden of disease worldwide, they have not been included in this analysis due to the lack of quantitative data on their incidence.

6 Psychiatric disorders

6.1 Seasonal affective disorder (SAD)

An affective disorder associated with changing seasons, the etiology of SAD has been studied with regard to photoperiod, latitude, temperature or cloud cover. A recent meta-analysis (*218*) suggested that the influence of latitude (as a proxy for UVR) on prevalence was small and other factors such as climate, genetics and the socio-cultural context were likely to be more important.

6.2 Schizophrenia

The increased risk of schizophrenia associated with season of birth (10% excess in winter or spring) (*219*), urban vs. rural place of birth (*220*) and in second-generation individuals of Afro-Caribbean descent (*220*) is well established. Early studies investigated the risk of schizophrenia as a function of exposure to influenza virus in utero (to explain the seasonal effect), but without a consistent association being found (*221, 222*). McGrath has proposed that low prenatal vitamin D may be a risk factor for later development of schizophrenia (*223*).

This hypothesis could explain the seasonality of birth relationship (mothers would be at greatest risk of prenatal vitamin D deficiency during winter and early spring), a higher incidence with urban birth, and the pattern seen in individuals with dark skin who have migrated to cool environments (dark skin produces less vitamin D for a certain amount of UVR). However, while variation by season of birth has been confirmed in the northern hemisphere, this effect appears to be much weaker in the southern hemisphere (*224*). Perhaps the strongest support for a role of low vitamin D as a risk factor for development of schizophrenia comes from a birth cohort study which showed that vitamin D supplementation in the first year of life is associated with decreased risk of schizophrenia in males (*225*). Genetic studies are ongoing to better understand this field of work (*226, 227*).

6.3 Effects on mood

Limited evidence suggests that UVR exposure either directly or acting via vitamin D synthesis is associated with enhanced positive affect and a reduction in negative affect (*228*).

7. Indirect effects

7.1 Effect on climate, food supply, disease vectors, atmospheric chemistry

While there will be health effects related to effects of UVR on the above factors, at this stage these are difficult to quantify and have not been included in this analysis.

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Table A.1.1 Studies reviewing the effects of UVR exposure on immune function

1. Effects on immunity and infection		
1.1 Suppression of cell-mediated immunity		
Cantorna, 2000 (*14*)	Review	Geographical variation in incidence of autoimmune diseases such as type 1 diabetes, multiple sclerosis and arthritis correlates with areas with low supplies of vitamin D. Experimental studies support an immunosuppressant effect in the development of autoimmunity in animal models.
Cantorna et al., 2004 (*156*)	Review	In experimental studies (mice), absence of vitamin D signaling is associated with a Th2 to Th1 shift. This has implications for Th1 driven disorders such as MS, type 1 diabetes and inflammatory bowel diseases (IBD). Vitamin D deficiency may be associated with accelerated IBD. No apparent effect of vitamin D on infections with HSV or Candida albicans. Effects of vitamin D status on immune function depend on the nature of the immune challenge and the calcium status of the host.
Cantorna and Mahon, 2004 (*5*)	Review	Review the evidence for vitamin D as protective for the development and progression of MS, rheumatoid arthritis, type 1 diabetes and the inflammatory bowel diseases, including intervention studies which support a protective role for vitamin D and possible mechanisms of effect.
Cantorna and Mahon, 2005 (*229*)	Review/ Experimental study	Vitamin D selectively regulates the immune system, inhibiting the development and function of Th-1 cells and inducing other T cells, including Th-2 cells. Vitamin D is effective in the treatment of experimental autoimmunity, possibly acting via inhibition of the TNF family of genes. The effect of vitamin D treatment on immune-based diseases depends on the Th1-Th2 predominance of the disease. Vitamin D inhibits autoimmunity even when animals are vitamin D sufficient.
Clydesdale et al., 2001 (*1*)	Review	UVR exposure results in both local and systemic immunosuppression.
Holick, 2004 (*230*)	Review	Overview of the role of UVR in the production of vitamin D and the growing evidence of a role for vitamin D deficiency as a risk factor for cancers, autoimmune disorders and cardiovascular diseases. Sensible sun exposure, in combination with increased dietary and supplemental vitamin D is advised to balance the risks of NMSC against the risks of vitamin D insufficiency.
Ponsonby et al., 2005 (*2*)	Review	Review epidemiological and experimental evidence for association between low UVR exposure and risk for MS, type 1 diabetes and rheumatoid arthritis – vitamin D and UVR exposure may have important but independent effects.
Selgrade et al., 1997 (*3*)	Review	Animal-based experiments suggest that UVR-induced immunosuppression is important in growth of skin cancers and the progression of certain infections at levels of UVR exposure consistent with human exposures. There are potential impacts on infectious disease and vaccine effectiveness. UVR exposure may exacerbate allergic disease by suppressing Th1 but not Th2 immune responses and affect autoimmune diseases in an adverse or beneficial manner depending on the disease.
Termorshuizen et al., 2002 (*34*)	Review	Experimental data suggest that UVR exposure may impair resistance to different systemic infections at relevant outdoor doses. In human studies, UVR exposure associated with: • Lower but clinically non-relevant antibody response to hepatitis B vaccination • small decrease in CD4+ T helper cells in patients with HIV • increase RHL in renal transplant recipients • decreased recurrence of upper respiratory tract symptoms.
Ullrich et al., 2002 (*231*)	Experimental	Solar simulated UVR, applied after immunization, suppressed immunological memory and the elicitation of delayed type hypersensitivity, possibly mediated by UV-induced DNA damage, suppressor T cells and/or IL-10.
Wilson et al., 1995 (*232*)	Review and meta-analysis	Decreased BCG efficacy at lower latitudes. Latitude accounted for 41% of the between-study variance – UVR exposure and immunosuppression one possible cause.
1.1.1 Multiple sclerosis		
Coo and Aronson, 2004 (*233*)	Systematic review	The association between development of MS and low sun exposure is plausible, but there is insufficient epidemiological evidence to develop a conclusion about the likelihood of a causal association.

Dumas and Jauberteau-Marchan, 2000 (*7*)	Review	MS prevalence shows a reverse latitudinal gradient. UVR is immunosuppressive particularly to the Th-1 immune cells that appear to be important in the development of autoimmunity.
Hayes et al., 1997 (*234*)	Review	Vitamin D_3 administration prevents experimental autoimmune encephalitis, an animal model of Multiple sclerosis. A protective effect of vitamin D could explain the association between increased MS rates at low altitude (cf at high altitude) in Switzerland; the latitudinal gradient in MS prevalence and the increased risk for MS inland in Norway (cf coastal regions), since fish is high in vitamin D_3 and is consumed in greater quantities in coastal regions.
McMichael and Hall, 1997; McMichael and Hall, 2001 (*6, 235*)	Reviews	There is ecological and experimental evidence for a protective effect of vitamin D/UVR exposure on the development of multiple sclerosis and other autoimmune diseases.
Ponsonby et al., 2002 (*236*)	Review	There is a gradient of increasing prevalence with increasing latitude for multiple sclerosis and type 1 diabetes, some evidence from population studies of a protective effect from vitamin D supplementation and evidence of biological plausibility via suppression of Th1 cell-mediated immune function by UVR exposure implicating low UVR exposure in the etiology of autoimmune diseases such as multiple sclerosis, type 1 diabetes and rheumatoid arthritis.
1.1.2 Type 1 diabetes		
Adorini et al., 2003 (*237*)	Animal study	Treatment with vitamin D arrests development of type 1 diabetes
Harris, 2005 (*238*)	Review	Reviews animal and human evidence – strong evidence of a protective effect of vitamin D adequacy (relatively high doses of vitamin D required) on risk of type 1 diabetes.
Zella and DeLuca, 2003 (*239*)	Review	Ecological, animal experimental and human evidence point to a protective effect of vitamin D on the development of type 1 diabetes, through plausible biological mechanisms.
1.1.3 Rheumatoid arthritis		
Als et al., 1987 (*240*)	Case-control	Low vitamin D in cases probably due to decreased exposure following decreased activity
Cantorna et al., 1998 (*22*)	Experimental	Symptoms of autoimmune arthritis were prevented by dietary supplementation with vitamin D. Similarly progression from mild to severe disease was prevented by vitamin D supplementation.
1.1.4 Other autoimmune diseases		
Lim et al., 2005 (*27*)	Review	Vitamin D is an important regulator of the immune system. Early studies showed high prevalence of vitamin D deficiency in patients with established Crohn's disease and this was thought to be due to malabsorption. However, more recent studies show high prevalence of vitamin D insufficiency at diagnosis of inflammatory bowel disease (compared to controls), with no difference between ulcerative colitis and Crohn's disease.
Pickering et al., 2001 (*24*)	Experimental	In mice, UVR exposure is an important trigger of both systemic and cutaneous SLE.
Sanders et al., 2003 (*25*)	Intervention study	93% of patients with SLE had aberrant clinical and histological reactions to UVR exposure. UVR exposure worsens clinical features of SLE and can result in the onset and progression of cutaneous lesions.
Zhu et al., 2005 (*26*)	Experimental	Vitamin D deficient IL-10 knockout mice develop accelerated inflammatory bowel disease which is maximally reversed by concomitant administration of both calcium and 1,25-dihydroxyvitamin D3. Dietary calcium and 1,25 D3 may directly and indirectly inhibit the TNF-α pathway and suppress inflammatory bowel disease.
1.2 Increased susceptibility to infection		
Garssen et al., 1998 (*29*)	Review	UVB irradiation suppresses both local and systemic immune responses. This has importance to the progression of skin cancers and possibly to infectious diseases in humans. However the clinical significance of such immunosuppression in humans is not clear.
Garssen et al., 1999 (*4*)	Experimental	Pre-exposure to UVB suppresses the CHS response to contact sensitizers and alterations in cytokine secretion consistent with inhibition of both Th-1 and Th-2 mediated immune responses.
Garssen et al., 1996 (*241*)	Risk assessment	Using data from animal models, risk assessment suggests that 104 min of solar UVR exposure at around noon in Spain or Italy (July, 40°N) would cause 50% suppression of immune response to Listeria in the most sensitive humans.

Norval, 2003 (*28*)	Review	UVR has deleterious effects on the immunological control of viral infections in rodent models. In humans, UVR may trigger the reactivation of latent HSV1 (up to 70% of susceptible individuals). There is less evidence for reactivation of varicella zoster virus or the role of UVR and HPV in the development of SCC in immunosuppressed individuals. More research is needed on the effect of UVR exposure on vaccine efficacy.
Vermeer and Hurks, 1994 (*30*)	Review	Low dose UVB irradiation causes immunosuppression that may have evolved to limit the damage from an inflammatory reaction to sun damage. However this immunosuppression has the effect of allowing skin cancers to progress and may have effects on exacerbation of infectious diseases. UVB-induced immunosuppression may allow cancerous transformation of HPV infection.
1.3 Impairment of prophylactic immunization		
Damian et al., 2001 (*32*)	Review	UVA and UVB are immunosuppressive for both CHS and DTH immune responses, but the effects of UVA are transient, whereas those of UVB are more sustained. Sunscreens are more protective for sun-induced erythema than for sun-induced immunosuppression.
Sleijffers et al., 2001 (*33*)	Intervention study	The effect of prior UVR exposure on the response to hepatitis B vaccination was examined – 97 of 191 volunteers had prior exposure to UVR. While there were alterations in CHS and in NK cell activity, there was no effect on either the humoral or cellular response to the vaccination.
Termorshuizen et al., 2002 (*34*)	Review	While UVR impairs resistance to some systemic infections in rodent models, doses required may be higher in humans. Although there is evidence of a lowered antibody response to hepatitis B vaccination during summer, and lower CD4+ T-helper cells in a cohort of persons with HIV, neither finding was of sufficient magnitude to be clinically non-relevant.
1.4 Reactivation of latent virus infection		
Axell and Liedholm, 1990 (*242*)	Cross-sectional	Decreased prevalence of RHL in smokers
Barkvoll and Attramadal, 1987 (*243*)	Cross-sectional	Increased prevalence of RHL with recurrent mechanical trauma to lips.
Jackson and Storey, 2000 (*37*)	Experimental	Human papillomaviruses (HPVs) are found in skin cancers of individuals with Epidermodysplasia verruciformis (EV) and in non-melanoma skin cancers in immunocompromised individuals on exposed body sites. E6 proteins from HPVs were shown to have anti-apoptotic activity following UVR exposure. This may allow the survival of HPV-infected lesions exposed to UVR and may induce and facilitate the persistence of UV-induced genetic changes in the skin.
Taylor et al., 1994 (*244*)	Experimental	UVB irradiation to the face of individuals with a history of RHL precipitated by UVR exposure resulted in recurrence only in those who were UVB-susceptible (ie were sensitive to the immunosuppressive effect of UVR exposure on the development of contact hypersensitivity). UVB-susceptible (UVB-S) individuals are 44% of the normal adult population but 90% of those with biopsy-proven NMSC are UVB-S.
Young et al., 1976 (*36*)	Follow-up	Triggers to herpes labialis include emotional stress, exposure to sun and illness.

Table A1.2. Detailed summary of epidemiological studies examining UVR effects on immune function

Study	Location	Design, N, Age	Exposure assessment	Outcome assessment	Adjusted covariates	Measure of effect	95% CI
1.1.1 Multiple sclerosis							
Bulman and Ebers, 1992 (*245*)	United States	Ecologic	Scandinavian birth/ancestry	Multiple sclerosis		Spearman's correlation = 0.73	
Embry et al., 2000 (*246*)	Southern Germany		Seasonal variation in vitamin D levels	Seasonal variation in gadolinium-enhancing MRI lesions in MS	Inverse correlation between lesion activity and 25(OH)D levels (note that these were measured on two different groups of people), with two month lag		
Fleming et al., 2000 (*247*)	Wisconsin, USA	Intervention study (single crossover)	Oral vitamin D	Relapsing remitting multiple sclerosis	Vitamin D well-tolerated but no change in appearance of new MRI lesions during treatment phase or clinically (p = 0.48)		
Freedman et al., 2000 (*9*)	USA (24 states)	Case-control Cases: n = 4282 Controls: n = 115,195	Occupational sun exposure Sun exposure of residence	Multiple sclerosis mortality	Age, sex, race, socioeconomic status	OR = 0.74 OR = 0.53	0.61 – 0.89 0.48 – 0.57
Goldacre et al., 2004 (*12*)	UK	Record linkage cohort study	Diagnosis of skin cancer	Multiple sclerosis	Age, sex, district of residence and calendar year	RR = 0.49	0.24 – 0.91
Koziol and Feng, 2004 (*248*)	California, USA	Follow-up study N = 24 Age: 31-52 years	Season	Relapses of multiple sclerosis		(Roger's statistic) R = 0.47	p = 0.79
Munger et al., 2004 (*11*)	USA	Prospective cohort N = 92, 253 (I) N = 95, 310 (II)	Vitamin D intake: Highest vs lowest quintile Supplement use ≥400IU/day	Incident multiple sclerosis	Age, smoking status, latitude at birth	 OR = 0.69 OR = 0.60	 0.42 – 1.15 0.39 – 0.92
van der Mei et al., 2001 (*249*)	Australia	Ecologic	UVR levels	Prevalence of multiple sclerosis	Negative correlation between UVR levels and MS prevalence (r = -0.91, p = 0.01) which is higher than the positive correlation with malignant melanoma incidence (r = 0.80, p = 0.10 for females).		
van der Mei et al., 2003 (*10*)	Tasmania, USA	Case-control Cases: n = 136 Controls: n = 272 Mean (SD)age: 43.5 (9.3) yrs	Av. time in sun summer, weekends & holidays 6-15 yrs (>4hrs/day cf <1) Actinic damage (hand)	Current diagnosis of MS	Melanin density at upper inner arm, ever smoked before diagnosis.	OR = 0.26 OR = 0.17	0.11 – 0.60 0.05 – 0.60
1.1.2 Type 1 diabetes							
Eurodiab, 1999 (*19*)	Europe	Case-control Cases: n = 820 Controls: n = 2335	Recalled vitamin D supplementation	Type 1 diabetes	Low birth weight, short duration of breast feeding, maternal age, study centre	OR = 0.67	0.53 – 0.86
Gregori et al., 2002 (*250*)	Italy	Experimental intervention	Treatment with 1α,25-dihydroxyvitaminD	Type 1 diabetes	Treatment of non-obese diabetic mice with vitamin D at non-hypercalcemic doses suppresses the immune response that causes Type 1 diabetes		
Hypponen et al., 2001 (*21*)	Northern Finland	Birth cohort N = 10366	Vitamin D supplementation dose - high vs low - recommended vs low	Type 1 diabetes	Sex, gestational and maternal age, parity, maternal education, social status, standardised birth weight, infant growth rate	 OR = 0.12 OR = 0.16	 0.03 – 0.51 0.04 – 0.51
Karvonen et al., 1998 (*13*)	Finland and Sardinia	Case-control N = 1405 (Finland); 425 (Sardinia)	Season of diagnosis in 2 countries	Diagnosis of type 1 diabetes	Significant seasonal pattern of diagnosis in both countries, with decreased incidence in summer months and increased incidence in autumn. Seasonal patterns differ by age group and by country – not explainable by differences in climate or temperature.		

		≤ 14 years					
Mooney et al., 2004 (*251*)	Scotland	Prospective study N = 4517 Age: 0.14 years	Season of diagnosis, by age and sex (winter diagnosis more common)	Diagnosis of type 1 diabetes	Group 0-4 male 0.4 female 5-9 male 5-9 female 10-14 male 10-14 female	Acrophase 7 January 8 November 17 December 1 January 12 December 9 January	P value 0.137 0.482 0.063 0.003 0.001 0.117
Roche et al., 2003 (*16*)	Ireland	Cohort study N = 952,020 Age: 0-16 years	Season of birth Season of diagnosis	Diagnosis of type 1 diabetes	Diagnosis of type 1 diabetes more common with summer birth in males ($p<0.05$); no seasonal differences in females (compared to the general population). Diabetes onset significantly less common in spring and summer ($p<0.01$) in males; no significant difference in females.		
Rothwell et al., 1999 (*18*)	Europe	Cohort study	Season of birth	Type 1 diabetes	Of 20 cohorts from 16 countries, only the cohort from Great Britain showed significant differences in the seasonality of birth between children with diabetes and the general population – peak in early summer, trough in winter ($p = 0.006$).		
Songini et al., 2001 (*17*)	Sardinia	Cohort study N = 1928 diabetics; 314084 general population Age: 0-29 yrs	Season of birth Season of diagnosis	Type 1 diabetes	Persons diagnosed with type 1 diabetes aged 0-14 and those aged 15-29 years were more likely to be born in summer months (compared to the general population) and more likely to be diagnosed in the winter months.		
Staples et al., 2003 (*15*)	Australia	Ecologic	Latitude	Type 1 diabetes Rheumatoid arthritis Eczema/ dermatitis Asthma		r = 0.77 r = 0.15 r = 0.50 r = -0.72	p = 0.026 p = 0.73 p = 0.21 p = 0.05
Stene et al., 2000 (*20*)	Norway	Case-control Cases: n = 85 Controls: n= 1071	Cod liver oil intake: -During pregnancy -First year of life Vitamin D intake: -First year of life	Type 1 diabetes in offspring	Age, sex, breastfeeding, maternal education, other supplement use	 OR = 0.36 OR = 0.82 OR = 1.27	 0.14 – 0.90 0.47 – 1.42 0.70 – 2.31
Ursic-Bratina et al., 2001 (*252*)	Slovenia	Case control N = 849 diabetics; 1345921 general population Age: 0-14 y	Season of birth Season of diagnosis	Type 1 diabetes	Persons with diabetes had a statistically different seasonality of month of birth cf the general population (higher summer births); diagnosis most common in winter.		
Willis et al., 2002 (*253*)	Canterbury, New Zealand	Case control N = 275 diabetics; 91,394 general population	Season of birth Season of diagnosis	Type 1 diabetes	Persons with type 1 diabetes more commonly born in summer ($p<0.01$ compared to the general population) and disease onset had a significant peak in winter ($p<0.01$). Suggests initiation of the autoimmune process in utero or perinatally.		
Zalloua et al., 2003 (*254*)	Lebanon	Cross-sectional	Season of diagnosis	Type 1 diabetes	Peak onset in winter; higher incidence in first borns and decreasing incidence as birth order increases.		
1.1.3 Rheumatoid arthritis							
Merlino et al., 2004 (*23*)	Iowa, USA	Prospective cohort	Dietary vitamin D intake Supplemental vitamin D intake Total vitamin D intake	Rheumatoid arthritis	Age, caloric intake, smoking status, hormone replacement therapy, decaffeinated coffee consumption and β – cryptoxanthin intake	OR = 0.72 OR = 0.66 OR = 0.67	0.46 – 1.14 0.43 – 1.00 0.44 – 1.00
1.2 Increased susceptibility to infection							
Saah et al., 1997 (*31*)	USA	Cohort N = 1651	UVR exposure	HIV progression	No positive correlation between development of AIDS or loss of T-lymphocytes with reported sun exposure. Among individuals HIV infected at baseline, those purposely seeking sun exposure less likely to have AIDS (OR = 0.67, 95% CI 0.39 – 1.11).		

1.4 Reactivation of latent viral infections							
Perna et al., 1987 (*255*)	USA	Experimental N = 5 Age = 26 - 45	UV irradiation	Reactivation of herpes simplex virus infection	Site-specific UV irradiation resulted in reactivation of infection in 8 out of 13 attempts after a mean of 4.4 days. Some patients appear more susceptible to UV-induced reactivation than others.		
Young et al., 1988 (*35*)	Wisconsin, USA	Case-control Cases: n = 139 Controls: n = 283 Age = 17+years	Outdoor job during childhood Severe facial sunburns Severe facial sunburns	Recurrent herpes labialis Recurrence rate		OR = 1.77 OR = 1.64 OR = 1.55	1.14 – 2.70 1.11 – 2.41 0.97 – 2.50

Table A1.3 Summary of reviews of UVR effects on the eyes

2. Effects on eyes		
Bergmanson and Soderberg, 1995 (*43*)	Review	Little light reaches the retina (absorbed by cornea and lens). Experimental evidence of damage due to both low and high intensity UVR. Good evidence for UVR causation of Photokeratitis. Chronic exposure may cause climatic droplet keratopathy (spheroid degeneration). Insufficient evidence to conclude a causal relationship between pinguecula and UVR exposure. Strong experimental and epidemiological evidence for a causal role of UVR exposure in pterygium. Increased risk of cataract, particularly cortical cataract with excessive UVR exposure (experimental and epidemiological evidence). Some evidence for an association with AMD but inconclusive. UVR exposure important for development of SCCC.
Dolin and Johnson, 1994 (*44*)	Review	Sufficient evidence that photokeratitis is caused by exposure to high dose solar radiation, occurring after 200 seconds of unattenuated exposure to 295-315nm UVR. CDK may be caused by solar radiation (limited evidence), but not specifically UVR. Particulate injury (sand, ice) may be important. Pinguecula similar pathologically to actinic keratosis of the skin. Conclude limited evidence for a role of UVR exposure in the causation of pinguecula. Limited evidence of an association between sunlight exposure and development of pterygium; role of UVR exposure unclear. Limited evidence for an association between UVR exposure and conjunctival neoplasms. Insufficient evidence for a causal association between UVR exposure and cataract. UVR exposure is probably not the cause of exfoliation syndrome. Insufficient evidence of a causal association between naturally occurring solar exposure and ocular melanoma. Little evidence of an association between acute macular degeneration and history of UVR exposure.
Taylor, 1989 (*256*)	Review	Association of UVR exposure and cataract is biochemically plausible via photo-oxidation of free or protein-bound tryptophan, photosynthetic processes involving activated species of oxygen, disruption of the membrane-cation transport system or damage to nucleic acids in lens epithelial cells. Experimental studies also supportive. Some support from epidemiological studies. Some indirect evidence of an association between AMD and UVR exposure.
Taylor, 1989 (*257*)	Review	Chesapeake Bay watermen study provided epidemiological evidence for an association between UVR exposure and cortical cataract, pterygium and climatic droplet keratopathy. Other studies have indicated an association between UVR exposure and PSC. While there is experimental support for a role of UVB in age-related macular degeneration there is little epidemiological support.
Young and Sands, 1998 (*258*)	Review	UVR exposure associated causes solar keratopathy, BCC of the eyelid, SCCC, pingueculae, pterygia, climatic droplet keratopathy, cataracts (all types), solar retinopathy, possibly AMD and uveal melanoma.
2.1 Acute photokeratitis and photoconjunctivitis		
Bergmanson, 1990 (*38*)	Experimental	UVR exposure of the primate cornea caused significant destruction of the epithelium and stromal swelling.
Kennedy et al., 1997 (*39*)	Experimental	Acute UV irradiation of human corneal stromal cells results in the production of IL-1, IL-6, IL-8 and TNF-α which may be responsible for UV-mediated corneal inflammation.
Sliney, 1987 (*40*)		Daily radiant UVB exposure to the cornea is less than the mathematically weighted safety limit occupational exposure limit of the American Conference of Governmental Industrial Hygienists – thus photokeratitis from outdoor daylight is rare. Reflected levels of UVR from light sand should be sufficient to cause a threshold photokeratitis within exposure periods of 6-8 hours.
2.2 Climatic droplet keratopathy		
Cullen, 2002 (*45*)	Review	Chronic exposure to UVR causes climatic droplet keratopathy with visual impairment, by depositing material in the superficial stroma and Bowman layer, possibly by photochemically altering diffusible plasma proteins reaching the cornea.
Sliney, 1999 (*49*)	Review	Epidemiological studies assessing the role of UVR in the causation of eye diseases may produce inconsistent findings due to lack of precision in the estimate

		of ocular UVR dose. Most ground surfaces reflect little UVR and greatest UVR exposure may thus occur where ground reflection is high. The role of particulate matter in the causation of CDK is unclear.
Young and Finlay, 1975 (*259*)	Cross-sectional	929 persons in Labrador and Northern Newfoundland. Increasing prevalence and severity of CDK with increasing age, in males and with outdoor occupation. Suggest UVR as the most significant causative factor (based on geographic variation).
2.3 Pterygium		
Cameron, 1965 (*51*)	Review	Good correlation between latitude and prevalence of pterygium. Hot, dry dusty countries have high prevalence, eg North Africa, Arabia, Mexico.
Coster, 1995 (*260*)	Review	Brief review suggests that high UVR exposure particularly in the second or third decade of life is important to pterygium development. Also a genetic predisposition.
Di Girolamo et al., 2005 (*55*)	Experimental	UVB exposure of pterygium epithelial cells was associated with induction of matrix metalloproteinase collagense-1 (MMP-1) and enhancement of the phosphorylated form of ERK1/2 in a time-dependent manner. The finding of specific UVB induced intracellular signaling pathways, supports a role for UVB in pterygium formation.
Hirst, 2000 (*261*)	Review	Increased risk of developing pterygium in subjects who spent the first five years of life at latitudes less than 30° and who spent most of their time outdoors, particularly in the first decade of life. Greater risk associated with working on sand; hazel-green eye colour; red hair; medium skin colour; moderate number of freckles; history of burning when sun-exposed; possible increased risk due to exposure to irritants; possibly HPV infection.
Shimmura et al., 2000 (*262*)	Experimental study	UVR exposed skin is characterized by specific mutations in the tumour suppressor gene p53 and increased telomerase activity (prolonging cell survival). Pterygia tissue shows some increase in telomerase activity but no increase in p53
Wang et al., 2000 (*263*)	Experimental study	Experimental study of tissue from pterygia and normal conjunctival specimens. UV irradiation induced induces mutations resulting in increased tropoelastin in conjunctival fibroblasts similar to that seen in the pinguecula subepithelial connective tissue of pterygia.
2.4 Pinguecula		
Norn, 1979 (*56*)	Cross-sectional	Prevalence of pinguecula in Eskimos in South Greenland was 56%, compared to 41% in Copenhagen, with increasing prevalence with increasing age. Incidence of pinguecula and CDK are correlated in both geographic series but are not correlated with pterygium.
Norn, 1982 (*57*)	Cross-sectional	Prevalence of pinguecula at the Red Sea is 90% - this is consistent with causation by high UVR exposure. Pterygia were equally present at the Red Sea and in Greenland and were quite small.
Norn, 1984 (*58*)	Cross-sectional	Pinguecula present in 60% of Japanese in Kyoto province (ages 0-89) with increasing prevalence with increasing age and male sex. The prevalence is lower than Jordan, higher than in Denmark but similar to that in Greenland. Prevalence was higher in rural than urban dwellers. Pterygium was rare.
2.5 SCCC		
Ateenyi-Agaba, 1995 (*264*)	Cross-sectional	RR for conjunctival tumours associated with HIV infection = 13.0; possible interaction with high UVR exposure
Guex-Crosier and Herbort, 1993 (*64*)	Case reports	Three cases reported with corneal intra-epithelial neoplasia in young adults with a history of contact lens wearing and repetitive exposure to strong ultraviolet light.
Kusewitt et al., 2000 (*65*)	Experimental	UVR exposure of the grey, short-tailed South American opossums (*Mondelphis domestica*) resulted in the formation of corneal tumours of a variety of histologies, but including squamous cell carcinoma of the cornea.
Newton, 1996 (*265*)	Review	SCCC related to HIV seropositivity, previous SCC, and UVR exposure and possibly ocular trauma or ocular HPV infection.
Sun et al., 1997 (*61*)	Review	Evidence for a causal association with UVB exposure: greater frequency of SCCC at low latitude; decreasing incidence with increasing latitude (in a dose-response manner); SCCC more common in patients with xeroderma pigmentosa; association between UVB exposure and SCC of the skin especially SCC of the eyelid. Other likely causative agents: HIV infection and HPV infection.
2.6 Lens opacity		
Ayala et al., 2000 (*80*)	Experimental	Repeated UVR exposure of the lens in rats at different time intervals indicated that the greatest sensitivity for a second UVR exposure occurred where the time from first UVR exposure was three days (compared to 6 hours, 1 day, 9 days and 30 days). When exposures are one month apart the lens is able to undergo physiological repair.
Brian and Taylor, 2001 (*266*)	Review	Risk factors for age-related cataract include UVR exposure, diabetes, therapeutic drugs, smoking and alcohol.
Colitz et al., 2005 (*83*)	Review	There are a number of mechanisms by which the mammalian lens protects and repairs UV-induced damage, including several endogenous anti-oxidants and

		dietary intake of anti-oxidants. Micronutrient poor diets and smoking increase the risk of cataract.
Hockwin et al., 1999 (*267*)	Review	Experimental evidence confirms an important role for UVR in cataractogenesis – acute lens damage from high dose UVR (uncommon) and (chronic lower dose) cocataractogenic promotion of other processes, eg changes in carbohydrate metabolism, oxidative stress etc.
Hodge et al., 1995 (*268*)	Review	Ecologic studies suggest an associated between cataract and UVR exposure, although in one study this was limited to cortical cataracts only. Evidence from case-control studies is more equivocal – some show an association but most consistent results are for cortical cataract.
Hu and Lao, 1987 (*269*)	Cross-sectional	Study from China indicating an inverse association of cataract with latitude and direct association with altitude (10 fold increase in cataract in Zedang – the region of highest latitude).
Taylor et al., 1994 (*244*)	Review	Chesapeake Bay watermen studies show a consistent relationship between individual ocular UVB exposure and risk of both cortical and posterior subcapsular cataract (p = 0.006), but no association with nuclear cataract.
West and Valmadrid, 1995 (*270*)	Review	Cortical and posterior subcapsular cataract most closely associated with environmental stresses including UVR exposure; nuclear cataract particularly associated with smoking.
West, 1999 (*271*)	Review	Ecological studies suggest increased risk of cataract with residence in areas of higher ambient UVR. Increased exposure to UVB association with increased risk of cortical cataract.
Zigman, 2005 (*82*)	Review	UVA irradiance is 1000 times that of UVB in sunlight. Little UVB penetrates the cornea to reach the lens (<2%), as UVA energy is about 30 times that of UVB. UVA penetrates the cornea (approx 50%) to reach the lens. There are a number of potential UVA targets in the lens and some evidence for an important role of UVA exposure.
2.7 Ocular melanoma		
Egan et al., 1988 (*272*)	Review	Conflicting evidence for role of UVR. For: rare in non-white populations. Against: no increase in incidence rate over time; not latitudinal gradient; no increased risk in persons with xeroderma pigmentosa; experimental evidence suggests that virtually no UVA or B is transmitted past the cornea and lens; negative findings from case-control studies.
2.8 Acute solar retinopathy		
Atmaca et al., 1995 (*93*)	Follow-up	Solar retinopathy following a solar eclipse associated with early but not late visual loss.
Eke and Wong, 2001 (*91*)	Case series	Eclipse retinopathy following a solar eclipse in 20 patients – persistent central scotomata at 14 months resolved by 21 months.
Kleinmann et al., 2002, (*90*)	Retrospective trial	Phototoxic retinopathy occurred following cataract surgery, induced by the operating microscope. This may occur during even short duration operations.
Rai et al., 1998 (*273*)	Case series	319 patients with solar retinopathy following sun gazing. Most resolve quickly, but some patients have persistent visual disturbances.
Verma et al., 1996 (*274*)	Case series	21 patients with eclipse retinopathy following unprotected (or insufficient protection) viewing of a solar eclipse. Some associated long-term visual damage.
Wong et al., 2001 (*92*)	Prospective study	Report of 45 patients who suffered acute solar retinopathy after watching a solar eclipse (age 15-82y). 5 patients had detectable retinal changes and reduced vision. 20 patients had visual disturbance mainly resolving over several months.
2.9 Macular degeneration		
Bressler and Bressler, 1995 (*95*)	Review	The evidence for an association between AMD and UVR exposure is limited, inconsistent and conflicting. There are positive associations with smoking and cardiovascular disease.
Penfold et al., 2001 (*97*)	Review	Population studies indicate that after age, the most significant risk factor for AMD is smoking (OR = 3.9).
Loeffler et al., 2001 (*96*)	Histological cross-sectional study	No statistically significant association between presence of pinguecula and AMD. There was a statistically significant association with senile scleral plaque (p = 0.02), but this became non-significant when adjusted for age. These results could support a UVR etiology for AMD but the UVR etiology of both pinguecula and scleral plaque is not established.
Young, 1988 (*94*)	Review	Action spectrum of damage to the retina suggests blue light (wavelength 400-500nm) most important. AMD probably multi-factorial, with a genetic element.

Table A1.4 Detailed summary of epidemiological studies examining UVR effects on eyes

Study	Location	Design, N, Age	Exposure assessment	Outcome assessment	Adjusted covariates	Measure of effect	95% CI
2.1 Acute photokeratitis and photoconjunctivitis							
Kirschke et al., 2004 (*42*)	Nashville, USA	Cohort	Exposure to damaged metal halide lamps	Development of photokeratitis within 12 hours	Attack rate for persons sitting in an identified high risk area was 46%; some protection from UV-blocking glasses or contact lenses.		
2.2 Climatic droplet keratopathy							
Johnson, 1981 (*46*)	Labrador and northern Newfoundland	Cross-sectional	Latitude of residence	Age of onset and severity of CDK	Peak prevalence, earliest age of onset and greatest severity of CDK was in those living at 55-56 degrees north. This corresponds to the area of highest intensity UVR reflected from ice and snow. Degree of CDK proportional to amount of time spent in outdoor activities such as hunting, trapping.		
2.3 Pterygium							
Ben-Amer, 1989 (*275*)	Libya	Cross-sectional	Housing conditions, trachoma	Pterygium	Association between pterygium, trachoma and poor housing		
Detels and Dhir, 1967 (*276*)	Canada India Thailand Taiwan	Cross-sectional N = 210 (cases); N = 104 (cases); N = 107 (controls) N = 110 (cases) N = 83 (controls) N = 153 (cases) N = 197 (controls)	Occupation as a sawmill worker	Presence of pterygium	Age adjusted prevalence of pterygium: Canada – 12% for East Indian sawmill workers Canada – 2% for white sawmill workers India - 7% for Kurali villagers India - 24% among sawmill workers India – 8% among urban controls Bangkok – 27% among sawmill workers Bangkok – 16% in cotton mill workers Taiwan – 31% among sawmill workers Taiwan – 10% among clothing workers Sawmill work cf other work: p<0.00001; increasing risk with increasing years in the sawmill. Good correlation with latitude but not solar radiation; suggest exposure to particulate matter more important than UVR exposure.		
Goldberg and David, 1976 (*277*)	South Africa	Case-control N = 105 eyes Age: 44 – 79 y	Tear film abnormalities (postulated as on the causal pathway from UVR to pterygium	Pterygium	No significant difference between normal eyes and those with pterygium in tear formation ie if pterygium is caused by UVR this is not mediated by its effect on the tear film		
Hirst, 2000 (*261*)	Australia	Review	Childhood sun exposure: - (latitude <30°) - Time spent outdoors (>50% cf <50%) Adult sun exposure - latitude <30° - Time spent outdoors - working environment (concrete vs indoor	Pterygium	 RR = 36.3 RR = 17.2 RR = 39.5 RR = 5.7 RR = 10.8	 6.7 – 196 6.2 – 47.6 6.7 – 196 3.1 – 10.6 4.1 – 28.1	
Liu et al., 2001 Abstract only, article in Chinese (*278*)	Haikou, China	Prevalence survey	Age, sex	Pterygium		Overall prevalence 7.86% M 6.4%; F 9.4%	
Luthra et al., 2001 (*279*)	Barbados	Cross-sectional study	Sun exposure (occupational, use of sun glasses)	Prevalence of pterygium	Age and sex (protective factors: dark skin, use of sunglasses)	OR = 2.02	1.65 – 2.47

McCarty et al., 2000 (*53*)	Melbourne, Australia	Cross-sectional N = 5147 Age: 40-101 years	Lifetime ocular sun exposure	Pterygium	Age, gender, rural residence	OR = 1.63	1.18 – 2.25
Mackenzie et al., 1992 (*50*)	Brisbane, Australia	Case control	Sandy living environment - 20-29 years - 0-5 years Latitude residence (<30) - 20-29 years - 0-5 years Time spent outdoors - 20-29 years - 0-5 years Did not wear sunglasses	Primary pterygium	Age	 OR = 10.81 OR = 1.6 OR = 39.5 OR = 36.3 OR = 5.7 OR = 17.2 OR = 5.4	 4.1 – 28.1 0.9 – 2.9 2.8 – 560.6 6.7 – 196.0 3.1 – 10.6 6.2 – 47.6 3.3 – 8.7
Moran and Hollows, 1984 (*280*)	Australia	Ecologic	Latitude of residence	Pterygium	Strong positive correlation with latitude		
Nakaishi et al., 1997 (*59*)	Japan	Cross-sectional Exposed: n = 783 Controls: n = 207 Age = 22 - 49	Occupation as a motorcycle policeman	Pinguecula Pterygia	RR (15 yrs driving cf 0) = 2.92 RR (Exposure index – km yrs, 200,000 vs none) = 2.66 Too few to analyse		2.18 – 3.86 2.08 – 3.40
Panchapakesan et al., 1998 (*281*)	New South Wales, Australia	Cross-sectional Pterygium: n = 236 Pinguecula: n = 2521 Age = 49+	Sun-induced skin damage	Pterygium Pinguecula	OR = 2.4 ns		1.5 – 3.8
Saw et al., 2000 (*282*)	Singapore	Case-control Cases: n = 61 Controls: n = 125 Age: 30+	Current sun exposure Sun exposure 5 yrs ago Sun exposure 10 yrs ago	Pterygium	Sex, age, use of spectacles, family history of eye disease, family income	OR = 1.05 OR = 1.27 OR = 1.31	0.83 – 1.34 1.06 – 1.54 1.09 – 1.57
Tang et al., 1999 Abstract only (*60*)	Taipei, Taiwan	Cross-sectional N = 394	Outdoor postal work	Pterygium Pinguecula	As occupational sun exposure increases by one unit, the risks of developing pinguecula and pterygium increase by 2.1% and 0.8% respectively		p<0.05 p<0.05
Taylor et al., 1989 (*47*)	Maryland, USA	Cross-sectional N = 838 Age: 30+	Ocular exposure: UVA_1 (A1) UVA_2 (A2) UVB (B) Av annual UVB UVA_1 (A1) UVA_2 (A2) UVB (B) Av annual UVB UVA_1 (A1) UVA_2 (A2) UVB (B) Av annual UVB	 Pterygium, Pingueculae Climatic droplet keratopathy	Age	 OR = 0.82 OR = 0.86 OR = 0.65 OR = 3.06 OR = 0.29 OR = 0.28 OR = 0.29 OR = 1.40 OR = 1.49 OR = 1.53 OR = 1.26 OR = 6.36	 0.45 – 1.19 0.48 – 1.25 0.33 – 0.98 1.77 – 5.31 0.03 – 0.55 0.02 – 0.54 0.05 – 0.52 0.88 – 2.23 1.07 – 1.92 1.09 – 1.96 0.88 – 1.63 3.46 – 11.68

Threlfall and English, 1999 (*52*)	Perth, Australia	Case-control Cases: n = 150 Controls: n = 135	Av. Latitude of residence, >32° cf <32° Av. Daily hrs sunshine at place of residence Av. Solar radiant energy at residence Av. Daily hrs personal sun exposure (9-5) Av. Daily hrs personal sun exposure (10-2) Av. Daily hrs ocular sun exposure (9-5) Av. Daily ocular radiation dose	Pterygium	Age group, sex	OR = 0.52 OR = 2.63 OR = 2.31 OR = 4.01 OR = 4.84 OR = 4.38 OR = 6.77	0.25 – 1.03 1.49 – 4.71 1.28 – 4.25 1.60 – 10.88 1.98 – 12.74 1.88 – 10.93 2.60 – 19.68
Wong et al., 2001 (*283*)	Singapore	Cross-sectional N = 1232 Age: 40-79	Occupation: Factory/production workers and machine operators Labourers and agricultural workers Smoking status: Y vs N	Pterygium	Age, sex	OR = 3.8 OR =3.2 OR = 1.7	1.9 – 7.5 1.6 – 6.6 1.1 – 2.7
2.5 Squamous cell carcinoma of the cornea and conjunctiva							
Lee et al., 1994 (*62*)	Australia	Case-control N (cases) = 60 N (controls) = 60	Fair skin Propensity to sunburn Pale iris History of previous skin cancers removed High early residential ambient UVR	SCCC		OR = 5.4 OR = 3.8 OR = 1.8 OR = 15.0 OR = 7.5	1.1 – 25.6 0.7 – 19.7 0.9 – 3.8 2.0 – 113.6 1.8 – 30.6
2.6 Cataracts							
AREDS, 2001 (*284*)	USA	Case-control N = 4477 Age: 60-80 yrs	Sunlight exposure (adult average annual ocular UVB exposure)	Cortical cataract Nuclear cataract		OR = 1.33 ns	0.98 – 1.82
Brilliant et al., 1983 (*285*)	Nepal	Cross-sectional N = 873 All ages	Altitude of residence Sunlight hours	Cataract prevalence		r = -0.533 r = 0.563	p<0.0001 p<0.0001
Chatterjee et al., 1982 (*286*)	India	Cross-sectional N = 1269 Age: 30+	Low total protein consumption, low education	Cataract	40% of the excess prevalence of Punjab cataract over that in a US population study could be accounted for by low protein consumption.		
Collman et al., 1988 (*68*)	North Carolina, USA	Case-control Cases: n = 113 Controls: n = 161 Age = 40-69	Sunlight exposure	Cataract		C: OR = 1.53 PSC:OR= 1.52 N: OR = 0.79 M: OR = 1.36	0.21 – 7.19 0.28 – 5.44 0.39 – 1.96 0.36 – 3.72
Cruickshanks et al., 1992 (*74*)	Wisconsin, USA	Cross-sectional N = 4926 Age: 43-84	Average annual ambient UVB exposure	Cataract: Cortical PSC Nuclear	Age	OR=1.36 (M) OR=0.94 (F) OR=1.17 (M) OR=1.10 (F) OR=0.93 (M) OR=0.97 (F)	1.02 – 1.79 0.70 – 1.26 0.79 – 1.73 0.70 – 1.72 0.78 – 1.12 0.78 – 1.20
Delcourt et al., 2000 (*79*).	France	Cross-sectional N = 2584 Mean age=70.4 yr	Annual ambient solar radiation Professional exposure to sunlight Leisure sunlight exposure	Cataract: Cortical (C) Posterior subcapsular (PSC) Nuclear (N) Mixed (M)	Age, sex, education level, oral corticosteroids, cancer, diabetes, smoking	C: OR = 2.48 PSC = ns N: OR = 1.76 M: OR = 3.98 C: ns PSC: OR=1.63 N & M = ns C, N & M: ns PSC: OR=0.62	1.24 – 4.99 0.95 – 3.24 1.98 – 7.98 1.01 – 2.63 0.43 – 0.90

Dong et al., 2003 (*81*)	Stockholm, Sweden	Experimental (rats)	UVR exposure, age	Development of cataract	UVR-irradiated rats developed cataracts with greater sensitivity in young cf old rats.		
Graziosi et al., 1996 (*287*)	Italy & USA	Cross-sectional element of case-control study N = 731	Sunlight index	Location of cortical opacity (Wedge-shaped cortical opacities markedly more frequent and more severe in the inferior-nasal quadrant of the lens): Inferior lens areal involvement cf superior involvement		OR = 1.73	1.03 – 2.93
Hammond et al., 2000 (*66*)	UK	Twin studies N = 506 twins Age: 50-79	Zygosity Environmental factors	Nuclear cataract	Heritability in nuclear cataract = 48% (95% CI 42 – 54%); remaining variance explained by age (38%, 95% CI 31-44) and unique environmental factors (14%, 95% CI 12-18%).		
Hollows and Moran, 1981 (*288*)	Australia	Cross-sectional N = 105,561	Indigenous status UV zone of residence	Cataract	Significant positive correlation between UVR and cataract prevalence ($p<0.005$) in Indigenous Australians, but not in the non-Indigenous population.		
Italian-American Cataract Study Group, 1991 (*72*)	Italy	Case-control Cases: n = 1008 Controls: n = 469 Age: 45 – 79	Work location in sunlight Leisure time in sunlight	Cataract: cortical (C), posterior subcapsular (PSC), Nuclear (N); Mixed (M)	Sex, education, cortisone use	OR = 1.75 (C); OR = 0.84 (PSC) OR = 0.65 (N) OR =1.75 (M) OR = 1.45 (C) OR = 0.64 (PSC) OR = 1.20 (N) OR = 1.45 (M)	1.15 – 2.65 ns p<0.05 1.09 – 1.93 ns ns
Jonasson et al., 2004 (*289*)	Reykjavik, Iceland	Cohort N = 1045	Time spent outside during weekdays (>4 hours cf seldom) at: Age 20-30 Age 40-50	Cortical cataract		 OR = 2.80 OR = 2.91	 1.01 – 7.80 1.13 – 9.62
Katoh et al., 2001 (*290*)	Iceland	Case-control Cases (I) n = 374 Cases (II) n = 82 Controls: n = 378 Age: >50 years	Sun exposure at ages: 20-30 40-50 Now	Cortical cataract I – grade 1 II – grade 2 and 3		 RR: (I) = 1.19 RR (II) = 2.80 RR (I) = 0.98 RR (II) = 2.91 RR (I) = 0.88 RR (II) = 2.94	 0.66 – 2.15 1.10 – 7.80 0.51 – 1.95 1.13 – 9.62 0.44 – 1.76 0.99 – 8.54
Klein et al., 1995 (*291*)	Beaver Dam, Wisconsin, USA	Cross-sectional Cases: n = 4677 43 – 84 years	Wisconsin Sun Years	Cortical cataract Nuclear sclerosis Posterior subcapsular cataract	Age, wearing glasses, diabetes, smoking, heavy drinking	OR = 0.94 (F); OR = 1.36 (M) OR = 0.97 (F); OR = 0.93 (M) OR = 1.10 (F); OR = 1.17 (M)	0.70 – 1.26 1.02–1.79 0.78 – 1.20 0.78 – 1.12 0.70 – 1.72 0.79 – 1.73
Leske et al., 1991 (*73*)	Massachusetts, USA	Case-control	History of diabetes Smoking Occupational sun exposure	Nuclear (N), cortical (C), or PSC cataract in at least one eye, with loss of visual acuity	Age, sex	OR = 1.47 (PSC) OR = 1.98 (C) OR = 0.47 (N) OR = 1.64 (PSC) OR = 1.10 (C) OR = 2.30 (N) OR = 1.28 (PSC)	0.70 – 3.08 1.25 – 3.13 0.19 – 1.19 0.87 – 3.08 0.78 – 1.84 1.30 – 4.07 0.72 – 2.26

						OR = 0.91 (C) OR = 0.53 (N)	0.64 – 1.30 0.30 – 0.94
Leske et al., 1999 (*292*)	Barbados	Cross-sectional	Diabetes High diastolic BP High waist-hip ratio	Cortical cataract	Age-stratified (<60 and ≥ 60)	OR = 2.23 OR = 1.49 OR = 1.36	1.63 – 3.24 1.00 – 2.23 1.00 – 1.84
Lim et al., 1998 (*293*)	New South Wales, Australia	Cross-sectional	Pinguecula Pterygium (UVR exposure proxies)	Cortical cataract	Age, sex, smoking, high blood pressure, diabetes, steroid use	OR = 1.40 OR = 0.95	1.15 – 1.70 0.69 – 1.31
McCarty et al., 1999 (*78*)	Victoria, Australia	Cross-sectional N = 5147 Age: 40 - 103	Average annual ocular UVB exposure	Cataract	Age, gender, iris colour, diabetes, gout, beta blocker use, myopia, glaucoma	Cortical OR = 1.44 PSC cataract: OR = 1.15	 1.21 – 1.73 0.90 – 1.46
Minassian et al., 1994 (*48*)	Mongolia	Cross-sectional N = 4344 persons (8634 eyes) Age: 40+	CDK (as a marker of high UVR exposure) (present vs absent)	Cataract	Age	40-54 years: OR = 13.19 >54 years OR = 0.53	 1.04 – 167 0.28 – 0.99
Mohan et al., 1989 (*71*)	India	Hospital based Case control	Education, Increasing cloud cover Blood pressure, Cooking fuels (gas vs dung)	Cataract – nuclear, cortical, PSC and mixed	Age, sex, year of examination,	OR = 0.62 (all types) OR = 0.78 (all types) OR = 1.44 (nuclear) OR = 0.62 (cortical and nuclear)	0.40 – 0.98 0.60 – 0.90 1.25 – 1.65 0.40 – 0.98
Neale et al., 2003 (*67*)	Nambour, Australia	Case-control Cases: n = 195 Controls: n = 159	Lifetime occupational sun exposure (high vs very low) Lifetime leisure exposure Occupational sun exposure: 13-19 yrs of age 20-29 yrs of age 30-39 yrs of age 40-49 yrs of age 50-59 yrs of age 60+ yrs of age	Nuclear cataract grade 2.0 or higher	Ages, sex, education, smoking, diabetes, wearing eyeglasses or sunglasses, occupational or leisure sun exposure (where appropriate)	OR = 2.11 OR = 0.84 OR = 2.12 OR = 5.94 OR = 1.15 OR = 0.86 OR = 2.17 OR = 1.38	0.74 – 5.98 0.51 – 1.38 0.84 – 5.41 2.07 – 17.10 0.33 – 3.96 0.28 – 2.62 0.55 – 8.53 0.19 – 10.2
Rosmini et al., 1994 (*75*)	Italy	Case-control Cases: n = 1008 Controls: n = 469 Age: 45 – 79 y	Sunlight index (indoor/outdoor work/leisure)	Cataract: cortical (C), posterior subcapsular (PSC), Nuclear (N); Mixed (M)	Age, sex, educational status, use of hat, parent/sibling with cataract, red blood cell G6PD level	OR=2.26 (C) (significant dose response relationship) PSC = ns N = 1.29 M (Cortical/PSC) = 4.40	1.14 – 4.46 0.38 – 4.35 1.70 – 11.4
Sasaki et al., 1999 (*294*)	Japan (2 sites), Reykjavik, Iceland, Singapore	Cross-sectional & case control N = 884, 301, 993 and 468 respectively Age = >50	Latitude Hours spent outside on weekdays (<4 cf 5+)	 Cortical cataract		Cortical and nuclear cataract less common in Reykjavik. OR = 2.11 (M)	 0.65 – 6.88

			20s – 30s 30s – 40s Present			OR = 1.06 (F) OR = 3.88 (M), OR = 0.93 (F) OR = 2.20 (M), OR = 0.64 (F)	0.57 – 1.97 1.11–13.53 0.51 – 1.71 1.03 – 4.71 0.38 – 1.05
Taylor et al., 1988 (*69*)	Maryland, USA	Cross-sectional N = 838 Mean age: 53 yrs	Av. Annual UVB exposure (Maryland Sun Years)	Cortical cataract Nuclear cataract		OR = 3.30 OR = 0.96	0.90 – 9.97 0.36 – 2.60
West et al., 1998 (*77*)	Maryland, USA	Cohort study N = 2520 Age: 65-84 yrs	Ocular UVB exposure (Maryland sun years)	Cortical cataract	Age, sex, race, diabetes	OR = 1.57	1.04 – 2.38
Wong et al., 1993 (*70*)	Hong Kong	Cross-sectional N = 685 Age: 55-74	Sun exposure score	Cataract of any type, grade 3, 4 or 5	Age, sex	OR = 2.1	0.6 – 7.9
2.7 Ocular melanoma							
Ajani et al., 1992 (*295*)	Boston, USA	Case-control Cases: 197 Controls: 385 Mean age = 59.2	Occupation: Agriculture, forestry, fishing workers Exposure to inks	Uveal melanoma	Age, ancestry, skin colour, moles, use of sunlamps, past income level	OR = 2.02 OR = 2.44	0.61 – 6.73 1.14 – 5.23
Dolin et al., 1994 (*84*)	UK	Ecologic correlation	Mortality rates for CMM over time	Mortality rates for uveal melanoma	Mortality rate of CMM increasing steadily, but not uveal melanoma. Suggest UVR exposure not causative		
Guenel et al., 2001 (*87*)	France	Case-control Cases: n = 50 Controls: n = 479 Age: 35 - 70	Eye burns (5 cf 0) Light eye colour Occupational exposure to artificial UVR (eg welding) Occupational exposure to sunlight	Ocular melanoma	Age, gender	OR = 3.3 OR = 3.0 OR = 5.5 OR (high vs none) = 0.9	1.1 – 9.6 1.4 – 6.3 1.8 – 17.2 0.4 – 2.3
Holly et al., 1990 (*296*)	Western USA	Case-control Cases: n = 407 Controls: n = 870 Age = 20-74	Eye colour (cf brown): - Green, gray, hazel - Blue Vacation outdoors in sunny climate Leisure time outdoors Exposure to UV or black lights Welding burn, snow blindness, sunburn to eye	Uveal melanoma	Age, coffee consumption.	 OR = 2.50 OR = 2.21 OR = 0.84 OR = 0.79 OR = 3.69 OR = 7.17	 1.77 – 3.54 1.58 – 3.09 0.59 – 1.20 0.59 – 1.04 1.57 – 8.70 2.50 – 20.57
Holly et al., 1996 (*85*)	California, USA	Case-control Cases: n = 221 Controls: n = 447 Age: 20-74	Occupation and duration: Sailors (≥6yrs cf 0) Welders (≥11 yrs cf 0)	Ocular melanoma	Age	 OR = 2.7 OR = 1.9	 0.60 – 12.2 1.0 – 3.6
Pane and Hirst, 2000 (*86*)	Queensland, Australia	Case-control Cases: n = 125 Controls: n = 375	Painful sunburns (6+ cf 0) Wearing sunglasses Childhood ocular sun exposure Adult ocular sun exposure Lifetime ocular sun exposure	Ocular melanoma		OR = 0.78 OR = 1.00 OR = 1.18 OR = 0.67 OR = 0.91	0.40 – 1.52 0.64 – 1.56 0.74 – 1.87 0.37 – 1.19 0.50 – 1.65
Schwartz and Weiss, 1988 (*297*)	USA	Ecologic N = 1247 tumours	Season of diagnosis	Uveal malignant melanoma	No significant variation in diagnosis overall or for tumours arising in the choroid. Strong seasonal variation in tumours coded as arising in the eyeball with large, late winter-early spring peak in males and smaller mid-spring peak in females.		

Schwartz and Weiss, 1988 (*298*)	USA	Ecologic N = 763 patients	Place of birth (southern cf northern USA) Av. Daily solar irradiance in state of birth	Ocular melanoma	Age, sex, residence at diagnosis	RR = 1.1 RR = 1.2	0.8 – 1.5 0.6 – 2.2
Seddon et al., 1990 (*299*)	New England, USA	Case-control Cases: n = 197 Controls: n = 385 (population controls)	Northern latitude ancestry Southern residence >5y Use of sunlamps Intense sun exposure Birthplace <40°latitude Outdoor work	Uveal melanoma	Age, no. of moles, freckles, skin colour, eye colour, hair colour, skin reaction to sun	RR = 6.5 RR = 2.8 RR = 3.4 RR = 1.7 RR = 0.2 RR = 0.6	1.9 – 22.4 1.1 – 6.9 1.1 – 10.3 0.9 – 3.0 0.0 – 0.7 0.3 – 1.4
Seddon et al., 1990 (*299*)	USA	Case-control Cases: n = 337 Controls: n = 800 (sibling controls)	Use of sunlamps Intense sun exposure Outdoor work Fluorescent lighting Sunbathing Outdoor hobbies	Uveal melanoma	Age, no. of moles, freckles, skin colour, eye colour, hair colour, skin reaction to sun	RR = 2.3 RR = 2.1 RR = 0.4 RR = 1.7 RR = 0.8 RR = 0.7	1.2 – 4.3 1.4 – 3.2 0.2 – 0.8 1.1 – 2.5 0.5 – 1.2 0.5 – 1.1
Shah et al., 2005 (*89*)		Meta-analysis 133 published reports	Ultraviolet light: Exposure to welding Outdoor leisure time Latitude of birth Occupational UVR exposure	Uveal melanoma		 OR = 2.05 OR = 0.86 OR = 1.08 OR = 1.37	 1.20 – 3.51 0.71 – 1.04 0.67 – 1.74 0.96 – 1.96
Tucker et al., 1985 (*300*)	Philadelphia, USA	Case-control Cases: n = 444 Controls: n = 424	Birth in Southern USA Brown eyes (cf blue) Leisure time outdoors Sunlamp use Gardening Increased vacation sun exposure Frequent sunbathing Eye protection in sun (never cf almost always)	Intraocular malignant melanoma	History of cataracts Age, eye colour	RR = 2.7 RR = 0.6 RR = 1.1 RR = 2.1 RR = 1.6 RR = 1.5 (p for trend=0.01) RR = 1.5 RR = 1.4	1.3 – 5.9 0.4 – 0.8 0.7 – 1.6 0.3 – 17.9 1.01 – 2.4 0.97 – 2.3 0.9 – 2.3 0.9 – 2.3
Vajdic et al., 2002 (*301*)	Australia	Case-control Cases: n = 290 Controls: n = 893 Age: 18-79	Tot. hrs exposure weekdays and weekends Tot. hrs exposure weekdays Tot. hrs exposure weekends Total lifetime occupational exposure Tot recreational hrs. since leaving school Ambient UVR 0-9 yrs	Choroidal and ciliary body melanoma - no consistent association for iris and conjunctival melanomas	Age, sex, place of birth, eye colour, ability to tan and squinting as a child	OR = 1.6 OR = 1.8 OR = 0.8 OR = 1.7 OR = 0.8 OR = 0.8	1.0 – 2.6 1.1 – 2.8 0.5 – 1.3 1.1 – 2.7 0.5 – 1.3 0.5 – 1.3

Table A1.5 Summary of studies reviewing UVR effects on skin

3. Effects on skin		
Berg et al., 1996 (*302*)	Animal study	UV irradiation of mice results in accumulation of p53 protein (an early event in induction of skin cancer)
Burke et al., 2000 (*303*)	Experimental	UVB exposure associated with development of skin cancers in rats; some protection by increased oral intake of vitamin E.
Diepgen and Mahler, 2002 (*304*)	Review	Increased risk of NMSC in fair-skinned, blue-eyed, red-haired populations and those with over-exposure to UVR. Chemical carcinogens, eg Arsenic, can also promote NMSC, particularly SCC. Having one NMSC is a risk factor for the development of further NMSC. CMM associated with fair skin, tendency to freckle, presence of a large number of naevi and childhood as well as lifetime sun exposure.
Engel et al., 1988 (*120*)	Cross-sectional	In the first National Health and Nutrition Examination Survey sunlight exposure was associated with higher prevalence of actinic skin damage, localized hypomelanism and hypermelanism, seborrheic keratoses, senile lentigines, freckles, acne rosacea, spider nevi, varicose veins, dry skin, wrinkled skin, pterygia, and arcus senilis.
Fleming et al., 1975 (*305*)	Case series	All skin cancers rare in black patients. Most SCC (61%) are on unexposed areas and 41% associated with previous burn or scarring. CMM most common on plantar and palmar surfaces. BCC rare.
Foster and Webb, 1988 (*306*)	Case series	In the Melanesians of the North Solomons, no BCC were seen 1981-85; SCC are rare and arise out of previously damaged skin; melanoma arises from the unpigmented plantar skin of the foot.
Green et al., 1999 (*307*)	Review	Descriptive, analytic epidemiological and experimental studies support a causative role for UVR exposure in the development of BCC, SCC and CMM.
Halder and Bridgeman-Shah, 1995 (*308*)	Review	Skin cancer in African Americans rare. Factors implicated in the cause of skin cancers include – sunlight, albinism, burn scars, X-rays, preexisting pigmented lesions, chronic inflammation and chronic discoid lupus erythematosus.
Heenen et al., 2001 (*117*)	Experimental	Erythema following UV irradiation correlates only loosely with DNA damage. There may be subpopulations with different susceptibility to DNA damage following UVR exposure.
Marks, 1995 (*104*)	Review	The likelihood of skin cancer developing depends on constitutional predisposition and subsequent exposure to environmental factors, particularly sunlight. The nature of the exposure that is important may be different for melanoma and NMSC both in wavelength and the pattern of sun exposure.
Quinn, 1997 (*309*)	Review	Strong epidemiological evidence for a causative role of UVR exposure in the genesis of skin cancers.
Woodhead et al., 1999 (*310*)	Review	SCC related to total and occupational sun exposure; for BCC and melanoma, the pattern of sun exposure may be important. Sunscreens decrease UVB exposure but may result in enhanced UVA exposure. Ozone depletion or increases in sun-seeking behaviour in Japanese people may result in increased levels of skin cancer.
3.1 Malignant melanoma		
Armstrong and Kricker, 1993 (*98*)		65% of melanomas occurring globally are due to sun exposure
Armstrong and Kricker, 1995 (*311*)	Review	CMM caused by UVR exposure – review of evidence from case-control studies and descriptive studies
Balch et al., 2001 (*312*)	Review	Concludes that melanoma caused by UVR exposure
Bulliard, 2000 (*313*)	Ecologic	Increased melanoma incidence in: lower latitudes (increase in incidence per degree of latitude: male – 5.6%, female – 4.05%), females, sites intermittently exposed to sun
Bulliard et al., 1999 (*314*)	Ecologic	Lifetime risk of melanoma peaked with women born in 1934 and men in 1944; sun exposure causative
Elwood, 1989 (*315*)	Review	Strong evidence of an association of UVR exposure with cutaneous malignant melanoma – risk positively related to place of residence and maximal with high acute intermittent exposure.
Gutman et al., 1993 (*316*)	Cross-sectional	Dark-skinned Sephardic Jews develop CMM less frequently than fair-skinned Ashkenazic Jews but once CMM occurs it tends to be more virulent.
Katsambas and Nicolaidou, 1996 (*317*)	Review	Increased risk of melanoma associated with: proximity to the equator in fair-skinned populations; trunk in males and lower limbs in females but variable between populations; different types of melanoma may be associated with different patterns of sun exposure; fair skin, blond h or red hair, tan poorly with sun exposure, childhood sun exposure, number of common melanocytic naevi.
Moan et al., 1999 (*318*)	Review	Present evidence for an important role of UVA in the induction of cutaneous malignant melanoma, including: Risk of melanoma vs NMSC in Africans compared to Caucasians, melanoma risk in albino Africans, increased risk in sun-sensitive individuals, relative latitudinal gradient of UVA vs UVB and melanoma vs SCC.
Osterlind, 1992 (*319*)	Review	Strongest disease determinant is number of pigmented naevi. Skin sensitivity to UVR and fair hair colour are also important in melanoma risk. Intermittent sun exposure may be more important than cumulative exposure.
Titus-Ernstoff, 2000 (*320*)	Review	Occurrence of melanoma in white subjects, on sun-exposed surfaces, and in association with latitude of residence as well as migration studies suggests an important role for

		UVR exposure in the causation of CMM. Timing and intermittency of sun exposure may be important for the development of different types of melanoma.
Tucker and Goldstein, 2003 (*321*)	Review	Two major susceptibility genes identified, but these account for a minority of melanoma cases. Host factors have major importance in the development of melanoma as has sun exposure.
Wei et al., 2003 (*322*)	Case-control	Hospital patients with decreased DNA repair capacity have an increased risk of cutaneous malignant melanoma, possibly via increased susceptibility to UVR-induced DNA damage.
3.2 Cancer of the lip		
de Visscher and van der Waal, 1998 (*101*)	Review	Cause of SCC of the lip is unclear, but is probably due to a complex multistep process of interactions of putative risk factors, including UVR exposure, tobacco smoking, herpes infections and others.
Main and Pavone, 1994 (*100*)	Review	Describe actinic cheilitis as a common condition caused by damage to the lips through sun exposure. The condition can be treated by use of appropriate sunscreen and can undergo malignant transformation to SCC of the lip.
3.3 and 3.4 Non-melanoma skin cancer		
Alam and Ratner, 2001 (*323*)	Review	Review of causes of SCC – UVR most common cause
Almahroos and Kurban, 2004 (*324*)	Review	Migrant studies, latitudinal pattern and animal models support causative role of UVR in development of NMSC
Armstrong and Kricker, 1995 (*311*)	Review	Review of evidence from case-control studies of the importance of sun exposure in NMSC.
Armstrong and Kricker, 2001 (*108*)	Review	Evidence presented that sun exposure causes non-melanoma skin cancers
Bachelor and Bowden, 2004 (*325*)	Review	Provides a review of the important role of UVA in the formation of SCC and BCC, acting at all stages of tumour development – initiation, promotion and progression.
Bang et al., 1987 (*326*)	Case series	Skin cancer more common on covered areas in blacks cf whites. BCC less common than SCC and most SCC associated with predisposing lesions and lesions on non-sun exposed skin.
Beckenstein and Windle, 1995 (*327*)	Retrospective	BCC on sun-exposed areas, but infrequent in black patients
de Gruijl et al., 2001 (*113*)	Review	Solar UVB radiation causes point mutations in the p53 gene and the PTCH gene, but other UV wavelengths may contribute to skin carcinogenesis with other wavelength dependent changes, particularly in growth-controlling pathways.
de Gruijl et al., 2003 (*112*)	Review	UV radiation is important in the development of BCC and melanoma and animal model have demonstrated that exposure at a very young age is more detrimental than exposure in adulthood. There are a number of gene mutations which are typical of UVB-induced damage and are consistent with adverse effects on tumour suppression.
Grossman and Leffell, 1997 (*106*)	Review	UVR has two roles in the development of NMSC – UVR causes mutations in cellular DNA that lead to unrestrained growth and tumour formation and by inducing a state of relative immunosuppression UVR inhibits tumour rejection.
Kricker et al., 1994 (*328*)	Review	Indirect evidence of link between sun exposure and NMSC – occurrence in fair-skinned populations; migrant studies; occurrence on sun-exposed sites; excessive incidence in persons with xeroderma pigmentosa. Direct evidence is weak and inconclusive.
Kwa et al., 1992 (*107*)	Review	Strong epidemiological evidence of association between UVR exposure and SCC.
Marks, 1995 (*329*)	Review	SCC is most common on sites with heavy UVR exposure, while BCC is more common on sites with only moderate exposure. There is a low rate of transformation of actinic keratoses to SCC.
Preston and Stern, 1992 (*330*)	Review	UVB most important for induction of skin cancer via DNA damage, impairment of immune function and inhibition of p53 tumour-suppressor genes. Other causes include chemical carcinogens, ionizing radiation, chronic ulceration or inflammation, immunosuppressed states, viral carcinogens and scarring dermatoses.
Sauter et al., 1998 (*109*)	Experimental	Repeated UVR exposure of treated human neonatal foreskins grafted onto mice resulted in histologic changes including precancers and invasive cancers in 24 out of 25 xenografts, but not in controls. Longer UVR exposure was associated with greater dysplasia and development of both SCC and CMM. There was a direct correlation with histologic changes consistent with sun damage.
Schmieder et al., 1992 (*331*)	Case-control	Small study of NMSC in relation to residential sun exposure. 90% of patients with NMSC are UVR-resistant (UVR-R) to the immunosuppressive effect of UVR on the development of contact hypersensitivity. There was no difference in the chronic high level residential UVR exposure between cases and controls; however cases were all UVR-

		susceptible (UVR-S), while only 4/9 controls were UVR-S. Stress importance of host factors in development of NMSC.
Scotto and Fears, 1980 (*332*)	Review	A two-fold increase in skin cancer occurs for each 8-11 degree decrease in latitude. Association between sunlight and NMSC stronger than that for melanoma – animal experiments show induction of NMSC with UVR (but not melanoma); 80% NMSC located on sun-exposed surfaces with less than 10% on trunk, cf melanoma where 25% occur on the trunk. Importance of behaviour to exposure, rather than just ambient UVR.
Scotto et al., 1996 (*333*)	Review	Dominant risk factor for NMSC is UVR from the sun. Evidence includes: tendency for tumours to arise on sun-exposed surfaces; high rates among outdoor workers; inverse correlation with latitude; predisposition of light-skinned populations; high rates among individuals with other evidence of sun damage; induction of skin cancer by UVR in experimental animals; high risk amongst persons with xeroderma pigmentosa.
Shai et al., 1999 (*334*)	Histological case series	Study demonstrates a gradual and continuous transition from solar keratoses to BCC in histological sections of tumours. Solar keratoses can also transform into SCC.
3.5 Sunburn		
Abarca et al., 2002 (*335*)	Cross-sectional	Increased sunburn during periods of sudden severe ozone depletion
Heenen et al., 2001 (*117*)	Experimental	Sunburn cells are dyskeratotic cells induced by acute exposure to UV radiation. Administration of the same erythemal dose to different individuals generates different amounts of DNA damage and suberythemal doses can generate typical UVB-induced pyrimidine dimers.
Selgrade et al., 2001 (*115*)	Experimental	Differences in sensitivity to immune suppression following UV irradiation for multiple skin types based on Fitzpatrick skin pigmentation classification or MED were not observed. However, immune suppression was related to the slope of the erythemal dose response curve – those with steep curves (across a range of skin types) showed a lower UVR threshold for immunosuppression than those with flat curves.
3.6 Photoageing/solar keratoses		
Berneburg et al., 1997 (*336*)		Increased mutation frequency of mitochondrial DNA in sun-exposed cf non-exposed skin.
Bernstein et al., 1996 (*119*)	Lab sun exposure	Sun exposed skin has increased and abnormal deposition of glycosaminoglycans, ie structural and functional changes, "weathering"
Engel et al., 1988 (*120*)		
Griffiths, 1999 (*118*)	Review	85% of wrinkling due to sun-exposure. Brown spots (actinic lentigines) due to sun exposure. UVA may be most important in Photoageing.
Holman and Armstrong, 1984 (*124*)	Case-control	Control subjects arriving in Australia have an increased number of naevi on their arms (compared to those arriving at later ages) suggesting that sun exposure in early life may be important for the development of melanocytic naevi.
Kambayashi et al., 2001 (*122*)	Experimental	Chronic low dose UV irradiation of the skin induces structural and quantitative changes in the epidermis that causes wrinkle formation.
Krutmann, 2000 (*337*)	Review	UVA induces mitochondrial DNA mutations that are important in photoageing.
Trautinger, 2001 (*338*)	Review	Nucleic acids and proteins are the major cellular chromophores absorbing in the UVB wavelength. In cellular proteins, tryptophan and tyrosine are the main amino acids that absorb UVB. In addition other biomolecules, including NADH, quinones, flavins, porphyrins, 7-dehydrocholesterol and urocanic acid absorb in the UVB range. UVB induces DNA damage and when this occurs in the p53 (tumour suppressor) protein keratinocytes lose their ability to undergo cell death upon high dose UVR exposure. Clonal expansion gives rise to actinic keratoses. Photoisomerization of UCA and the generation of reactive oxygen species may contribute to photoageing.
Yaar and Gilchrest, 2001 (*339*)	Review	Characteristics of sun-aged skin; review of experimental evidence linking sun exposure to skin cancers.
3.7 Photodermatoses		
Arrese et al., 2001 (*130*)	Experimental	Genetic predisposition to actinic prurigo associated with UV-induced release of TNF-α by keratinocytes and subsequent epidermal effects.
Boonstra et al., 2000 (*340*)	Clinical follow-up	Lowered MED in cases, pathologic reaction to UVA and UVB.
Grabczynska et al., 1999 (*341*)	Case series	HLA typing confirmed a strong association between actinic prurigo and DR4 allele. No HLA association in polymorphic light eruption (PLE) but patients with PLE may progress to actinic prurigo.
Gupta et al., 2000 (*133*)	Case series	Estimated prevalence 0.34 per 100,000; abnormal responses to UVA in 53% of cases, but some patients benefit from narrow band UVB phototherapy.
Gupta et al., 1999 (*132*)	Case reports	Familial cases of hydro vacciniforme who developed vesicles following brief sun exposure, particularly UVA.
Lonceint et al., 2001 (*128*)	Case reports	Photoinduced eczema was triggered by handling of an antibiotic used in preparing animal feed.
McGregor et al., 2000 (*342*)	Review	Description of polymorphic light eruption and actinic prurigo – inherited conditions showing a clear causal association with sunlight exposure
Millard et al., 2000 (*131*)	Twin study	Results from an examination of the heritability of polymorphic light eruption are consistent with either a model comprising additive genetic and unique environmental factors or a dominant gene model. In the former model, additive genetic factors account for 84% of the variance in susceptibility with the remaining 16% associated with unique

		environmental factors.
Roelandts and Ryckaert, 1999 (*125*)	Review	Solar urticaria due to an antigen-antibody reaction. It appears that antigens induced in the serum or plasma by light irradiation become photoallergens. There are diverse action spectra which may be attributed to differences in photoallergens, in particular their molecular weight.
Schnell et al., 2000 (*129*)	Genetic study	Familial patterns of actinic prurigo are consistent with simple dominant inheritance with incomplete penetrance.
Uetsu et al., 2000 (*126*)	Case series	40 patients with solar urticaria – action spectrum in the visible light range in 60%; in the UVA range in 10%, in the UVB range in 10%, in the UVA to the UVB in 8%, from UVA to visible light in 3% and in a broad range from UVB to visible light in 10%.
Wolf and Oumeish, 1998 (*343*)	Review	PLE may be a type-IV hypersensitivity response to a sunlight-induced cutaneous antigen. Chronic actinic dermatitis may be caused by sensitisation to an endogenoous carrier protein altered by UVR or to photooxidised endogenous or exogenous substances. Solar urticaria appears to be an immediate hypersensitivity response to an unidentified photoallergen. Actinic prurigo has a strong hereditary element. Hydro vacciniforme is rare, unknown cause, with action spectrum in UVA and occasionally also UVB. Also reviews photoallergy including drug-induced.
3.8 Psoriasis		
Braathen et al., 1989 (*344*)	Cross-sectional	Higher prevalence of psoriasis in urban cf rural regions.
Ferrandiz et al., 2001 (*134*)	Cross-sectional	Geographic variation in prevalence of psoriasis in Spain – more common in the central dry region of the country.
Finzi and Benelli, 1998 (*135*)	Case series	Prevalence of psoriasis higher in Northern European than Southern European countries. Distribution within Italy is homogeneous.
Raychaudhuri and Farber, 2001 (*136*)	Review	Psoriasis is more common in colder northern climates than in the tropical regions. Caucasians seem to be more affected than other races. Strong genetic basis, particularly with HLA Cw6. Appears to be less common in the hot, humid and rainy climates of western Africa, compared to the dry, rainless countries of eastern Africa. Environmental factors are thought to include upper respiratory infection, psychological stress, humidity and cold weather.

Table A.1.6 Detailed summary of epidemiological studies examining UVR effects on skin

Study	Location	Design, N, Age	Exposure assessment	Outcome assessment	Adjusted covariates	Measure of effect	95% CI
3.1 Melanoma							
Armstrong and Kricker, 1993 (*98*)		Ecologic	Sun exposure	Melanoma incidence		PAR = 0.68-0.97	
Autier and Dore, 1998 (*345*)	Belgium, Germany and France	Case control Cases: 412 Controls: 445	Sun exposure during adulthood and childhood (high vs low sun exposure)	Cutaneous malignant melanoma	Age, gender, skin phototype, hair colour	 OR = 6.9 OR = 2.5	 1.4 – 4.3 3.3 – 14.2
Bataille et al., 2004 (*346*)	North East Thames, UK	Case-control Cases: n = 413 Controls: n=416 Age: 16-75 yrs	More than 10 severe sunburns (cf <10) Ever sunbed use (young individuals, fair skin) Age of sunburn, cumulative sun exposure	Cutaneous malignant melanoma	Age, gender, skin type	OR = 1.94 OR = 2.66 ns	1.02 – 3.86 1.66 – 6.09
Berwick et al., 2005 (*347*)	Connecticut, USA	Follow-up n = 528	Presence of solar elastosis (vs absence) Skin awareness (Yes vs No)	Death from melanoma	Sex, age at diagnosis, education, ever severely sunburned, intermittent sun exposure index, site of melanoma, mitoses, ulceration, Breslow thickness, physician skin examination	HR = 0.4 HR = 0.5	0.2 – 0.8 0.3 – 0.9
Boniol et al., 2005 (*348*)	Europe	Ecologic	Season of diagnosis, Location	Cutaneous malignant melanoma	Summer peak in incidence in Western Europe (summer/winter =1.31, p<0.0001) but not in Central Europe; amplitude of seasonality increases with low latitude and is increasing over time.		
Breitbart et al., 1997 (*349*)	Germany	Case-control Cases: n = 513 Controls: n=498	Vacation history of sunburns	Cutaneous malignant melanoma		OR = 1.9	1.1 – 3.4
Chen et al., 1996 (*350*)	Connecticut USA	Case-control Cases: n = 548 Controls: n = 494	Number of sunburns Total recreational sun exposure Total years in outdoor jobs	Site specific CMM	Sex, age, skin colour, number of naevi on arms, skin type	ORs=1.5–1.9 ORs=2.4–2.7 ORs=0.3–0.9	0.8 – 3.4 1.1 – 5.8 0.1 – 1.3
Cooke and Fraser, 1985 (*351*)	New Zealand	Ecologic and cross-sectional N = 1000 Age <70	Migrant status	Death from CMM	Age standardised mortality rate (ASMR) for British migrants aged 35-64 with: 5-19 years residence = 2.9 per 100,000; ≥20 yrs residence = 3.9/100,000. For those who migrated at <30 yrs of age, ASMR = 7.1/100,000; ASMR for NZ non-Maori = 7.5/100,000.		
Cristofolini et al., 1987 (*352*)	Italy	Case-control Cases: n = 103 Controls: n = 205 Age = 21 – 79 y	Sunburn (adult) Outdoor occupation Heavy sun exposure (last 20 yrs)	CMM	Skin colour, hair colour, dysplastic naevi	RR = 0.64 RR = 1.65 RR = 0.67	0.28 – 1.47 0.93 – 2.90 0.40 – 1.12
Dubin et al., 1990 (*353*)	New York, USA	Case-control Cases: n = 289 Controls: n = 527	Occupational sun exposure Recreational sun exposure Overall sun exposure	Cutaneous malignant melanoma	Age, sex	OR = 1.77 OR = 1.53 OR = 1.73	0.9 – 4.0 1.0 – 2.4 1.1 – 2.8
Elwood and Jopson, 1997 (*354*)		Meta-analysis	Sun exposure: Intermittent	Incidence of cutaneous malignant melanoma		 OR = 1.87	 1.67 – 2.09

			Occupational Total sun exposure Childhood sun exposure Adolescent sun exposure Adult/all ages exposure			OR = 0.76 OR = 1.20 OR = 1.62 OR = 1.95 OR = 1.91	0.68 – 0.86 1.00 – 1.44 1.35 – 1.95 1.60 – 2.36 1.69 – 2.17
Elwood et al., 1984 (*355*)	Western Canada	Case control Case: 595 Control: 595 20-79	Childhood sunburn (severe or frequent compared to rare or mild)	Cutaneous malignant melanoma	Hair colour, skin colour, eye colour, freckles in adolescence, sun reaction, ethnic origin	RR = 1.3	0.9 – 1.8
Elwood et al., 1985 (*356*)	Canada	Case – control Cases: n = 595 Controls: n = 595 Age: 20-79	Occupational sun exposure Recreational (summer) Vacation (summer) Sunny vacations Annual sun exposure	Cutaneous malignant melanoma	Hair colour, skin colour, history of freckles and ethnic origin	OR = 0.9 OR = 1.7 OR = 1.5 OR = 1.7 RR = 1.2	0.6 – 1.5 1.2 – 2.7 1.0– 2.3 1.2– 2.3 0.7 – 2.0
Elwood et al., 1990 (*357*)	England	Case-control Case: n = 195 Control: n=195 20-79 years	Severe sunburn (never vs ever) Aged 8-12	Cutaneous malignant melanoma	Naevi on arms, freckling, social class, hair colour, tendency to sunburn	OR = 2.4 OR = 3.6 (ns for other ages)	0.8 – 7.3 1.4 – 11.2
Fears et al., 2002 (*358*)	Philadelphia, San Francisco	Case control Cases: n = 718 Controls: n = 945 20-79 yrs	Average annual UVB flux Hours in the sun 0-19 Hours in the sun 20+	Cutaneous malignant melanoma		OR=1.19 (M) OR=1.16 (F) OR=0.99 (M) OR=0.99 (F) OR = 1.03	1.05 – 1.35 1.02 – 1.32 0.97 – 1.01 0.96 – 1.01 1.01 – 1.05
Gandini et al., 2005 (*359*)		Meta-analysis	Intermittent sun exposure Chronic sun exposure Total sun exposure Sunburns Childhood sunburn Adulthood sunburn	Histologically confirmed cutaneous malignant melanoma	Sun sensitivity, skin pigmentation, tendency to burn	RR = 1.61 RR = 0.95 RR = 1.34 RR = 2.03 RR = 2.24 RR = 1.92	1.31 – 1.99 0.87 – 1.04 1.02 – 1.77 1.73 – 2.37 1.73 – 2.89 1.55 – 2.37
Garbe and Orfanos, 1992 (*360*)	Germany, Austria and Switzerland	Case-control Cases: n = 200 Controls: n = 200	Sun exposure	Cutaneous malignant melanoma	Increased risk of CMM with any professional sun exposure (cf none) but no increased risk with increasing duration of occupational sun exposure.		
Garland et al., 2003 (*361*)		Ecologic (global)	UVA radiation UVB radiation UVA/UVB ratio UVA (controlling for skin pigmentation)	CMM mortality	Age	r = -0.50(male); -0.57 (female), p<0.001 r = -0.48 (male); -0.57 (female), p<0.001 r = 0.49 (male), 0.55 (female), p<0.001 Positive association, p<0.02 (male); p = 0.12 (female)	
Graham et al., 1985 (*362*)	New York State, USA	Case-control Cases: n = 404 Controls: n = 521	Cumulative sun exposure	Development of CMM	Age	OR=0.56 (M) OR=0.77 (F)	0.18 – 1.73 0.31 – 1.91

			Average annual sun exposure			OR=0.38 (M) OR=0.67 (F)	0.19 – 0.76 0.34 – 1.33
Green et al., 1999 (*363*)	Australia & Scotland	Case-control Cases: n = 275 Controls: n = 496 Age: >18y	Total body naevi counts Naevi on soles Penetrative injury to hands or feet Exposure to agricultural chemicals Cumulative sun exposure	Acral melanoma on soles and palms		RR = 6.3 RR = 7.5 RR = 5.0 RR = 3.6 RR = 1.8	2.5 – 15.6 3.0 – 18.6 3.0 – 8.6 1.5 – 8.3 1.0 – 3.1
Green et al., 1985 (*364*)	Queensland, Australia	Case-control Cases: n = 236 Controls: n = 236	Number of severe sunburns (≥6 cf 0-1)	Development of CMM	Presence of naevi	RR = 2.4	1.0 – 6.1
Grob et al., 1990 (*365*)	France	Case-control Cases: n = 207 Controls: n = 295 Age: 18-81	Frequency of sunburns in recent years Outdoor occupation Cumulative lifetime outdoor sun exposure	Development of CMM	Age, complexion, social level, hair colour, maximum depth of suntan, naevi	RR = 1.71 RR = 6.01 RR = 3.42	0.63 – 4.63 2.08 – 17.36 1.64 – 7.13
Holly et al., 1995 (*366*)	San Francisco, USA	Case-control Cases: n = 452 Controls: n = 930 Age: 25-59y	Sunburn before age 12 Years lived in sunny climate Time spent outdoors on weekdays (last 10 y) Time spent outdoors on weekends (last 10y)	CMM		OR = 3.3 OR = 1.2 OR = 0.83 OR = 0.84	2.3 – 4.7 0.80 – 1.90 0.46 – 1.5 0.37 – 1.9
Jones et al., 1992 (*367*)	Australia	Ecologic	Latitude	Age standardized mortality from CMM	Little variation by state despite considerable latitudinal variation. Excess female incidence cf male.		
Kennedy et al., 2003 (*368*)	Leiden, The Netherlands	Case-control Cases: n = 580 Controls: n = 386 30 – 80 years	Lifetime sun exposure Painful sunburn: 0-19 years 20-39 years 40-59 years	Cutaneous malignant melanoma	Age, sex, skin type	OR = 1.4 OR = 1.4 OR = 1.6 OR = 0.66	0.40 – 4.8 0.86 – 2.1 1.0 – 2.5 0.26 – 1.7
Krishnamurthy, 1992 (*369*)	India	Ecologic	Latitude Ozone levels UVR levels	Incidence of CMM	Slight negative latitudinal association r = -0.44, p = 0.07 Negative correlation with ozone levels r = -0.36, p>0.05 Positive association with UVR levels r = 0.30, p>0.05		
Loria and Matos, 2001 (*370*)	Argentina	Case-control	>20 naevi on arms Skin phototype I or II Holidays at beach (>48wks lifelong) Light eye colour Sunburn at <15 years old Participant in outdoor sports	Cutaneous malignant melanoma	Case control matching for age, sex and hospital	OR = 6.3 OR = 4.1 OR = 5.3 OR = 2.8 OR = 2.4 OR = 3.2	1.3 – 29.9 1.5 – 11.7 2.1 – 13.1 1.3 – 6.3 1.0 – 5.9 1.3 – 7.8
MacKie and Aitchison, 1982 (*371*)	Glasgow, Scotland	Case-control Cases: n = 113 Controls: n = 113 Age: 18-76 y	History of severe sunburn	Cutaneous malignant melanoma	Skin type, social class	OR = 2.8	1.1-7.4
MacKie et al., 1989 (*372*)	Glasgow, Scotland	Case-control Cases: n = 280 Controls: n=280	History of severe sunburn (3+ vs none)	Cutaneous malignant melanoma	Total naevi, atypical naevi, freckling tendency, tropical residence, ultraviolet use, skin type	OR (M) = 7.6 OR (F) = 2.3	1.8 – 32 0.9 – 5.6
Naldi et al., 2000 (*373*)	Italy	Case-control Cases: n = 542	Sunburn: never vs ≥15 years	Cutaneous malignant melanoma	Age, gender, education and pigmentary characteristics	OR = 1.1	0.8 – 1.5

		Controls: n = 538 Median 54 years	<15 years			OR = 1.6	1.0 – 2.4
Noonan et al., 2001 (*374*)	Washington DC, USA	Experimental	Severe sunburn at different life stages	Cutaneous malignant melanoma	Single dose of severe burning UVR in neonatal but not adult transgenic mouse is necessary and sufficient to produce human melanoma-type tumours in later life.		
Osterlind et al., 1988 (*375*)	Denmark	Case-control Cases: n = 474 Controls: n = 926 Age: 20-79 y	No. sunburns <15y No. sunburns 15-24y No. sunburns last 10 y	Cutaneous malignant melanoma	Sex, number of raised naevi, freckles, hair colour	OR = 2.7 OR =1.9 OR =3.0	1.6 – 4.8 1.2 – 3.1 1.5 – 5.9
Page et al., 2000 (*376*)		Cohort study N = 9237	Non-Prisoner of war Pacific POW Pacific European POW	CMM mortality	Age, officer status, regular army status	OR = 1.04 OR = 3.35 OR = 2.76	0.09 – 11.94 0.39 – 28.76 0.31 – 24.81
Pfahlberg et al., 2001 (*377*)	Germany	Case-control Cases: n = 603 Controls: n = 627	Frequency of sunburns: Whole life Childhood Adulthood	Cutaneous malignant melanoma	Study centre, ethnic origin, age, sex	 OR = 3.07 OR = 2.01 OR = 2.09	 1.73 – 5.59 1.18 – 3.49 1.35 – 3.35
Robsahm and Tretli, 2001 (*378*)	Norway	Case-control Cases: n = 13934 Control:n = 130,507	Residence history ≤ 17 and >17 yrs – high sun radiation (H), medium sun radiation (M); low sun radiation (L)	Cutaneous malignant melanoma	Age, sex, birth cohort, period of diagnosis, level of education and type of work	H – H = 1.0 H – M = 0.89 M – H = 0.73 M – M = 0.69 M – L = 0.44 L – M = 0.54 L – L = 0.43 L – H = 0.70 H – L = 0.73	Reference 0.68 – 1.2 0.63 – 0.85 0.67– 0.73 0.23 – 0.82 0.35 – 0.81 0.39– 0.46 0.57 – 0.86 0.41 – 1.3
Scotto and Fears, 1987 (*379*)	USA	Ecologic	UVB levels	CMM incidence	Increasing UVB is associated with increasing melanoma incidence across the United States (slope 0.7 cases per 100,000 per year per 10^4sunburn units, for males; 0.8 for females, $p<0.05$). Slope is steeper for sun-exposed sites.		
Siskind et al., 2002 (*380*)	Queensland, Australia	Case-control Cases: n = 1263 Controls: n=3111	Childhood sun exposure Av. Daily sun exposure since age 20y Six or more sunburns NMSC before or at diagnosis	CMM and relatives with CMM	Analysis within family strata, adjusted for age. Also adjusted for skin colour, hair colour, propensity to burn in the sun, naevus density	OR = 1.15 OR = 1.52 OR = 1.31 OR = 1.26	1.07 – 1.25 1.27 – 1.83 1.08 – 1.58 1.02 – 1.55
Solomon et al., 2004 (*381*)	Seattle, USA	Case-control Cases: 386 Controls: 727 Age: 35 – 74 yrs	Lifetime UVR exposure (highest vs lowest quartile) UVR exposure-1-10 yrs UVR exposure-11-20yrs UVR exposure-21-30yrs UVR exposure-31-40yrs UVR exposure-41-74yrs	Primary cutaneous malignant melanoma	Age, sex, income , tendency to burn and sunburns aged 2-10 years	OR (F) = 1.99 OR(M) =1.24 OR(F) = 2.14 OR(M) =1.34 OR(F) = 2.33 OR(M)= 1.19 OR(F) = 1.42 OR(M)= 1.03 OR(F) = 1.80 OR(M)= 1.74 OR(F) = 1.14	0.95 – 3.03 0.62 – 1.86 1.08 – 3.20 0.65 – 2.03 1.19 – 3.46 0.60 – 1.78 0.71 – 2.12 0.52 – 1.55 0.93 – 2.67 0.83 – 2.65 0.31 – 1.98

						OR(M)= 0.81	0.19 – 1.44
Sorahan and Grimley, 1985 (*382*)	UK	Case-control Cases: n = 58 Controls: n = 333 Age: 20-70	Bouts of painful sunburn 1-4 cf none 5+ cf none Holidays abroad in hot climate: 1-4 cf none 5-20 cf none 21+	Cutaneous malignant melanoma	Age, sex, no. moles on right forearm, burning after 30min exposure to midday sun	 OR = 3.0 OR = 4.2 OR = 2.5 OR = 0.8 OR = 5.0	 p<0.01 p <0.01 p <0.01 p <0.01 p <0.01
Veierod et al., 2003 (*383*)	Norway and Sweden	Prospective cohort study N = 106379 Age: 30-50 years	Number of large asymmetric naevi on legs (≥7 vs 0) Hair colour (Red vs black) Sunburns per year (≥2 vs 0), aged: 10-19 years 20-29 years 30-39 years 40-49	Cutaneous malignant melanoma	Age, region of residence	RR = 5.29 RR = 4.05 RR = 2.42 RR = 1.69 RR = 1.71 RR = 0.96	2.33–12.01 2.11 – 7.76 1.46 – 4.02 1.04 – 2.76 1.06 – 2.76 0.41 – 2.27
Walter et al., 1999 (*384*)	Ontario, Canada	Case-control Cases: n = 583 Controls: n = 608 Age: 20-69	Beach vacation last 5y Severe sunburn last 5y Beach vacation at 12 y Outdoor activity days ages 10-20 y	Cutaneous malignant melanoma	Age, sex, skin reaction to initial summer sun exposure	OR = 1.04 OR = 1.28 OR = 1.67 OR = 0.67	0.82 – 1.32 0.97 – 1.69 1.31 – 2.12 0.52 – 0.86
Weinstock et al., 1989 (*385*)	USA	Cohort study (Nurses' Health Study	5+ sunburns 15-20 y 5+ sunburns 30+ y	Cutaneous malignant melanoma	Method of data collection	RR = 2.2 RR = 1.3	1.2 – 3.8 0.7 – 2.3
Weinstock et al., 1991 (*386*)	USA	Cohort study (Nurses' Health Study)	Summary indicator of sun sensitivity (sensitive vs not) Frequency of swimsuit use: in sun sensitive in sun resistant	Cutaneous malignant melanoma	Method of data collection, latitude of residence at 15-20 y.	 RR = 3.72 RR = 3.5 RR = 0.3	 1.86 – 7.42 1.3 – 9.3 0.1 – 0.8
Westerdahl et al., 1994 (*387*)	Sweden	Case-control Cases: n = 400 Controls: n = 640 Age: 15-75y	>5 sunburns <15y >5 sunburns 15-19 >5 sunburns>19y Outdoor employment during summer Vacations in sunny places No. sunburns per year (≥3 cf 0)	Cutaneous malignant melanoma	Raised naevi, red hair colour, blond/fair hair colour	RR = 1.0 RR = 0.9 RR = 2.2 RR = 0.8 RR = 1.2 RR = 1.9	Ns ns 1.1 – 4.1 0.6 – 1.0 0.8 – 1.8 1.0 – 3.4
White et al., 1994 (*388*)	Washington State, USA	Case-control Cases: n = 256 Controls: n = 273 Age: 25-65 y	Av. Annual sun exposure in last 10yrs Lifetime occupational sun exposure Sun exposure index: at ages 2-10 yrs at ages 11-20 yrs Skin reaction to acute sun exposure (severe burn cf tan)	Cutaneous malignant melanoma	Age, sex, education	OR = 0.88 OR =0.64 OR =0.43 OR =0.50 OR = 5.68	0.47 – 1.64 0.33 – 1.23 0.27 – 0.68 0.30 – 0.83 2.56 – 12.6
Whiteman et al., 1997 (*389*)	Queensland, Australia	Case – control Cases: n = 52 Controls: n = 156	>10 naevi >5mm diameter Heavy facial freckling Inability to tan	Cutaneous malignant melanoma	Matched on age, school, sex	OR = 9.9 OR =6.4 OR =8.8	2.5 – 38.9 1.9 – 21.6 2.1 – 36.2

		Age <15 y	Family history Peeling sunburns Total cumulative UV			OR =4.2 OR =1.4 OR =1.1	1.9 – 9.3 0.6 – 3.1 0.3 – 3.8
Wolf et al., 1998 (*390*)	Austria	Case-control Cases: n = 193 Controls: n = 319 Age: 21-89 yrs	Medium skin colour (cf light) Use of sunscreen (often cf rarely) No sunburn: >30 sunbaths (cf <20) Yes sunburn: >30 sunbaths (cf <20)	Cutaneous malignant melanoma	Age, sex	OR = 0.63 OR = 2.32 OR = 0.09 OR = 0.78	0.41 – 0.99 1.36 – 3.97 0.02 – 0.39 0.35 – 1.74
Zanetti et al., 1992 (*391*)	Italy	Case-control Case: n = 260 Control = 416 Mean age =55	History of sunburns in childhood Severe sunburns lifelong	Cutaneous malignant melanoma	Sex, age	OR = 6.5 OR = 1.5	3.4 – 12.3 0.8 – 2.7 p for trend = 0.04
Zaridze et al., 1992 (*392*)	Moscow	Case-control Cases: n = 96	Sunbathing at age 18-20 (often vs very rarely)	Cutaneous malignant melanoma	Skin colour, freckles on arms, raised naevi on arms, naevi on trunk (diameter >6mm), oral contraceptive use	OR = 3.35	0.64 – 17.37 p for trend = 0.03
3.2 Cancer of the lip							
Levi et al., 1997 (*99*)	Switzerland	Follow-up N = 4639	Previously diagnosed SCC of the skin	Cancer of the lip	Standardized incidence ratio for cancer of the lip = 3.1 (also increased risk of BCC, melanoma and lung cancer)		
3.3 and 3.4 Non-melanoma skin cancer							
Altman et al., 1987 (*393*)	Texas, USA	Case series		BCC in black patients	Mainly seen in sun-exposed regions		
Araki et al., 1999 (*394*)	Japan	Cross-sectional	Severe sunburn in childhood	Actinic keratoses	Prevalence Exposed = 256.2/100,000 Unexposed = 78/100,000		
Aubry and MacGibbon, 1985 (*395*)	Montreal, Canada	Case-control Cases: 306 Controls: 610 Men: 68.1 yrs Women = 72.7 yrs	Sunlight exposure	Squamous cell carcinoma of the skin	Occupational sun exposure (high vs low) Fitted RR = 1.58 Non-occupational sun exposure (high vs low) RR = 1.64		
Corona et al., 2001 (*396*)	Italy	Case-control Cases: n = 166 Controls: n = 158	Mean number of weeks spent at the beach before age 20 3-4 wks 5-8 wks >8wks	BCC		 OR = 1.8 OR = 3.7 OR = 4.5	 0.8 – 4.4 1.5 – 9.0 1.9 – 10.5
Dubin et al., 1990 (*353*)	New York, USA	Case-control Cases: n = 75 Controls: n = 527	Occupational sun exposure Recreational sun exposure Overall sun exposure	NMSC or solar keratoses	Age, sex	OR = 0.17 OR = 1.81 OR = 2.01	0.0 – 1.8 0.8 – 4.3 0.9 – 5.3
English et al., 1998 (*397*)	Geraldton, Western Australia	Case-control Cases = 132 Controls = 1031 Age:40-64 years	Total accumulated hours of sun exposure: All sites Site-specific	Squamous cell carcinoma	Age, sex, year of interview, ability to tan and propensity to burn	 OR = 1.4 OR = 1.2	 0.70 – 2.8 0.46 – 2.9
English et al., 1998 (*398*)	Geraldton, Western	Case-control Cases = 145	Elastosis of the neck	Squamous cell carcinoma	Age, sex, year of interview, facial solar lentigines, facial telangiectasia, solar keratoses	OR = 5.0	1.4 – 18 (p for trend<0.001)

	Australia	Controls = 1458 40-64 years	Cutaneous microtopography			OR = 3.5	1.3 – 9.7 (p for trend<0.001)
Gallagher et al., 1995 (*399*)	Canada	Case-control Cases: n = 226 Controls: n = 406	Sunburn (5 – 15 y) Sunburn, pain≥2 days (5-15y) Mean recreational sun exposure per year (0-19y) Mean cumulative sun exposure per year (lifetime)	BCC	Age, mother's ethnic origin, skin colour, hair colour	OR = 1.6 OR = 4.5 OR = 2.6 OR = 1.3	1.0– 2.7 1.7 – 12.3 1.1 – 6.5 0.7 – 2.4
Gallagher et al., 1995 (*400*)	Canada	Case-control Cases: n = 180 Controls: n = 406 Age: 25-79y	Sunburn (5 – 15 y) Sunburn, pain≥2 days (5-15y) Mean recreational sun exposure per year (0-19y) Mean cumulative sun exposure per year (lifetime) Occupational sun exposure (last ten years)	SCC	Age, mother's ethnic origin, hair colour and skin colour	OR = 0.6 OR = 10.5 OR = 1.6 OR = 1.0 OR = 4.0	0.6 – 1.4 2.9 – 38.0 0.6 – 4.5 0.4 – 2.1 1.2 – 13.1
Green et al., 1996 (*401*)	Nambour, Queensland, Australia	Cohort study N = 2095 Age: 20-69	Elastosis of the neck Solar lentigines on hand Occupational sun exposure Leisure time sun exposure No. painful sunburns	SCC BCC SCC BCC SCC BCC SCC BCC SCC BCC	Sex, age	OR = 5.92 OR = 2.20 OR = 1.96 OR = 3.14 OR = 1.37 OR = 1.25 OR = 1.29 OR = 0.85 OR = 3.28 OR = 1.68	2.36 – 14.84 1.46 – 3.32 0.76 – 5.02 1.82 – 5.42 0.80 –2.34 0.88 – 1.78 0.66 – 2.52 0.59 – 1.21 1.41 – 7.59 1.10 – 2.57
Grodstein et al., 1995 (*402*)	USA	Prospective cohort N = 107,900 Age: 30-55 y	Lifetime number of sunburns Regular time outdoors Region of residence (Florida vs Northeastern US)	SCC	Age, cigarette smoking, tendency to sunburn, number of moles, hair colour.	RR = 2.4 RR = 0.9 RR = 2.1	1.5 – 4.0 0.6 – 1.2 1.1 – 3.9
Hogan et al., 1990 (*403*)	Canada	Case-control Cases: n = 178 Controls: n = 284	History of severe sunburn	SCC		RR = 1.36	1.06 – 1.76
Hunter et al., 1990 (*110*)	USA	Prospective cohort	Location of residence California cf Northeast Florida cf Northeast	BCC	Age, time period, time spent outdoors, sunscreen habit, hair colour, childhood tendency to sunburn, lifetime number of severe and painful sunburns on face or arms.	 RR = 1.51 RR = 2.03	 1.25 – 1.83 1.46 – 2.83
Kennedy et al., 2003 (*368*)	Leiden, The Netherlands	Case-control Cases: n = 580 Controls: n = 386 30 – 80 years	Lifetime sun exposure Painful sunburn: 0-19 years	SCC Nodular BCC (nBCC) Superficial multifocal BCC (sBCC) SCC	Age, sex, skin type	OR = 6.5 OR = 2.3 OR = 1.6 OR = 1.5	1.7 – 25.6 0.96 – 5.7 0.56 – 4.4 0.97 – 2.3

			20-39 years	nBCC sBCC SCC		OR = 1.6 OR = 2.6 OR = 1.1	1.1 – 2.2 1.7 – 3.8 0.73 – 1.7
			40-59 years	nBCC sBCC SCC nBCC sBCC		OR = 1.2 OR = 1.0 OR = 0.84 OR = 1.5 OR = 0.90	0.86 – 1.7 0.66 – 1.5 0.37 – 1.8 0.86 – 2.4 0.44 – 1.8
Kricker et al., 1991 (*102*)	Geraldton, Western Australia	Case-control Cases = 226 (BCC); 45 (SCC) Controls = 1015 40-64 years	Elastosis of the neck Cutaneous microtopography Elastosis of the neck Cutaneous microtopography	SCC BCC	Age, sex, age at arrival in Australia, ethnicity, freckling	OR = 3.33 OR = 1.88 OR = 3.96 OR = 2.15	1.23 – 9.04 0.72 – 4.90 1.58 – 9.93 0.99 – 4.70
Kricker et al., 1995 (*111*)	Geraldton, Western Australia	Case-control Cases = 201 Controls = 700 40-64 years	Increasing intermittency of sun exposure at ages 15 – 19 years Lifetime hours of sun exposure with site exposed	BCC	Age, sex, ability to tan and total sun exposure	OR = 3.86 OR = 1.85	1.93 – 7.75 1.09 – 3.13
Kricker et al., 1995 (*404*)	Geraldton, Western Australia	Case-control Cases = 192 Controls = 700 40-64 years	Total hours of sun exposure to the anatomic site	BCC	Dose response curve with peak risk around 5000 hours		
Kromberg et al., 1989 (*103*)	Johannesburg, South Africa	Cross-sectional n = 111	Albinism Sun exposure	SCC and BCC	Albinos in South Africa have approximately 1000 times increased risk of developing skin cancer compared to the black pigmented population.		
Milan et al., 2002 (*405*)	Finland	Twin study	MZ vs DZ twinship	CMM and NMSC	SIRMZ/SIRDZ CMM = 1.7 (1.0-2.9) NMSC = 1.4 (0.7-2.5), ie environmental factors most important in causation		
Robinson and Rademaker, 1992 (*114*)	Illinois	Cohort N = 61 Age 50-68 y	Sun exposure index (an index of approach to sun exposure following surgery for previous skin cancer)	Development of BCC	Significantly higher development of new BCC in patients with high sun exposure. High sun exposure was highly correlated with low CD_4/CD_8 ratio. Numbers of prior BCC and current sun exposure were the strongest predictors of development of new BCC.		
Rosso et al., 1996 (*406*)	Spain, France, Italy	Case-control BCC: n = 1549 SCC: n = 228 Controls: n=1795	Age at first sunburn No. sunburns in lifetime Outdoor work in lifetime Holidays at beach Water sports in lifetime	BCC SCC BCC SCC BCC SCC BCC SCC BCC SCC	Age, sex, centre	OR = 1.45 OR = 1.35 OR = 1.05 OR = 0.94 OR = 1.00 OR = 1.6 OR = 1.47 OR =0.92 OR = 1.47 OR = 1.43	1.0– 2.12 0.62 – 2.97 0.86 – 1.42 0.55 – 1.62 0.78 – 1.30 1.04 – 2.47 1.18 – 1.84 0.82 – 1.04 1.04 – 2.07 0.73 – 2.79
Suzuki et al., 1996 (*407*)	Japan	Ecologic	UVB levels	BCC, actinic keratoses, SCC	Incidence rate of BCC, SCC and AK five times higher in the southern part of Japan than in the north, with average daily UV dose 1.8 times higher in Miyazaki (south) than in Kobe (mid); and Sapporo (north) 0.53 times lower than Kobe.		
Vitasa et al., 1990 (*408*)	Maryland, USA	Cross-sectional n = 808	Cumulative UVB exposure Above/below median	BCC		OR = 0.69	0.31 – 1.53

		Age: 30+	Upper quartile/lower 3 quartiles	SCC BCC SCC		OR = 2.05 OR = 1.11 OR = 2.53	0.84 – 5.01 0.50 – 2.44 1.18 – 5.40
Zanetti et al., 1996 (*409*)	South Europe	Case-control Cases (BCC)= 1549 Cases (SCC) = 228 Controls = 1795	Number of sunburns in a lifetime Age at first sunburn	BCC SCC BCC SCC	Age, sex, hair colour, eye colour, skin reaction to sun exposure and study centre	OR = 1.30 OR = 0.54 OR = 1.68 OR = 1.26	0.95 – 1.78 0.24 – 1.21 1.17 – 2.39 0.56 – 2.80
3.5 Sunburn							
Hall and Rogers, 1999 (*116*)	USA	Cross-sectional N = 1583	Sun sensitivity, use of protective measures	Sunburn	Sex, age, poverty index, education	Higher melanin content of skin in African Americans (cf whites) gives an estimated SPF of 13.4. But about 6% of African Americans report extreme sun sensitivity and history of severe sunburn.	
3.6 Chronic sun damage (photoageing)							
Gallagher et al., 1991 (*123*)	Vancouver, Canada	Cross-sectional N = 1592 Age: 6-18 years	Ethnic origin – white, Asian, Indo-Pakistani	Melanocytic nevus density	At all ages, melanocytic nevus density was lower in Asians and Pakistanis than in white persons. Risk factors for high melanocytic nevus density in white populations were history of numerous sunburns, lighter skin colour, sun sensitivity. These risk factors were not apparent in Asian or Pakistani children.		
Green, 1991 (*410*)	Nambour, Australia	Cross-sectional N = 1539 Age: 20-55 years	Age Past history of skin cancer Outdoor occupation	Premature ageing of the skin	Strong correlation with increasing age ($p<0.01$) Correlation with solar keratoses or previous skin cancer, after controlling for age ($p<0.05$) Correlation with outdoor occupation in men ($p<0.01$)		
Holman and Armstrong, 1984 (*124*)	Western Australia	Case-control N (cases) = 511 N (controls)=511	Duration of residence of migrants	Melanocytic naevi	Trend toward higher proportion of persons with 1-4 or 5 or more naevi in those who had arrived in Australia before 10 years of age, compared to those who had arrived at an older age ($p = 0.009$).		
Singer et al., 1994 (*121*)	USA	Cross-sectional N = 120 Age: 43 – 81	Time spent driving an automobile	Degree of photodamage to the face	Weak, but significant correlation ($r = 0.22$, $p = 0.15$) between time spent in automobile as a driver and asymmetrical facial photodamage. No apparent increase associated with driving with the window open, suggesting an important UVA effect on photodamage.		
3.7 Photodermatoses							
Darvay et al., 2001 (*127*)	UK	Retrospective record analysis N = 2715	UV filter use	Positive photopatch test	Photoallergic dermatitis is rare and occurs in association with use of UV filters, such as PABA. Patients with photodermatoses are at increased risk of developing photoallergy		

Table A1.7 Summary of studies reviewing other UVR effects on human health

Reference	Study type	Results
4. Vitamin D production		
Beadle et al., 1980 (*411*)	Cohort	In ten normal subjects, serum vitamin D levels correlated well with serial estimates of personal UVR dose.
Calvo et al., 2005 (*412*)	Review	Vitamin D inadequacy is widely documented. Vitamin D intakes worldwide are often too low to sustain healthy vitamin D levels, even in countries where there is mandatory fortification of foods.
Chatterjee, 2001 (*413*)	Review	Vitamin D receptors (VDRs) are found in liver, kidney, breast, colon, cardiac muscle, thyroid, brain, pancreas, pituitary, skin muscle, placenta, immune cells, parathyroid and others. Some of the actions of vitamin D may be mediated via non-genomic mechanisms and thus not require binding to the VDR. At physiological concentrations, vitamin D protects cell proteins and membranes against oxidative stress. Also induces apoptosis in most cancer cells, stabilizes chromosomal structure and prevents DNA breaks. Reviews important role of vitamin D in cancer development.
Deluca and Cantorna, 2001 (*414*)	Experimental	Vitamin D3 can prevent or markedly suppress experimental autoimmune encephalomyelitis (EAE, an animal model for multiple sclerosis), rheumatoid arthritis, systemic lupus erythematosus, type 1 diabetes and inflammatory bowel disease in animal models.
Dusso et al., 2005 (*151*)	Review	
Giovannucci, 2005 (*199*)	Review	Ecologic evidence for a beneficial role of vitamin D on total cancer mortality and survival after diagnosis. Substantial epidemiological evidence of a protective effect for risk of colorectal cancer; sparse data of a protective effect on breast cancer. Biological plausibility but insufficient epidemiologic evidence of a protective effect for prostate cancer.
Holick, 1994 (*137*)	Review	Review of the formation and requirements of vitamin D. There is increasing evidence of the importance of vitamin D in maintaining bone health, particularly in the elderly. Vitamin D production by the skin is influenced by season, time of day of exposure, latitude, aging, sunscreen use and skin pigmentation.
Holick, 2003 (*415*)	Review	Major function of vitamin D is to maintain calcium homeostasis by increasing the efficiency of the intestine to absorb dietary calcium. Inadequate dietary calcium causes vitamin D-induced enhancement of osteoclast activity to dissolve calcium stored in bone. However, vitamin D receptors (VDR) are also present in the brain, heart, stomach, pancreas, activated T and B lymphocytes, skin and gonads. Vitamin D is anti-proliferative and chronic deficiency may be associated with increased risk of hypertension, multiple sclerosis, cancers of the colon, breast, ovary and prostate and type 1 diabetes.
Holick, 2004 (*416*)	Review	Sunscreens efficiently absorb UVB and when used properly (2mg/cm^2) a sunscreen with an SPF of 8 reduced cutaneous production of vitamin D_3 by >95%.Vitamin D deficiency during bone development causes rickets and during adulthood contributes to the development of osteoporosis. Risk factors for vitamin D deficiency include: obesity, exclusive breastfeeding, elderly, deeply pigmented skin, indoor living. Intervention studies in animals show that vitamin D administration in early life prevents the development of type 1 diabetes, multiples sclerosis and rheumatoid arthritis. Follow-up and intervention studies in humans indicate a protective effect of supplemental vitamin D intake for type 1 diabetes and a decrease in diastolic and systolic blood pressure with increased UVB exposure (but not with UVA exposure). Vitamin D inadequacy implicated as a risk factor for several cancers.
Mason and Diamond, 2001 (*145*)		Vitamin D deficiency not uncommon in elderly Australians, particularly those in institutions due to reduced mobility, limited sunlight exposure and the assiduous use of sun-protection agents and the reduced ability of aged skin to produce vitamin D from a given dose of UV light. Another at-risk group are dark-skinned or veiled women and their babies.
Matsuoka et al., 1988 (*146*)	Cross-sectional	Chronic sunscreen use was associated with significantly lower mean serum vitamin D levels (40.2 ± 3.2 nmol/L) than age-matched controls (91.3 ± 6.2nmol/L).
Mosekilde, 2005 (*417*)	Review	Vitamin D deficiency is common among community-dwelling elderly in developed countries at higher latitudes and particularly among institutionalized elderly, due to atrophic skin changes and diminishing renal production. Vitamin D deficiency is a risk factor for osteoporosis, falls and fractures due to effects on both bone and muscle; treatment with vitamin D reduces these risks. There is insufficient evidence of causality for the association between vitamin D insufficiency and cancers of the breast, prostate and cancer and with type 2 diabetes. However there is sufficient evidence of an association with hypertension – RCT evidence that vitamin D treatment (in combination with calcium) reduces blood pressure in the elderly.
Peterlik and Cross, 2005 (*418*)	Review	Because of differential regulation of renal and extra-renal 25-hydroxyvitamin D-1α-hydroxylase activity, even moderately low serum levels of 25(OH)D_3 can cause alterations of specific cell functions in multiple organ systems with extra-renal VDRs. Author suggests there is sufficient evidence, especially biological plausibility, but supported by epidemiological studies, for a causal association with cancers of the colon, rectum, breast and prostate and perhaps others. Vitamin D also has a plausible protective effect on the development of tuberculosis, inflammatory bowel diseases, multiple sclerosis, rheumatoid arthritis, type 1 diabetes and the metabolic syndrome.
4.1.1 Rickets, osteomalacia, osteoporosis		
Agus, 1999 (*419*)	Review	Cutaneous vitamin D production declines with age; common in winter and in dark-skinned people and prevalent in adult populations in US.
Binet and Kooh, 1996 (*420*)	Cross-sectional	17 cases vitamin D deficiency rickets 1988-1993 in Toronto, Canada. All in children of African-Asian origin, exclusively breast-fed, no vitamin D supplementation and little or no sunlight exposure.
Blok et al., 2000 (*421*)	Case studies	Vitamin D deficient children in Auckland, NZ – 12 of 18 (in 1998) of Indian ethnic origin; remainder Maori or Islander, presented with signs of rickets
Ekanem et al., 1995 (*422*)	Case series	20 cases of nutritional rickets in Calabar, Nigeria associated with higher SES – children sun-deprived as they were inside while the parents were at work. Generally low prevalence of rickets in Calabar due to high dietary intake (coastal city).

Holick, 2001 (*139*)	Review	Relationship between rickets and lack of UVR exposure first recognised in 1822 and rickets was first treated with sunlight exposure 100 years later. In addition to rickets, secondary hyperparathyroidism and bone resorption can precipitate or exacerbate osteoporosis, while phosphaturia decreases serum phosphate and causes a mineralisation defect that may lead to osteomalacia. Muscle pain and weakness may also be associated with lower levels of vitamin D insufficiency and deficiency.
Kreiter et al., 2000 (*423*)	Case series	Vitamin D deficiency rickets in African American infants associated with being breast-fed, not receiving vitamin D supplements and low sun exposure of mothers and infants.
Lips, 2001 (*149*)	Review	Vitamin D deficiency causes secondary hyperparathyroidism, high bone turnover, bone loss, mineralization defects and hip and other fractures and possibly myopathy and falls. Vitamin D is formed less readily following UVB exposure in the elderly. The consequences of an indoor lifestyle may be less in the USA than elsewhere because of the fortification of certain food.
Narchi et al., 2001 (*424*)	Case reports	Adolescents in Saudi Arabia with low sun exposure and dietary vitamin D developed rickets.
Shaw and Pal, 2002 (*138*)	Review	Vitamin D has effects on skeletal muscle, the immune system possibly the central nervous system (through induction of proteins including nerve growth factor). Deficiency has been implicated as a risk factor for type 1 diabetes, ischaemic heart disease and tuberculosis in Asian populations in high latitude countries such as Britain. Deficiency is not uncommon among dark-skinned populations in high latitude regions and in newborn breast-fed infants whose mothers are vitamin D deficient. Asian populations may have a genetic predisposition to vitamin D deficiency with exacerbation of deficiency during high growth periods such as in early childhood, adolescence, pregnancy and lactation.
Zlotkin, 1999 (*425*)	Case report	12 month old white infant in Toronto, Canada diagnosed with rickets following active sun avoidance and use of strong sunscreen.
4.1.2 Tuberculosis		
Cadranel et al., 1988 (*159*)	Case report	Cultured alveolar macrophages obtained by bronchoalveolar lavage from a patient with tuberculosis synthesized 1,25 OHD_3. This extrarenal production of vitamin D3 may have contributed to the hypercalcemic observed in this patient.
Crowle et al., 1987 (*157*)	Experimental	Macrophages derived from cultured blood monocytes and infected with Mycobacterium tuberculosis bacilli were exposed to 1,25 D3. Growth of bacilli was inhibited by 1,25 D3 even when this was added three days after infection. Macrophages have vitamin D receptors and can convert 25(OH)D to 1,25 D_3.
Lewis et al., 2005 (*426*)	Meta-analysis	Hypovitaminosis D has been implicated as a risk factor for tuberculosis; with possible genetic susceptibility involving the VDR gene. Meta-analysis of several case control studies examining associations between VDR polymorphisms and TB risk was inconclusive.
Ness et al., 1999 (*152*)	Review	Reviews the adverse and possible beneficial effects of sun exposure, including historical use of heliotherapy for the treatment of cutaneous tuberculosis, effects on coronary heart disease, mental health and vitamin D mediated effects.
Rockett et al., 1998 (*155*)	Experimental	In a human cell line differentiated to a macrophage-like phenotype, 1.25 D3 suppresses the growth of Mycobacterium tuberculosis, possibly through vitamin D-induced NO production.
Roelandts, 2005 (*153*)	Review	Reviews the pioneering work of Niels Finsen including the use of heliotherapy in the successful treatment of tuberculosis.
Rook et al., 1986 (*158*)	Experimental	1,25 OHD3 inhibited the growth of mycobacterium in cultured macrophages with additive effects with those of interferon gamma.
4.2 Cancers		
Ainsleigh, 1993 (*427*)	Review	Sunlight most important for adequacy of vitamin D levels; some support for an association between low sun exposure and increased risk of breast cancer, colon cancer, NHL, progression of CMM.
Garland et al., 2006 (*428*)	Systematic review	Observational and ecological studies generally support an important increased risk of prostate, ovarian, breast and colon cancer associated with low vitamin D or sunlight exposure. Vitamin D insufficiency is common, particularly in deeply pigmented populations and cancer outcomes tend to be worse in the latter. Genetic studies indicate an increased cancer risk in those with the bb genotype associated with lower circulating $1,25(OH)_2D$ and with some VDR genotypes. There are a number of plausible biological pathways by which vitamin D could be protective for cancer risk.
Giovannucci, 2005 (*199*)	Review	Ecological studies (regional UVB), winter season of diagnosis and associations of higher total cancer mortality with obesity and African American status (all associated with lower circulating vitamin D) are compatible with a protective role for adequate vitamin D for overall cancer mortality. Suggestive evidence for a protective effect in individual studies for colorectal cancer; limited data for breast and prostate cancers.
McCarty, 2000 (*429*)	Review	Proposes possible causal chain from low vitamin D, via increased parathyroid hormone production to cancer promotion.
4.2.1 Non-Hodgkins Lymphoma		
Cliff and Mortimer, 1999 (*430*)	Case series	Six cases in which diagnosis of NHL predated a diagnosis of SCC with localization to the head and neck. Authors suggest sunlight as a common etiological agent.
Cartwright et al., 1994 (*163*)	Review	Increasing incidence of NHL may be associated with increased recreational exposure to sunlight and UVR. Supporting epidemiological evidence includes the association with non-melanoma skin cancer and the similar geographic pattern of these diseases; increasing incidence primarily in countries with a predominantly fair skinned population; high rates of HNL in farmers and agricultural workers; experimental data showing UVR effects on immune function.
McMichael and Giles, 1996 (*164*)	Review	Review of evidence linking NHL to increased sun exposure – UVR causes immune suppression; positive latitudinal gradient in NHL, some concordant shifts with CMM in migration studies.

4.2.2 Prostate cancer		
Ahonen et al., 2000 (*179*)	Case-control	Increased risk of prostate cancer with vitamin D levels below median, especially younger (<52) men Adj OR = 3.1 (1.6-6.1)
Feldman et al., 2000 (*431*)	Review	Mortality rates from prostate cancer vary inversely with latitude in US. Mixed findings suggesting low vitamin D levels are associated with increased risk of prostate cancer. Genetic polymorphisms in VDR gene may contribute to risk of prostate cancer. Epithelial cells of the prostate have VDRs.
Grant, 2004 (*432*)	Ecologic	In a multi-country ecologic study of prostate cancer mortality, the strongest risk factor was animal product intake, with low solar UVB as a weaker risk factor (based on prostate cancer mortality rates by country and annual solar UVB from European ground stations).
Hanchette and Schwartz, 1992 (*174*)	Ecologic	In 3073 counties of USA there is an inverse correlation between UVR and prostate cancer mortality, with lower rates in the South than in the North.
Krishnan et al., 2003 (*433*)	Review	Biological plausibility for a protective role of vitamin D on the development of prostate cancer. Vitamin D analogs may be useful in therapy and small trials have shown that $1,25(OH)D_3$ administration can slow the rise of prostate specific antigen in prostate cancer patients.
Lou et al., 2004 (*434*)	Review	VDR is present in prostate epithelial and cancer cells. $1,25(OH)_2D$ is able to inhibit growth of prostate epithelial and cancer cells. Vitamin D induces cell cycle arrest and apoptosis in prostate cancer lines – this action may be androgen dependent. 25(OH)D may be key to the regulation of cell proliferation in the prostate; lack of vitamin D action may occur due to vitamin D deficiency (eg diet, low sun exposure) or vitamin D resistance (enhanced 24-hydroxylast; VDR gene polymorphism, interaction with endogenous steroids).
Moon et al., 2005 (*435*)	Review	There is individual and ecological epidemiological evidence to support a protective role of vitamin D levels for the development of prostate cancer. Modest UVR exposure reduces the risk of prostate cancer and this reduction is mediated by skin type – at lower levels of UVR exposure, skin type 1 is protective for prostate cancer development, probably through enhanced vitamin D synthesis.
Ruijter et al., 1999 (*436*)	Review	Vitamin D important in the normal growth and function of the prostate, as well as in prostate carcinogenesis. Evidence for link with vitamin D/UVR: increase incidence with age and concomitant increase in vitamin D deficiency with age; higher incidence in blacks; increased incidence in migrant Asians as they adopt a Western diet (lacking in large amounts of fish oil); mortality demonstrates an inverse correlation with latitude. Also supportive experimental evidence.
Schwartz, 1992 (*437*)	Review	Mortality rates from MS and from prostate cancer show a north-south gradient in USA – similar to colon cancer, dental caries and Parkinson's disease. Author suggests a common aberration in vitamin D for these clinically dissimilar diseases via effects on associated proteins and immune function.
Schwartz, 2005 (*173*)	Review	Ecologic, experimental and some epidemiological studies support a role for vitamin D adequacy in the etiology and progression of prostate cancer.
Stewart and Weigel, 2004 (*438*)	Review	Vitamin D receptors and 1α-hydroxylase are expressed in the normal prostate epithelial cells; thus 25(OH)D can be converted locally to active $1,25(OH)_2D$. Strong ecological and experimental evidence but mixed epidemiological evidence for a protective role of UVB exposure/vitamin D intake in prostate cancer onset and progression. Early results of intervention studies using vitamin D analogs are promising.
Tuohimaa et al., 2001 (*439*)	Experimental	Full spectrum lighting exposure over 1 month did not increase 25(OH)D levels or change UCA production in skin. In rat and human prostates and prostate cancer cell lines vitamin D was actively metabolised and upregulated androgen receptor expression, while androgens upregulated vitamin D receptor. Vitamin D alone or with androgen suppressed epithelial cell proliferation.
4.2.3 Breast cancer		
Grant, 2002 (*183*)	Ecologic	Using ecologic data on breast cancer mortality (world age-standardized rates from WHO), diet (country level, from FAO) and latitude (as a proxy for solar UVB irradiation), the most important risk factor is the fraction of energy derived from animal products. Latitude is a weaker risk factor ($r = 0.66$, $p<0.001$ for all countries).
Welsh, 2004 (*440*)	Review	Animal studies using VDR knockout mice show that vitamin D (in physiological concentrations) inhibits proliferation and induces differentiation in the mammary gland. VDR ablation is associated with increased sensitivity to tumor genesis. 1α hydroxylase has been identified in normal mouse mammary glands and in benign and malignant human breast tissue; there may be local conversion of 25(OH)D to the active $1,25(OH)_2D$. 24-hydroxylase (which converts of 25(OH)D and $1,25(OH)_2D$ to inactive forms) is expressed in breast cancer cells.
4.2.4 Colon and colorectal cancer		
Emerson and Weiss, 1992 (*187*)	Ecologic	Incidence rates of colon and rectal cancer varied inversely with levels of solar UVR in men; similar but weaker trend for colon cancer in women (but not rectal cancer)
Gorham et al., 2005 (*441*)	Systematic review	Using data from observational studies, dose response relationships were developed. Individuals with oral intake of ≥1000IU/day or with serum 25(OH)D of ≥82nmol/L, had a 50% lower incidence or colorectal cancer compared to reference groups.
Harris and Go, 2004 (*442*)	Review	The protective effect of vitamin D supplementation may depend on calcium levels (and vice versa). Vitamin D has direct effects on colonic epithelium: regulation of growth factor and cytokine synthesis and signaling, modulation of cell cycle, apoptosis and differentiation.
Norat and Riboli, 2003 (*198*)	Review	Meta-analysis suggests that total dairy product and milk intake have independent protective effects no risk of colon cancer (OR = 0.62, 95% CI 0.52 – 0.74; OR = 0.80, 95% CI 0.68 – 0.95 respectively). The apparent protective effect of vitamin D may be related to a protective effect of increased calcium.
Tangpricha et al., 2001 (*443*)	Laboratory study of colonic	Risk of colon cancer is decreased three-fold in people with vitamin D levels greater than 20µg/L. The gene for 1α-hydroxylase that converts 25(OH)D to active $1,25(OH)_2D_3$ is expressed in human colonic tissue in different amounts in normal and malignant tissue. The colon's 1α-hydroxylase might be necessary to maintain colon cellular health.

	tissue	
4.3 Cardiovascular effects		
Zittermann et al., 2005 (*204*)	Review	Increasing latitude, low altitude, winter season and urban residence (vs rural) are associated with higher mortality from cardiovascular disease, as well as with lower vitamin D inducing UVB. There are plausible biological pathways whereby vitamin D adequacy could decrease risk of CVD – inhibition of vascular smooth muscle proliferation, suppression of vascular calcification, down regulation of pro-inflammatory cytokines, up regulation of anti-inflammatory cytokines and as a negative regulator of the rennin-angiotensin system. Further research is required.
4.3.1 Hypertension		
Krause et al., 1998 (*205*)	Intervention study	18 patients with mild untreated essential hypertension were randomised to treatment with UVB or UVA exposure. Treatment caused a significant reduction in systolic and diastolic blood pressure in the UVB ($p<0.001$) but not the UVA group and was associated with increased in vitamin D concentration.
Rostand, 1997 (*203*)	Review	There is a linear rise in blood pressure with increasing distance from the equator and BP is higher in winter than summer and is affected by variations in skin pigmentation. Hypothesise that decreased UVR exposure and lowered vitamin D levels stimulate changes in the vascular system that lead to hypertension.
4.3.2 Coronary heart disease		
Grimes et al., 1996 (*208*)	Ecologic study	Increased UVR exposure may lead to lower cholesterol levels through conversion of cholesterol to vitamin D, with subsequent decrease in coronary heart disease. Cholesterol levels are positively correlated with latitude ($p<0.001$) and death rates of CHD are negatively associated with hours of sunshine per annum.
Pell and Cobbe, 1999 (*206*)	Review	Coronary heart disease exhibits a winter peak and summer trough in incidence and mortality. CHD patients have significantly lower 25(OH)D levels in summer and winter, but seasonal variation in vitamin D levels may be less pronounced in CHD patients. There may be a threshold effect, with CHD risk decreasing from the bottom to second quartile of 25(OH)D, but plateauing thereafter.
4.3.3 Stroke		
Sato, 2000 (*211*)	Review	Vitamin D insufficiency or deficiency is common after stroke and is caused by a combination of inadequate dietary intake and reduced sunlight exposure. In the first year after stroke, 25(OH)D concentration is a determinant of bone mineral density in hands affected by the stroke. In the second year after stroke, 25(OH)D concentration was a determinant of bone mineral density on both affected ad unaffected hemiplegic sides.
4. Metabolic effects		
Boucher, 1998 (*444*)	Review	Reviews the evidence for vitamin D deficiency as a risk factor for syndrome X, and thus the increased risk of degenerative vascular disease and glucose intolerance. In experimental work, vitamin D deficiency is associated with decreased insulin secretion and glucose intolerance. Studies using vitamin D as an intervention in diabetes have shown mixed results.
5. Psychiatric disorders		
5.1 Seasonal affective disorder		
Mersch et al., 1999 (*218*)	Review	Review of the literature indicates that the mean prevalence of seasonal affective disorder (SAD) is twice as high in North America compared to Europe, but that there is no significant latitudinal variation in the prevalence of SAD over all studies ($r = 0.07$, $p = 0.42$). There is a latitudinal correlation within North America ($r = 0.90$, $p = 0.003$) and within Europe ($r = 0.70$, $p = 0.06$). Authors conclude that any latitudinal influence is weak. Other contributing environmental factors may be climate and the social and cultural environment. In addition there may genetic factors in the etiology.
5.2 Schizophrenia		
Davies et al., 2003 (*445*)	Systematic review	Significant excess of winter/spring births (versus summer/autumn births); pooled OR = 1.07 (1.05 – 1.08), population attributable risk = 3.3%. Positive correlation between season of birth and latitude, $r = 0.27$, $p<0.005$.
Eyles et al., 2003 (*446*)	Experimental	Low maternal vitamin D associated with alterations of neonatal brain in rats – cortex longer but not wider, enlarged lateral ventricles, cortex thinner and more cell proliferation throughout the brain.
Mackay-Sim et al., 2004 (*226*)	Review	Reviews recent work on candidate susceptibility genes in schizophrenia and propose that low vitamin D during brain development may have an important interaction with susceptibility genes. The nuclear hormone receptor regulates gene expression and there are neural vitamin D receptors.
McGrath and Castle, 1995 (*222*)	Review	There is modest support for an increased risk of schizophrenia for births after the 1957 influenza epidemic, although two cohort studies find no association. There is little support for an association with other influenza epidemics.
McGrath, 1999 (*220*)	Review and hypothesis	Vitamin D receptors are present in neural tissue and vitamin D is a potent inducer of nerve growth factor synthesis. There is an increased risk of schizophrenia with winter season of birth, and urban birth and an excess risk in second generation Afro-Caribbean migrants to the UK.

McGrath and Welham, 1999 (*224*)	Review	Indirect evidence linking low prenatal vitamin D levels with schizophrenia – season of birth, migrant studies, urban birth, intrauterine famine.
McGrath, 2001 (*223*)	Review	Overview of vitamin D and links to autoimmune diseases, schizophrenia and cancers.
6. Medication reactions		
Beggs, 2000 (*217*)	Review	174 products list photosensitivity as possible adverse reactions. Ozone depletion may worsen this problem.
Gocke et al., 1998 (*447*)	Review	Psoralene, chlorpromazine derivatives and fluoroquinolones are photomutagenic.
7. Indirect effects		
7.1 Effect on climate, food supply, disease vectors, atmospheric chemistry		
Zepp et al., 1998 (*448*)	Review	UVB has effects on mineral nutrient cycling in the terrestrial biosphere, eg changes in the chemical composition of living plant tissue, photodegradation of dead plant matter etc and in acquatic biogeochemical cycles.
Rousseaux et al., 1999 (*449*)	Observational	Damage to DNA in plants in southern South American temperate ecosystems associated with ozone loss.
Neale et al., 1998 (*450*)	Modeling	Photosynthesis of Antarctic phytoplankton inhibited by ambient UVR. Models of ozone depletion indicate this could worsen.
Häder et al., 1998 (*451*)	Review	Solar UVR affects growth and reproduction of aquatic phytoplankton as well as their photosynthetic pigment. Increasing UVR is likely to damage phytoplankton at the molecular, cellular, population and community levels but there are few convincing data. Phytoplankton damage may have consequences for the food web.

Table A1.8 Detailed summary of epidemiological studies examining other effects of UVR exposure, on human health

Study	Location	Design, N, Age	Exposure assessment	Outcome assessment	Adjusted covariates	Measure of effect	95% CI
4. Vitamin D production							
Andiran et al., 2002 (*141*)	Turkey	Cross-sectional 54 newborns and their mothers Mean age = 24.5 yrs	Low SES, Low maternal vitamin D levels Mother being covered; Low maternal educational level	Serum 25OHD levels		OR = 4.3 OR = 15.2 OR = 6.8 OR = 6.8	p = 0.090 p = 0.002 p = 0.011 p = 0.017
Atli et al., 2005 (*209*)	Turkey	Cross-sectional N = 420 Age: >65 years	Type of dwelling: Old age home vs own home	Vitamin D deficiency		40.1% 24.4%	
Bischof et al., 2002 (*452*)	South Africa	Case-control n = 20 6-29 years	Vitamin D levels	Long bone fractures	Significant elevation of PTH in those with long bone fracture (p = 0.02), but no significant difference in vitamin D levels:		
Brock et al., 2004 (*210*)	Sydney, Australia	Cross-sectional N = 185	Residential status Able to walk unaided (no, vs yes) Sun exposure (low vs adequate)	Vitamin D levels at the end of summer	Vitamin D levels were lowest in elderly persons in nursing homes (OR = 3, 95% CI 1.3 – 7.0), compared to hostel (OR = 2.3, 95% CI 1.2 – 4.3) or self care (reference). OR = 11.4 (5.6 – 23.0) OR = 3.0 (1.6 – 6.6)		
Du et al., 2001 (*142*)	Beijing, China	Cross-sectional N = 1248 girls Age 12-14 years	Diet, UV exposure	Vitamin D levels	Prevalence of clinical vitamin D deficiency was 9.4% in winter; of subclinical deficiency (<12.5nmol/L, asymptomatic) was 45.2% in winter and 6.7% in summer. Low winter vitamin D associated with low summer vitamin D and low calcium intake		
Gannage-Yared et al., 2000 (*453*)	Lebanon	Cross-sectional n = 316 Age: 30-50 yrs	Dietary Vitamin D Veil wearing Parity Rural or urban residence	Serum Vitamin D levels	High prevalence of vitamin D insufficiency (72.8%); Severe hypovitaminosis D in 30.7% with higher prevalence in veiled women. Inadequate intake, veil wearing, urban dwelling and high parity independent (p<0.05) predictors of vitamin D insufficiency.		
Glerup et al., 2000 (*150*)	Denmark	Cross-sectional (3 groups) n = 69 Mean ages: 32.2 – 36.1yrs	Sunlight exposure Dietary intake in 3 groups – Danish women; Danish Moslem women; Arab Moslem women	Serum vitamin D levels	High prevalence of symptomatic vitamin D insufficiency in veiled women (88% cf 32% Danish controls). Severe vitamin D deficiency in 85% of veiled Arab women living in Denmark. High oral intake among Danish Moslem women is insufficient to maintain normal serum vitamin D		
Gloth et al., 1995 (*147*)	Baltimore, USA	Cohort n = 244 Age: >65 yrs	Indoor confinement	Serum vitamin D levels	48% of sunlight-deprived subjects had vitamin D deficiency. Mean vitamin D level: 31.4 nmol/L in sunlight deprived group, cf 51.9nmol/L in ambulatory controls (p <0.001)		
Goswami et al., 2000 (*454*)	Delhi, India	Cohort study – 6 groups n (total) = 138 Age: all	Sunlight exposure, skin pigmentation, dietary intake.	Serum vitamin D levels	Mean 25(OH)D concentrations varied among the six study groups and were related to direct sunlight exposure and skin pigmentation – ie highest in a group of soldiers, lower in physicians and nurses. Depigmented group had higher vitamin D than physicians, nurses despite lower sun exposure.		
Hatun et al., 2005 (*455*)	Turkey	Cross-sectional n = 42 Age: <3 months	Maternal sunlight exposure; breast-feeding; use of supplemental vitamin D	25(OH)D levels	Vitamin D deficient infants were predominantly exclusively breast-fed and did not receive vitamin D supplements (83%); mothers had limited sunlight exposure and did not take vitamin D suppements		
Hirani and Primatesta, 2005 (*456*)	UK	Cross-sectional n = 1766 Age: >65 years	Institutionalization Gender (F vs M) Season (winter vs summer) Limiting long-standing illness Manual social class	25(OH)D levels		OR = 2.1 OR = 1.67 OR = 3.57 OR = 2.40 OR = 2.02	p<0.05 1.2 – 3.0 1.15 – 2.42 2.06 – 6.20 1.61 – 3.57

			BMI (<25kg/m² cf ≥25)				1.39 – 2.93
Ho et al., 1985 (*457*)	Beijing, China	Randomized controlled trial n = 54 Age: 1-8 months	Sunshine exposure	25(OH)D levels	Infants in the control and experimental groups had similar 25(OH)D concentrations at randomization. Sun-exposed infants had a greater rise in 25(OH)D than control infants (p<0.001).		
Inderjeeth et al., 2000 (*143*)	Hobart, Tasmania, Australia	Cross-sectional n = 109 (inpatient) Mean age 79 years (Range: 60 – 101) n = 52 (community) (Range: 64 – 88)	Hospitalisation vs community dwelling	Vitamin D deficiency	Subjects with vitamin D deficiency were older (80 vs 76 years, p<0.001), had lower BMI (p<0.001), poorer physical functional status (p = 0.02), lower activity levels (p<0.001) and less habitual sun exposure (p<0.001).		
Islam et al., 2002 (*144*)	Bangladesh	Cross-sectional N = 189, female Age: 16-40 years	Socioeconomic status (SES)	Vitamin D levels	17% of lower SES women and 12% of higher SES women had serum 25(OH)D <25 nmol/L; 50% of lower SES and 38% of higher SES women had vitamin D levels ≤ 37.5nmol/L. Lactation was a risk factor for hypovitaminosis D in both groups.		
Larsen et al., 2005 (*458*)	Denmark	Non-randomised intervention study	Vitamin D and calcium supplementation vs home safety inspection and dietary advice	Falls in the elderly	Age, marital status	RR = 0.88	0.79 – 0.98
Levis et al., 2005 (*459*)	South Florida, USA	Follow-up study	Season	25(OH)D levels	End of winter: 38% men and 40% women have vitamin D insufficiency; end of summer: 22% have vitamin D insufficiency. 14.8% summer increase in levels in men; 13% increase in women		
McGrath et al., 1993 (*148*)	Auckland, New Zealand	Retrospective case review N = 50 Age: 14-97 years	Pre-existing medical conditions Elderly immobile	Severe vitamin D deficiency	44% of patients were elderly immobile; Patients were more likely to be resident in a private hospital or rest home (55% cf 21%, p<0.01) and 86% were either housebound or had reduced mobility. Severe hypovitaminosis D does occur even at low latitude in association with poor diet and inadequate sun exposure.		
Muhe et al., 1997 (*460*)	Ethiopia	Case-control	Rickets	Pneumonia	Weight, breastfeeding, family size	OR = 13.37	8.08 – 24.22
Nozza and Rodda, 2001 (*461*)	Melbourne, Australia	Case series	Maternal vitamin D levels and country of origin	Vitamin D deficiency	55 children treated for Vitamin D deficiency over 5 years. Mothers were from Africa, India/Pakistan, the Middle East and Italy. Only mother of European descent suffered from agoraphobia and depression.		
Nurmi et al., 2005 (*462*)	Finland	Prospective n = 223 Age:38-96 years	Vitamin D levels	Hip fracture	Hypovitaminosis D (<37.5nmol/L) in 53% of patients with hip fracture, with severe (<20nmol/L) in 9%. Residential status and hypovitaminosis D: own home – 50%; residential homes – 55%; institutionalized – 61%.		
Ono et al., 2005 (*463*)	Japan	Cross-sectional studies n = 197 Age: 43.3±12.7 yrs	Season	Vitamin D levels	Prevalence of hypovitaminosis D (<20ng/ml) 86.7%, 33.4%, 1.0% and 26.0% in March, June, September and December respectively. Serum OH(D) higher in men than women (p<0.001); with higher body weight (p = 0.009) and higher BMI (p = 0.001).		
Pasco et al., 2001 (*140*)	Geelong, Australia	Cross-sectional n = 861 Age: 20.2 – 91.9	Dietary vitamin D intake Sunbathing frequency	25(OH)D levels	Dose response relationship in serum 25(OH)D levels for sunbathing frequency. Winter 25(OH)D levels, but not summer levels, dependent on oral intake.		
Sachan et al., 2005 (*464*)	Lucknow, India	Cross-sectional n = 207 pregnant women; 117 newborns	Urban/rural residence Sun exposure in last trimester	Vitamin D levels	84% of both rural and urban women had hypovitaminosis D (<22.5ng/ml 25(OH)D). Sun exposure in last trimester higher in rural women (p<0.001), but no difference in mean 25(OH)D levels. High correlation between maternal 25(OH)D and cord blood 25(OH)D (r = 0.79, p<0.001).		

Saraiva et al., 2005 (*465*)	Sao Paulo, Brazil	Cross-sectional studies n = 214 Mean age: 79.1 years (SD 5.9 yrs)	Season Skin colour	Vitamin D levels	Greatest difference in 25(OH) D levels between autumn (mean = 59.1 nmol/L) and spring (mean = 43.7nmo/L) No significant difference between blacks and non-blacks in 25(OH) D levels High correlation between 25(OH)D levels and UVR of the preceding season (r = 0.98)		p = 0.02 p = 0.66
Sullivan et al., 2005 (*466*)	Bangor, Maine, USA	Prospective cohort n = 23 Age: 9-11 years	Season	Vitamin D levels	48% had hypovitaminosis D (<50nmol/L) at some time during the three year study period. No significant year-to-year difference in overall serum 25(OH)D and high correlation between levels in March and those in September (r = 0.83 to 0.94, p<0.001).		
Weisberg et al., 2004 (*467*)	USA	Case review n = 166 Age: 4-54 months		Rickets	54% of cases (where sex was reported) were male, 83% African American or black, 4% nonwhite (of African American or Indian descent), 6% white, 2% Hispanic, 2% Alaskan native and ≤1% Middle Eastern, Asian or unknown. 96% (where detail reported) were exclusively breast fed, without supplementation		
4.1.2 Tuberculosis							
Davies et al., 1985 (*160*)	Wales	Prospective case-control n = 50 Mean age: 43.1 (SD = 18.8)	Serum 25(OH)D concentration	Tuberculosis	25(OH)D levels of cases significantly lower than that of controls (p<0.005)	Cases: Median = 6.4ng/ml; Range = 0.9 – 29.7 Controls: Median = 10.9 ng/ml; Range = 3.6 – 53.0	
Douglas et al., 1996 (*161*)	UK	Ecologic	Season	Notification of tuberculosis	TB notifications more common in summer (opposite of other chest infections) with a summer peak of amplitude 10% on cosinor analysis. Suggest this may be related to low post-winter vitamin D levels, poor macrophage function and reactivation of dormant infection.		
Douglas et al., 1998 (*154*)	UK	Ecologic	Season of TB notification Ethnicity	Notification of tuberculosis	Presence of a summer peak of clinical diagnosis was confirmed. The seasonal variation is particularly marked in patients of Indian Subcontinent ethnic origin.		
Ustianowski et al., 2005 (*468*)	London, UK	Cross-sectional study of persons diagnosed with TB n = 210	Ethnic group Religion	Serum vitamin D levels	Somali, East African Asian and Indian patients had significantly lower 25(OH)D levels than white Europeans or Chinese and South East Asians (p<0.05). Christians had significantly higher 25(OH)D levels than Muslim (p<0.01), Hindu (p<0.01) or Sikh (p<0.05) patients. Indian (OR = 2.42, 95% CI 1.5 – 3.89) and Somali (2.09, 95% CI 1.02 – 4.29) patients had significantly increased odds of having undetectable 25(OH)D levels. No significant association with site of TB or localized vs systemic disease.		
Wilkinson et al., 2000 (*162*)	UK	Case-control Cases: n = 126 Controls: n = 116	Serum 25(OH)D deficiency VDR genotype	TB status		OR (for TB) = 2.9 No significant independent association with any VDR genotype	1.3 – 6.5
4.2 Cancers							
4.2.1 Non-Hodgkin Lymphoma							
Adami et al., 1995 (*165*)	Denmark and Sweden	Record linkage	NHL CLL	SCC Malignant melanoma		NHL& SCC: RR = 5.5 CLL & SCC: RR = 8.6 SCC & NHL: RR = 2.0 CMM &NHL:	 4.6 – 6.6 7.2 – 10.3 1.7 – 2.4

						RR = 1.4	1.1 – 1.7
Bentham, 1996 (*167*)	England and Wales	Ecologic	Estimated levels of solar radiation	NHL	Social class, employment in agriculture	RR = 1.34	1.32 – 1.37
Douglas et al., 1999 (*169*)	Leeds, UK	Ecologic	Season of diagnosis	Incidence of NHL	Using a normal approximation to the Poisson distribution, there were troughs in incidence in January for male, female and pooled incidence rates (non-significant at p = 0.01). Authors conclude no evidence of seasonality, but further work is required.		
Hughes et al., 2004 (*171*)	Australia	Case-control Cases: n = 704 Controls: n = 694 Age: 20-74	Sun exposure: Lifetime working Working days Non-working days Eye colour (hazel vs brown) Skin colour (fair vs olive) Tanning ability (poor vs deep tan) Previous skin cancer	NHL	Age, sex, state, ethnicity,	 OR = 1.12 OR = 0.95 OR = 0.47 OR = 1.48 OR = 1.44 OR = 1.70 OR = 1.17	 0.87 – 1.69 0.68 – 1.33 0.34 – 0.66 1.07 – 2.04 1.01 – 2.07 1.06 – 2.71 0.90 – 1.54
Newton, 1995 (*166*)	US	Ecologic	Ambient solar ultraviolet index	Incidence of NHL	Incidence of NHL declines with increasing exposure in the United States in men (regression coefficient -0.044, 95% CI -0.030 to -0.058) and in women (-0.022, 0.003 to -0.047). Note there is no adjustment for possible confounders, such as SES.		
Porojnicu et al., 2005 (*469*)	Norway	Follow-up Age: 0-29: n = 950 30+: n = 2189	Season of diagnosis: Winter Spring Summer Autumn	Death from Hodgkin lymphoma	Age at diagnosis, birth cohort, decade of diagnosis, sex, place of residence	 RR = 1.0 RR(0-29) = 0.97 RR(30+) = 0.95 RR(0-29) = 0.80 RR(30+) = 0.90 RR(0-29) = 0.36 RR(30+) = 0.84	 0.49 – 1.87 0.74 – 1.21 0.37 – 1.70 0.70 – 1.14 0.15 – 0.87 0.65 – 1.07
Smedby et al., 2005 (*170*)	Denmark and Sweden	Case-control Cases: n = 3740 Controls: n=3187 Age: 18-76 yrs	Sunbathing aged 20 (4 times/week cf never) Sunburns aged 20y Sunbathing (4 times/week cf never) Sunburns aged 20y	Incident NHL Hodgkin lymphoma	Sex, country, skin reaction to sun	OR = 0.7 OR = 0.6 OR = 0.7 OR = 0.8	0.6 – 0.9 0.5 – 0.8 0.5 – 1.0 0.5 – 1.3
4.2.2 Prostate cancer							
Ahonen et al., 2000 (*179*)	Helsinki, Finland	Nested case control Cases: n = 149 Controls: n = 596 54 – 69 years	Low serum 25 vitamin D levels (<30 cf >55 nmol/L) Low vitamin D +Age <52	Prostate cancer	Treatment with gemfibrozil, smoking. HDL, systolic blood pressure, BMI	OR = 1.7 OR = 1.8 OR = 3.5	0.9 – 2.9, p for trend = 0.02 1.0 – 3.2; p for trend = 0.01 1.7 – 7.0
Bodiwala et al., 2003 (*177*)	England	Case-control N (cases) = 453 N (controls)=312	Mean hours cumulative sun exposure per year Positive childhood sunburn Adult sunbathing score History of regular foreign holidays	Prostate cancer incidence (controls had benign prostatic hypertrophy)	Age at diagnosis	OR = 0.999 OR = 0.37 OR = 0.81 OR = 0.50	0.999 – 1.000 0.24 – 0.56 0.77 – 0.86 0.36 – 0.69
Freedman et al., 2002 (*201*)	United States	Death certificate based case-control	Residential exposure to sunlight (high vs low)	Mortality from: Breast cancer Ovarian cancer Prostate cancer Colon cancer	Age, sex, race, socioeconomic status, occupational exposure to sun, physical activity (last three based on usual occupation)	 OR = 0.74 OR = 0.84 OR = 0.90 OR = 0.73	 0.72 – 0.76 0.81 – 0.88 0.87 – 0.93 0.71 – 0.74

Hanchette and Schwartz, 1992 (*174*)	United States	Ecologic	Solar UV radiation levels	Prostate cancer mortality	There is a strong negative correlation between prostate cancer mortality and an index of UVR radiation which includes latitude and measures of cloud cover (r = -0.25, p<0.0002). There was a positive correlation with latitude (r = 0.19, p<0.0001).		
Grant, 2004 (*470*)		Ecologic	UVB radiation levels	Prostate cancer mortality	Weak inverse association between UVB levels and prostate cancer mortality		
John et al., 2005 (*471*)	San Francisco, USA	Case control Cases: n = 450 Controls: n = 455 Age: 40-79 years	High sun exposure index High occupational outdoor activity Lifetime outdoor activities High activity VDR polymorphisms High activity alleles + high sun exposure	Advanced prostate cancer	Age, family history of prostate cancer	OR = 0.51 OR = 0.73 OR = 1.08 OR = 0.48 OR = 0.25	0.33 – 0.80 0.48 – 1.11 0.62 – 1.87 0.27 – 0.87 0.07 – 0.81
Luscombe et al., 2001a (*176*)	Staffordshire UK	Case-control Cases: n = 210 Controls: n = 155 Mean age: 70.6y	Sun exposure history MCIR Arg^{160}/Arg^{160} TYR A2/A2	Prostate cancer	Hair colour, eye colour, skin type	OR = 0.13 OR = 2.24 OR = 0.50	0.06 - 0.31 1.18 - 4.24 0.36 – 0.97
Luscombe et al., 2001b (*178*)	Staffordshire UK	Case-control Cases: n = 210 Controls: n = 155 Mean: 70.6 yr	Skin type 1 (vs 4)	Prostate cancer metastases	Age, stage and grade of cancer	OR = 0.17	0.03 - 0.82
Luscombe et al., 2001c (*175*)	Staffordshire UK	Case-control 210:155 Mean: 70.6 yr	Childhood sunburn Regular sunny holidays Sunbathing Low exposure to UVR	Development of prostate cancer	Age	OR = 0.18 OR = 0.41 OR = 0.83 OR = 3.03	0.08 – 0.38 0.25 – 0.68 0.76 – 0.89 1.59 – 5.78
Nomura et al., 1998 (*180*)	Hawaii, USA	Nested case-control N (cases) = 136 N (controls)=136	Quartiles of Pre-disease vitamin D levels (Q4 cf Q1)	Incident prostate cancer		OR = 0.8	0.4 – 1.8
Platz et al., 2004 (*181*)	USA	Nested case control Cases: n = 460 Controls: n=460 Age:47.8 – 84.3y	Quartiles of (Q4 cf Q1): $1,25(OH)_2D$ levels 25(OH)D levels 25(OH)D levels	Incident prostate cancer Prostate cancer aggressiveness: More aggressive Less aggressive	Family history, height, vigorous physical activity, diabetes mellitus, vasectomy, cigarette smoking (last 10 y), intake of energy, red meat, fish, lycopene, fructose, α-linolenic acid, use of vitamin E and selenium supplements	 OR = 1.25 OR = 1.19 OR = 0.78 OR = 1.40	 0.82 – 1.90 0.79 – 1.79 0.35 – 1.73 0.83 – 2.35
Tuohimaa et al., 2004 (*172*)	Norway, Finland, Sweden	Nested case-control Cases: n = 622 Controls: n=1451 Age: 40-60 at enrolment	25(OH)D level: ≤ 19 nmol/L 20-39 nmol/L 40-59 nmol/L 60-79 nmol/L ≥80 nmol/L	Incident prostate cancer	Matched on age, date of blood sampling, country and region inside country.	 OR = 1.5 OR = 1.3 OR = 1 OR = 1.2 OR = 1.7	 0.8 – 2.7 0.98 – 1.6 Reference 0.9 – 1.5 1.1 – 2.4
4.2.3 Breast cancer							
Garland et al., 1990 (*182*)	United States	Ecologic	Total average sunlight at ground level	Breast cancer mortality	Risk of fatal breast cancer in major urban areas of the US was inversely proportional to intensity of sunlight (r = -0.80, p = 0.0001).		
Gorham et al., 1990 (*472*)	USSR	Ecologic	Total ambient average annual sunlight energy	Breast cancer incidence	Negative association between sunlight energy and breast cancer incidence, r = -0.75, p<0.001.		
Grant, 2002 (*183*)		Ecologic	Latitude Fish intake	Breast cancer mortality	Weak inverse correlation between fish intake and breast cancer mortality Positive correlation with UVB radiation.		

John et al., 1999 (*185*)	USA	Cohort n = 5009 Age: 25-74 yrs	Total vitamin D intake (≥200IU cf <100IU without supplements) Residential and occupational sun exposure (high vs low) High sun exposure + ≥200IU intake vitamin D	Incident breast cancer	Age, education, age at menarche, age at menopause, body mass index, alcohol consumption, physical activity	RR = 0.86 RR = 0.67 RR = 0.71	0.61 – 1.20 0.41 – 1.06 0.44 – 1.14
Robsahm et al., 2004 (*473*)	Norway	Cohort N = 41,988	Residential sun exposure (highest vs lowest) Occupational sun exposure (high vs low) Season of diagnosis (Fall vs winter)	Death from breast cancer	Age at diagnosis, birth cohort, period of diagnosis, disease stage at diagnosis	RR = 0.95 RR = 1.10 RR = 0.85	0.86 – 1.05 p(trend)=0.10 1.00 – 1.15 0.82 – 0.90
Shin et al., 2002 (*186*)	United States	Cohort N = 88691	Vitamin D intake (>500IU/day vs ≤150IU/day): Postmenopausal women Premenopausal women	Breast cancer incidence	Age, time period, physical activity, history of benign breast disease, family history of breast cancer, height, weight change since 18, BMI at age 18, age at menarche, parity, age at first birth, alcohol intake, total energy intake, total fat intake, glycemic index, β-carotene intake, total active vitamin E intake, calcium intake	RR = 0.94 RR = 0.72	0.80 – 1.10 0.55 – 0.94
4.2.4 Colon and colorectal cancer							
Feskanich et al., 2004 (*191*)	USA (Nurses Health Study)	Nested case control Cases: n = 193 Controls:n=383 Age(mean):65.5y	Quintile of 25(OH)D (ng/ml): 1 (14.9 – 17.4) 2 (19.6 – 24.8) 3 (24.1 – 29.6) 4 (27.9 – 34.5) 5 (35.3 – 44.5)	Colorectal cancer	Body mass index, physical activity, pack-years of smoking, menopausal status, use of HRT, duration of aspirin use, family history of colorectal cancer, daily intake of calcium, folate, methionine, retinol, red meat and alcohol	OR = 1.00 OR = 0.93 OR = 0.79 OR = 0.58 OR = 0.53	Reference 0.53 – 1.63 0.44 – 1.40 0.31 – 1.07 0.27 – 1.04 p for trend = 0.02
Garland and Garland, 1980 (*474*)		Ecologic	Ambient UVR	Colon cancer	Inverse association between colon cancer death rates and annual mean daily solar radiation in the USA (r = 0.9 for metropolitan states, 0.6 for non-metropolitan states)		
Garland et al., 1989 (*189*)	Maryland, USA	Prospective cohort Cases: n = 34 Controls: n = 67 Age: 35+	Serum 25(OH)D (≥20ng/ml cf 0-19 ng/ml)	Colon cancer		OR = 0.3	p = 0.05
Kampman et al., 2000 (*197*)	California, Utah, Minnesota	Case control Cases: n = 1993 Controls: n = 2410	Dietary vitamin D Sunshine exposure Supplemental vitamin D	Incident colon cancer	Age, sex, BMI, family history, physical activity, intake of energy, dietary fibre, aspirin, NSAIDs	OR (M) = 1.4 OR (F) = 1.1 OR (M) = 0.9 OR (F) = 1.0 OR (M) = 0.5 OR (F) = 0.6	1.0 – 2.2 0.7 – 1.7 0.7 – 1.1 0.8 – 1.4 0.2 – 1.1 0.4 – 1.1
Levine et al., 2001 (*194*)	Southern California	Case-control Cases: n = 473 Controls: n = 507	Quartile of dietary vitamin D (highest vs lowest) Quartile of dietary vitamin D + low	Colorectal adenomas		OR = 0.83	0.49 – 1.41

			calcium intake			OR = 0.40	0.22 – 0.71
McCullough et al., 2003 (*196*)	USA	Cohort study n = 127,749 Age: 50-74 at enrollment	Quintile of total vitamin D intake (highest vs lowest) Men Women Men and women combined	Incident colorectal cancer	Age, smoking, BMI, education, physical activity, family history of colorectal cancer, total energy, percent saturated fat, fruit, vegetables, multivitamin use, HRT (women only)	 RR = 0.71 RR = 1.00 RR = 0.80	 0.51 – 0.98 0.68 – 1.47 0.62 – 1.02
Moan et al., 2005 (*475*)	Norway	Follow-up n = 27745	Season of diagnosis of colon cancer	Incidence of colon cancer Death from colon cancer by 18 months	No significant seasonal variation in incidence rates of colon cancer; clear seasonal variation in death rates with lowest death rates following autumn diagnosis for men and women; no significant north-south gradient in death rates.		
Peters et al., 2001 (*195*)	Bethesda, Maryland	Case-control Cases: n = 236 Controls: n=218 Age: 18-74 yrs	25(OH)D levels	Colorectal adenomas	For each 10ng/ml increase of serum 25(OH)D, the risk of colorectal adenoma decreased by 26% (OR = 0.74, 95% CI 0.60 – 0.92). This inverse association may be stronger in subjects with calcium intake above the median.		
Platz et al., 2000 (*193*)	USA (Nurses Health Study)	Nested case control Cases: n = 326 Control: n = 326 (women only)	Quartiles of: 25(OH)D levels Q1 Q2 Q3 Q4 $1,25(OH)_2D$ levels Q1 Q2 Q3 Q4	Colorectal adenomas	Body mass index, physical activity, aspirin use, cigarette pack-years smoked, alcohol consumption, intake of red meat and methionine, 1980 folic acid, 1990 post-menopausal hormone use	 OR = 1.00 OR = 0.64 OR = 0.58 OR = 1.04 OR = 1.00 OR = 0.64 OR = 0.80 OR = 0.71	 Reference 0.41 – 1.00 0.36 – 0.95 0.66 – 1.66 Reference 0.41 – 1.02 0.50 – 1.30 0.43 – 1.15
Pritchard et al., 1996 (*192*)	Sweden	Case-control Cases: n = 569 Controls:n=512	Quartiles of dietary vitamin D intake (Q4 cf Q1)	Colon cancer Rectal cancer	Age, sex, total caloric and protein intake	OR = 0.6 OR = 0.5	0.4 – 1.0 0.3 – 0.9
Tangrea et al., 1997 (*190*)	Finland	Nested case control Cases: n = 146 Controls: n=290 Age: 50-69y (males only)	Quartiles of 25(OH)D levels Q4 cf Q1	Colorectal cancer: Proximal colon Distal colon Distal colon+rectum		 RR = 1.3 RR = 0.6 RR = 0.5	 0.4 – 4.2 0.2 – 1.5 0.2 – 0.9
4.2.5 Other cancers							
Douglas et al., 1999 (*169*)	UK	Ecologic	Season of presentation (1984 – 93)	Acute lymphoblastic leukemia (ALL) Acute myeloid leukemia (AML) Chronic myeloid leukemia (CML) Non-Hodgkins lymphoma (NHL)	Peak in March (males) and in October (females), ns at $p < 0.01$. Peak in males (February) and in females (January), ns at $p < 0.01$ Peak in males (September) and a trough in females (April), ns at $p<0.01$ Trough in January for males and females, ns at $p<0.01$.		
Grant, 2002 (*188*)		Ecologic	UVB radiation levels	Cancers	Negative latitudinal gradients in mortality from cancers of breast, colon, ovary, prostate, NHL, bladder, esophageal, kidney, lung, pancreatic, rectal, stomach, corpus uteri.		
Grant et al., 2005 (*202*)	United States	Ecologic	Solar UVB irradiance	Cancers	Vitamin D sensitive cancers include bladder, breast, cervical, colon, esophageal, gallbladder, gastric, laryngeal, ovarian, pancreatic, prostate, rectal, renal, uterine corpus, cancer, Hodgkin and non-Hodgkin lymphoma. Estimated economic burden from cancers, attributable to insufficient UVB is 10-15 billion dollars.		

Hakansson et al., 2001 (*476*)	Sweden	Cross-sectional n = 323, 860 men	Sun exposure	Myeloid leukemia Lymphocytic leukemia NHL Ocular melanoma Stomach cancer	Age, smoking, magnetic field exposure	RR = 2.0 RR = 1.7 RR = 1.3 RR = 3.4 RR = 1.4	1.1 – 3.6 0.9 – 3.2 0.9 – 1.9 1.1 – 10.5 1.0 – 1.9
Lefkowitz and Garland, 1994 (*200*)	United States	Ecologic	Average annual sunlight energy	Ovarian cancer mortality	Ozone and sulphur dioxide levels, age	Inverse correlation in all women (p = 0.04). In women 45-64 years, death rates in the north were five times those in the south.	
Mizoue, 2004 (*477*)	Japan	Ecologic	Averaged annual solar radiation 1961-1990	Cancer mortality: Esophagus Stomach Colon Rectum Colorectum Pancreas Gallbladder and bile duct Prostate/Breast	Mean prefectural income Salt intake Fat intake Fat intake Fat intake Fat intake	Male; female r = -0.45; -0.41 r = -0.44; -0.35 r = -0.41; -0.33 r = -0.40; -0.39 r = -0.49; -0.42 r = -0.53; -0.31 r = -0.55; -0.50 r = -0.07; -0.06	 p<0.01; 0.01 p<0.01; 0.05 p<0.01; 0.05 p<0.01; 0.01 p<0.01; 0.01 p<0.01; 0.05 p<0.01; 0.01
Robsahm et al., 2004 (*184*)	Norway	Cross-sectional N = 115,096	Breast, colon or prostate cancer; Residence at death Season of death	Mortality from breast, colon or prostate cancer	Age at diagnosis, birth cohort, period of diagnosis, stage of disease at diagnosis	No geographic variability in case fatality (solar radiation at residence); Cancers diagnosed in summer and fall had the lowest risk of cancer death	
Zhou et al., 2005 (*478*)	Boston, USA	Cohort study n = 456	Vitamin D intake Season of surgery (summer vs winter) Surgery (summer vs winter) and high (vs low) vitamin D intake	Recurrence free survival from non-small cell carcinoma of the lung		ns HR = 0.75 HR = 0.33	 0.56 – 1.01 0.15 – 0.74
4.3 Cardiovascular effects							
Lind et al., 1995 (*213*)	Sweden	Cross-sectional N = 45 men Age: 56– 67 years	Serum 1,25(OH)D_2 levels Serum 25(OH)D levels	VLDL triglycerides Serum triglycerides Fasting insulin Sys BP (supine) Dias BP (supine) VLDL triglycerides Serum triglycerides Fasting insulin Sys BP (supine) Dias BP (supine)	Age, BMI, Waist-hip ratio, serum creatinine	r = -0.47 r = -0.45 r = -0.41 r = -0.35	p = 0.005 p = 0.007 p = ns p = ns p = 0.02 p = ns p = ns p = 0.05 p = ns p = ns
4.3.2 Coronary Heart Disease							
Grimes et al., 1996 (*208*)	UK and the Seven Countries Study	Ecologic	Latitude Hours of sunshine per annum Season	Cholesterol levels Age adjusted death rates from CHD Cholesterol levels		r = 0.936 r = -0.85 Clear seasonal variation; with winter>summer	p<0.001 p<0.001
Elford et al., 1989 (*207*)	United Kingdom	Cohort N = 7735 men	Location of birth Current residence	Major ischemic heart disease event	There is a geographic gradient in incidence of IHD events in the UK, regardless of location of birth, where risk if highest in the north (high latitude) and lowest in the South		

					(lower latitude).		
4.3.3 Cerebrovascular disease							
Poole et al., 2006 (*212*)	UK	Case-control Cases: 44 Controls: 96	Serum vitamin D levels	First ever acute stroke	Season	Z = -1.4 SD	-1.7, -1.1
4.4 Metabolic effects							
Boucher et al., 1995 (*214*)	London, UK	Case-control N (case) = 44 N (control)=15	Vitamin D levels	Diabetes risk Oral glucose tolerance test specific insulin	Age, sex	95% at risk of diabetes (cases) and 80% of low-risk persons (controls) were vitamin D deficient (25(OH)D<11ng/ml) r = 0.59 (p = 0.0001) (cases) R = 0.39 (p = 0.04)	
Chiu et al., 2004 (*215*)	Los Angeles, USA	Experimental n = 126 Age 22-29 years, Glucose tolerant volunteers	25(OH)D concentration	Blood pressure BMI Waist-hip ratio Plasma glucose concentration Insulin sensitivity B-cell function	Sex, age, ethnicity, season	Not significant R = -0.25 Not significant Negative correlation with fasting, 60-, 90- and 120 min post-challenge plasma glucose (r = -0.52) Positive correlation (r = 0.46) Lower 25(OH)D associated with decompensated β-cell function	
Hitman et al., 1998 (*216*)	UK	Cross-sectional genetic study N = 171 Age: 30-65 years	VDR genotype: Apa1 Bsm1 Taq1	Insulin secretion among Bangladeshi Asians at risk for type 2 diabetes	Vitamin D status		p = 0.001 p = 0.039 p = 0.01
				Gene dosage effect for insulin secretion: lowest with the aa genotype (OR = 68.5 95% CI 48.9 – 95.8); highest with AA (46.8, 112.8 – 191.0) and intermediate for the aA genotype (97.2, 76.6 – 116.2)			
Scragg et al., 1995 (*479*)	New Zealand	Case-control N (cases) = 238 N (controls)=238 Age: 40-64 years	Serum 25(OH)D concentrations <60nmol/L 61 – 82 nmol/L >8882nmol/L	Incident diabetes mellitus NIDDM) or impaired glucose tolerance (Y/N)	Sex, age, ethnicity, date of interview, BMI tertile, hypertension, leisure physical activity, serum lipids	 OR = 1.00 OR = 0.57 OR = 0.36	 Reference 0.32 – 1.02 0.19 – 0.71
5. Psychiatric disorders							
5.2 Schizophrenia							
Davies et al., 2000 (*480*)	Queensland, Australia	Ecologic	Season of birth	First admission for schizophrenia	Strong annual periodicity (p<0.001) for first admissions in males with a peak in August (Southern Hemisphere winter) and a trough in summer months. Similar trend for women. Similar pattern in relation to seasons seen in Northern Hemisphere.		
McGrath et al., 1994 (*221*)	Southern Hemisphere	Ecologic	Influenza epidemics	Schizophrenia	After two of three examined influenza epidemics, there was an excess of schizophrenia births in either males (1954 epidemic) or females (1957 epidemic)		
McGrath et al., 1995 (*219*)	Australia	Cross-sectional n = 9348	Season of birth	Schizophrenia	Age incidence	Quarterly birth distribution significantly different from general population $\chi 2$ =12.5, p = 0.0001. Highest births in winter, autumn	
McGrath et al., 1999 (*224*)	Australia	Meta-analysis	Season of birth Winter vs other seasons Winter and spring vs other seasons	Schizophrenia		OR = 1.04 OR = 1.03	0.99 – 1.08 0.99 – 1.07
McGrath et al., 2002	Australia	Ecological	Perinatal sunshine duration	Schizophrenia	Significant agreement between trend cycles for sunshine duration and schizophrenia birth		

(*481*)	Netherlands	n = 6630 (Australia) n = 24 474 (Netherlands)			rates (p = 0.004)		
McGrath et al., 2004 (*225*)	Finland	Cohort study N = 9114 Age: 1966 birth cohort	Vitamin D supplements: None Irregular Regular	Development of schizophrenia before 31 years (males only)	Parity, gestational and maternal age, length of maternal education, social status, birth weight	RR = 1.00 RR = 0.08 RR = 0.12	 0.01 – 0.95 0.02 – 0.90
Morgan et al., 2001 (*482*)	Western Australia	Ecologic	Season of birth	Schizophrenia Affective psychoses Neurotic depression	No association between season of birth and any of the tested outcomes. Statistically significant increase in risk of schizophrenia in females in 3rd quarter (RR = 1.15, CI 1.01 – 1.32) and decreased for females and overall (RR = 0.87, CI 0.79 – 0.96) in the 4th quarter of the year		
Ozer et al., 2004 (*227*)	Turkey	Family genetic study N = 40	VDR genotype	Psychosis	Based on genetic analysis of a single, large, inbred family, there was no linkage between the chromosome containing the VDR gene locus and psychosis. There was no cosegregation of psychosis and rickets. Authors concluded that vitamin D deficiency does not act as a risk factor in those susceptible to psychosis.		
5.3 Effects on mood							
Lansdowne and Provost, 1998 (*228*)	Newcastle, Australia	Intervention study n = 44 Age: 18-43 yrs	Vitamin D3 supplement	Affect	Volunteers receiving vitamin D supplementation (either 400IU or 800IU daily for 5 days) showed significant (p<0.001) enhancement of positive affect and (non-significant) reduction in negative affect.		

Annex 2 Epidemiologic studies used for estimation of population attributable fraction and descriptive studies of disease distribution

Section 1. Assessment of population attributable fraction

This section lists the references of the case-control and ecologic studies examined for estimation of PAF.

Melanoma

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Annex 3 Disease worksheets

Section 1: Worksheet for: Cutaneous malignant melanoma (CMM)

Case definition and sequelae: (ICD-10) C43.
The disability weights used in this study are listed in Table A3.1.

Table A3.1 Disability weights (Dutch weights)

Disease phase/treatment	Disability weight
Primary treatment, no evidence dissemination	0.190
No evidence of dissemination after initial treatment	0.190
Primary treatment, lymph node but no distant dissemination	0.430
In remission	0.190
Disseminated melanoma	0.810
Terminal phase (Dutch weight for end-stage disease)	0.930

Analysis of published case-control studies indicates a PAF for malignant melanoma of around 0.2, with non-significant variation by latitude (p = 0.18, see graph below). As noted in this document (Section 2.3) this is likely to underestimate the true PAF for two reasons:

- Measurement error in assessing UVR exposure
- The reference group is not a truly 'non-exposed' group. Rather it is a less exposed portion of a population being compared to a more exposed portion of the same population.

This estimate, based on case-control studies, however, refers to how much of the inter-individual variation in risk of CMM within a single population can be attributed to inter-individual variation in UVR exposure. This is a different parameter from that estimated by population-level (ecological) analyses, which estimates how much of the difference in incidence rates between populations is attributable to differences in population-specific average ambient levels of UVR exposure.

In an ecological analysis, Armstrong et al (*1*) estimated a PAF of 0.96 in males and 0.92 in females, based on comparison of white and black populations in the USA. The black population is the reference 'unexposed' population. Yet there may be constitutional differences between these two populations that contributes to the difference in incidence between the groups but is unrelated to UVR exposure. Armstrong also calculated a PAF based on a comparison of ethnically similar white populations in two different locations, NSW in Australia and the United Kingdom. The calculated PAF was 0.89 in males and 0.79 in females. The population living in the UK is the reference 'unexposed' population.

If one plots incidence rates derived from Jones et al (*2*) for the states of Australia, against the latitude of the capital city (to represent UVR exposure), a PAF can be calculated, using the low rate in Tasmania as the incidence rate in the 'unexposed'. The calculated PAF is 0.70 in males and 0.66 for females. (Using the latitude of the middle of the state, the PAF is 0.62 for males and 0.59 for females).

Interestingly, a similar plot of age-standardized incidence rate for melanoma (from Globocan 2000 (*3*)) against latitude of the capital city for European countries reveals a reverse gradient, with a higher incidence of CMM at higher latitudes. This presumably reflects the complexity of the relationship between measures of UVR exposure and melanoma incidence. It may be that ecologic data from Australia provide the best ecologic estimate of PAF as the variation in melanoma incidence by latitude (as a proxy for UVR exposure) is less confounded by ethnic and behavioural differences, than estimates based on inter-country data.

Figure A3.1 represents the PAF derived from all relevant identified case-control studies that have used as the exposure measure, episodes of sunburn, or intermittent high intensity exposure. There were less data on other types of exposure, e.g. occupational exposure, and for melanoma it is likely that it is this intermittent pattern of UVR exposure that is most important. Studies used to derive the PAF are listed in Table A3.2. Note that some studies provided more than one data point, as different measures of exposure were included in the same study, e.g different ages at which sunburn was experienced (childhood, adolescent or adult).

Figure A3.1 Latitudinal variation in PAF of sunburn or intermittent sun exposure for melanoma

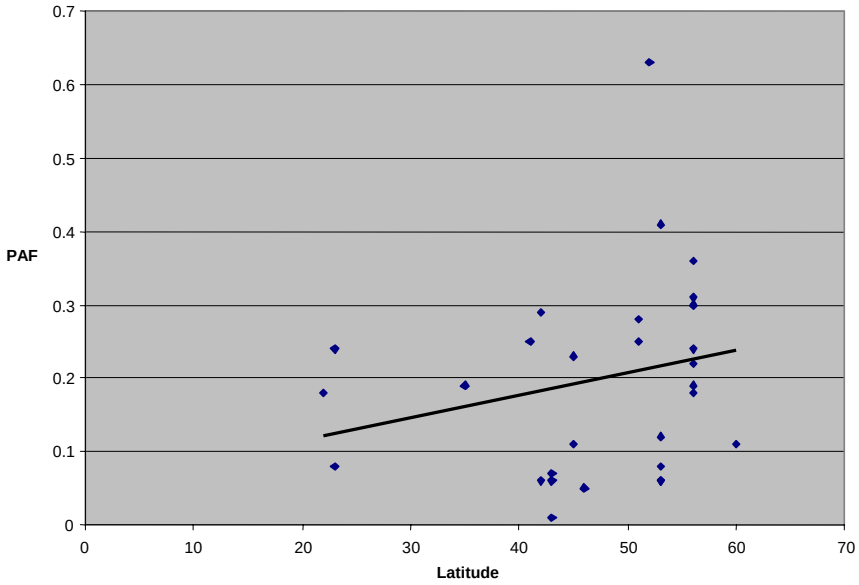

Table A3.2 Case control studies used to derive population attributable fractions of sunburn or intermittent UVR exposure, for CMM

No	Reference	Odds ratio (95 % CI)	Exposure measure
4	Bernengo, 1987	1.5 (0.7-3.5)	Severe blistering sunburn
5	Cristofolini, 1987	1.2 (0.7-2.1) ever	Severe sunburn
6	Dubin, 1990	1.61 (1.0-2.6)	Severe blistering sunburn
7	Elwood, 1984	1.3 (0.9-1.8)	Sunburn
8	Elwood, 1985	1.7 (1.1-2.7)	Hours recreational sun exposure
9	Green, 1985	2.4 (1.0-6.1)	Sunburn
10	Klepp, 1979	2.4 (1.0-5.8)	Southern Europe sunbathing holidays
11	Loria, 2001	2.4 (1.0-5.9)	Childhood sunburn
12	MacKie, 1982	2.8 (1.1-7.4)	Severe sunburn
13	MacKie, 1989	7.6 (1.8-32) male 2.3 (0.9-5.6) female	Severe sunburn
14	Naldi, 2000	1.1 (0.8-1.5) ever 1.6 (1.0-2.4) child	Severe sunburn
15	Osterlind, 1988	3.0 (1.5-5.9) adult 1.9 (1.2-3.1) adol. 2.7 (1.6-4.8) child	Sunburn
16	Pfahlberg, 2001	3.07 (1.73-5.59) adult 2.01 (1.18-3.49)	Blistering sunburn
17	Siskind, 2002	1.31 (1.08-1.58)	>6 sunburns
18	Sorahan, 1985	4.2	Painful sunburns
19	Walter, 1999	1.28 (0.97-1.69)	Severe sunburn last 5 years
20	Weinstock, 1989	1.1 (0.6-2.3) ever 1.9 (1.1-3.4) adolescent	Blistering sunburn
21	Westerdahl, 1994	1.9 (1.2-3.1) adult 1.6 (1.0-2.5) adol. 1.6 (1.0-2.6) child	Severe sunburn
22	Whiteman, 1997	1.7 (0.5-5.9)	Blistering sunburn
23	Zanetti, 1992	1.5 (0.8-2.7) ever 1.2 (4.6-31) child	Severe sunburn
24	Zaridze, 1992	3.4 (0.6-17.4)	Sunbathing

Although Figure A3.1 suggests an increase of PAF with latitude, this is non-significant. We chose to use a PAF of 0.5 (no latitudinal gradient) as a lower estimate (approximately midway between ecological and case-

controls studies) and 0.9 as an upper estimate, in line with ecological studies. A lower estimate of 0.2 as suggested by case-control studies was thought to be unrealistic due to measurement error in the assessment of UVR exposure.

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Section 2: Worksheet for: Cutaneous Squamous cell carcinoma (SCC)

Case definition and sequelae: (ICD-10) C44
The disability weights for cutaneous squamous cell carcinoma are based on a combination of disability weights from the Dutch study and the Australian Burden of Disease study, and are listed in Table A3.3.

Table A3.3 Disability weights for disease stages/treatment for SCC

Disease phase/treatment	Disability weights
Squamous cell carcinoma, primary treatment. No lymph node involvement	0.070 (Dutch weight)
Squamous cell carcinoma, primary treatment, lymph node involvement	0.300 (imputed by comparison with similar weight for melanoma)
Squamous cell carcinoma – local recurrence	0.070 (as for primary treatment, no LN involvement)
Disseminated disease	0.400 (from Australian BoD study)
Terminal phase	0.930 (Dutch weight for end-stage disease)

The attributable risks for lightly pigmented populations were calculated from case-control studies, as outlined in section 2.3. While attributable risks were calculated for each type of exposure, in view of the current theories of the type of exposure that is important in the development of SCC, those relating to occupational and cumulative exposure were graphed by latitude (see Figure A3.2). There was a non-significant latitudinal gradient in the PAF ($p = 0.55$) with a mean of 0.35 and an intercept at PAF = 0.50. There are few data points on which to base the trendline, and substantial variation in estimates of population attributable fraction for latitude, reflecting the difficulties in obtaining accurate sun exposure data when conducting epidemiological studies.

There are few data available to allow calculation of the population attributable fraction in populations with medium pigmentation. The incidence in white populations is four to ten times higher than Hispanics in the southern USA, (*1*) and is lower in Japanese in Japan than Japanese in Hawaii, (*2*) but the rate in Japanese in Hawaii is less than that of whites in Hawaii (23/100,000 compared to 118/100,000) (*2*,*3*). There is a latitudinal gradient in skin cancer incidence in Japan, suggesting risk attributable to UVR (*4*). It is unclear whether SCC in populations of medium pigmentation behaves more like SCC in lightly pigmented populations or deeply pigmented populations. It may be that the PAF should be the same as for lightly pigmented populations, or be between the PAF for lightly pigmented and deeply pigmented populations. Further research is clearly needed to answer this question but for the purposes of this assessment we have assigned an attributable fraction that is one fifth the attributable fraction for lightly pigmented populations based on patterns of incidence in different populations in the same location.

The PAF assigned to black populations is based on data that indicate that SCC is extremely rare in these populations (*5*) and largely occurs at sites of chronic inflammation, eg tropical ulcers. While it is plausible that some SCC may develop in non-pigmented scar tissue due to an effect of UVR exposure, it seems likely that most SCC in dark-skinned populations are not related to UVR exposure. The PAF above is set at one fifth of the rate for populations with medium pigmentation. This is somewhat arbitrary but reflects the evidence to date suggesting that SCC in deeply pigmented populations is generally unrelated to UVR exposure. There are, however, no studies that have specifically attempted to calculate the relative risk or the PAF for UVR exposure in deeply pigmented populations.

Figure A3.2 PAF for SCC for occupational and total, sun exposure

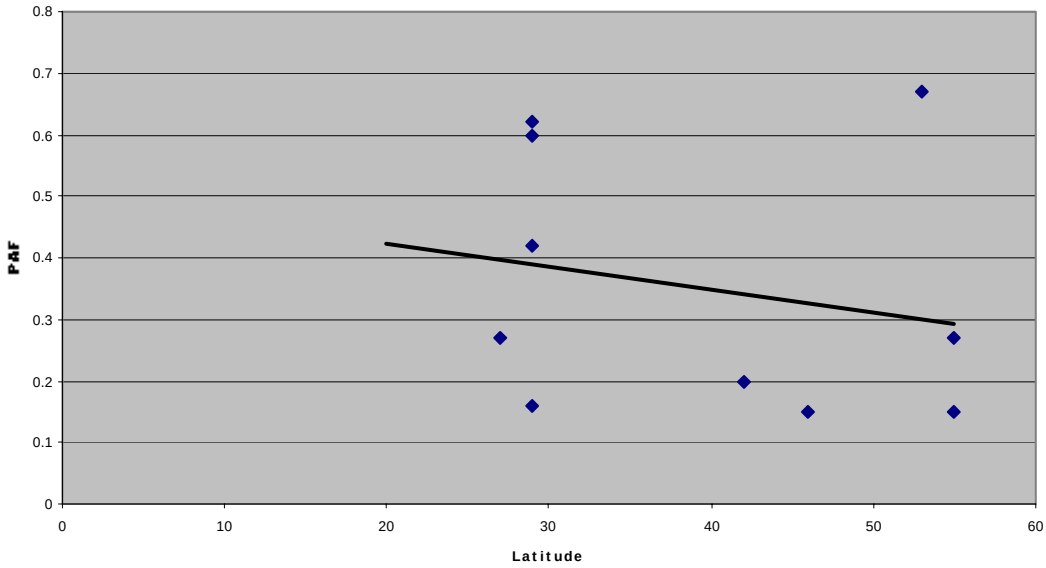


Figure A3.2 depicts the PAF for squamous cell carcinoma, based on occupational and total estimated exposure. Points on the graph are based on analyses in the studies listed in Table A3.4.

Table A3.4 Case control studies on occupational or total, sun exposure and SCC

No.	Reference	Odds ratio (95% CI)	Exposure measure
6	Aubry, 1985	9.1 (0.99-84.47)	Occupational exposure
7	English, 1998	1.2 (0.58-2.8)	Occupational exposure
		3.5 (0.97-12)	Total exposure history
8	English, 1998	2.5 (0.88-6.9)	Total exposure history
9	Gallagher, 1995	1.4 (0.4-4.3)	Occupational exposure
		1.1 (0.6-2.1)	Total exposure history
10	Green, 1996	1.37 (0.80-2.34)	Occupational exposure
11	Kennedy, 2003	6.5 (1.7 – 25.6)	Occupational exposure
12	Rosso, 1996	1.6 (0.93-2.75)	Occupational exposure

(Note that some studies generate more than one point by measuring more than one type of exposure, e.g. occupational and total exposure).

The mean PAF from these studies is 0.35, intercept (extrapolated) is 0.5 and there is no significant latitudinal gradient. Occupational or total sun exposure is probably the most important pattern of sun exposure for SCC occurrence. As case-control studies tend to give low PAF because of difficulties in measuring exposure and in defining a non-exposed population we assumed a lower estimate of PAF of 0.5 and an upper estimate of 0.7 in lightly pigmented groups, based on the extensive epidemiological experience of members of this working group. Table A3.5 summarizes the PAFs used in this assessment for groups with different skin pigmentation.

Table A3.5 Summary of the PAF for SCC for different pigment groups

	Lightly pigmented	Medium pigmentation	Darkly pigmented
Lower	0.5	0.1	0.02
Upper	0.7	0.14	0.028

Note that the different PAF by pigment group means that the PAF cannot be simply applied to the total burden of disease estimates. Rather, for each region, the proportion of cases in each pigment group was calculated. These proportions were then applied to the regional disease estimates (in DALYs) and the PAF applied to each

pigment group estimate. The total DALYs for the region were then summed to give the total attributable burden of disease due to SCC for the region.

The mortality rate from SCC by age group and gender was estimated from incidence rates as presented in Table A3.6 derived from the Australian Burden of Disease Study (*13*).

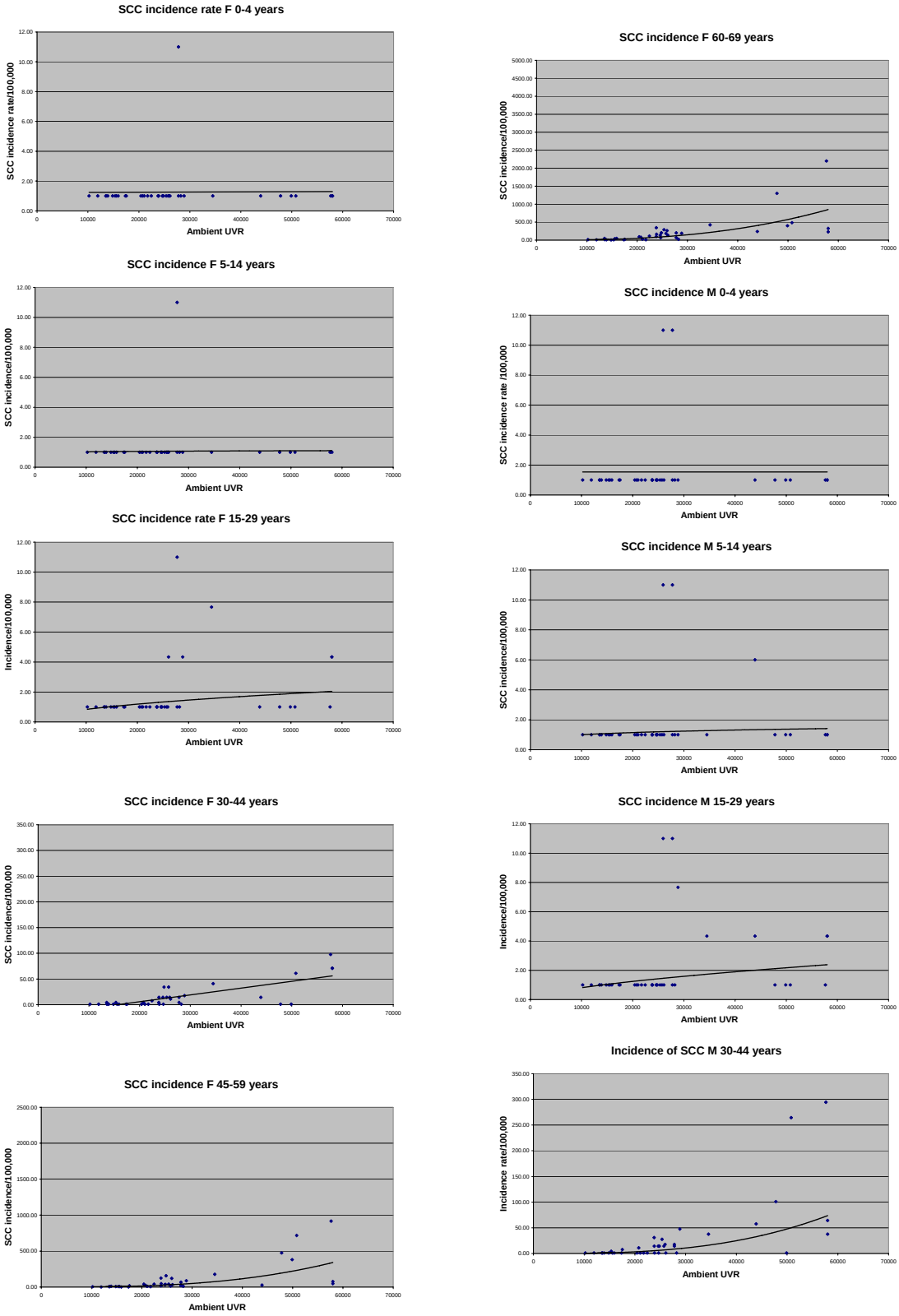
Table A3.6 Incidence to mortality ratios, by age group

Ratio of incidence to mortality rates for SCC	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
Males	0	0	0	0	635.2	863.5	541.0	291.3	85.2
Females	0	0	0	0	0	1149.4	653.5	516.1	120.4

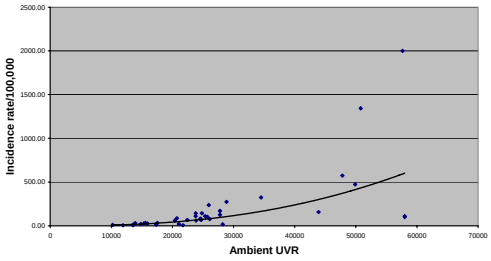
Note: The mortality rate was derived by dividing the incidence rate by this incidence to mortality ratio except in those cells with a zero, where the mortality rate was taken as zero.

Incidence data from published epidemiological literature were used to develop dose-response curves which are presented in Figure A3.3.

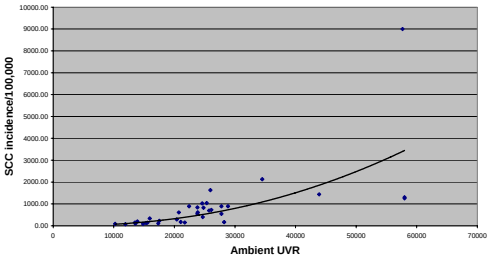
Figure A3.3 Variation in incidence of SCC with annual ambient UVR



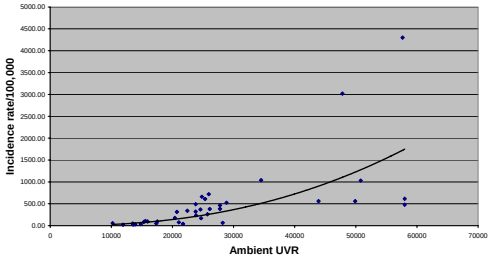
Incidence of SCC M 45-59 years



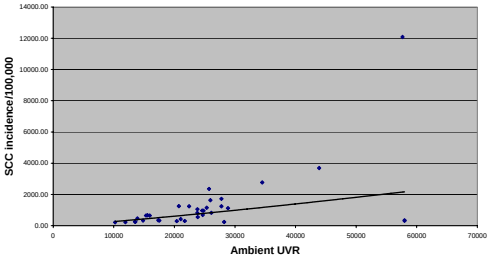
SCC incidence M 70-79 years



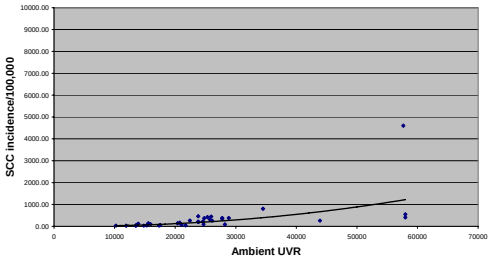
Incidence of SCC M 60-69 years



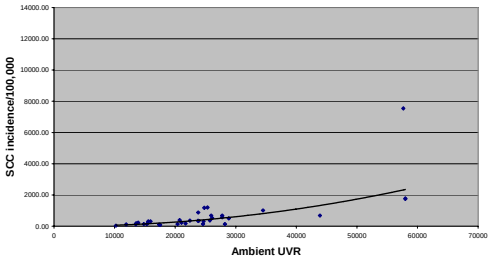
SCC incidence M 80+ years



SCC incidence F 70-79 years



SCC incidence F 80+ years



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Section 3: Worksheet for: Basal cell carcinoma

Case definition and sequelae: (ICD-10) C44
The disability weights for basal cell carcinoma (BCC) of the skin are based on a combination of weights from the Dutch study and the Australian Burden of Disease Study and are listed in Table A3.8.

Table A3.8 Disability weights for stages of disease in BCC

Disease phase/treatment	Disability weight
Localised disease	0.050 (Australian BoD study)
Lymph node involvement	0.3 (same as SCC)
Disseminated disease	0.4 (as for SCC)
Terminal disease	0.930 (Dutch for terminal illness)

Population attributable fractions were calculated from case-control studies and plotted against latitude of the study. While the trendline suggests decreasing PAF with increasing latitude (see Figure A3.4), this trend is not significant (p = 0.32, intercept = 0.33, mean = 0.25). Since it may be that the pattern and timing of exposure to UVR is important in the etiology of BCC, case-control studies may fail to capture the true risk related to UVR. Measures of sun exposure are coarse and rely on memory of distant events – most BCC arise in the elderly, while it may be sun exposure in youth that is important. As for melanoma, the population attributable fraction derived from case control studies is likely to underestimate the true population attributable fraction.

There are no published calculations of attributable fraction for UVR causing BCC, based on ecologic studies, such as Armstrong has undertaken for CMM (*1*). However, using a similar methodology where

$$PAF = (I_p - I_u) / I_p$$

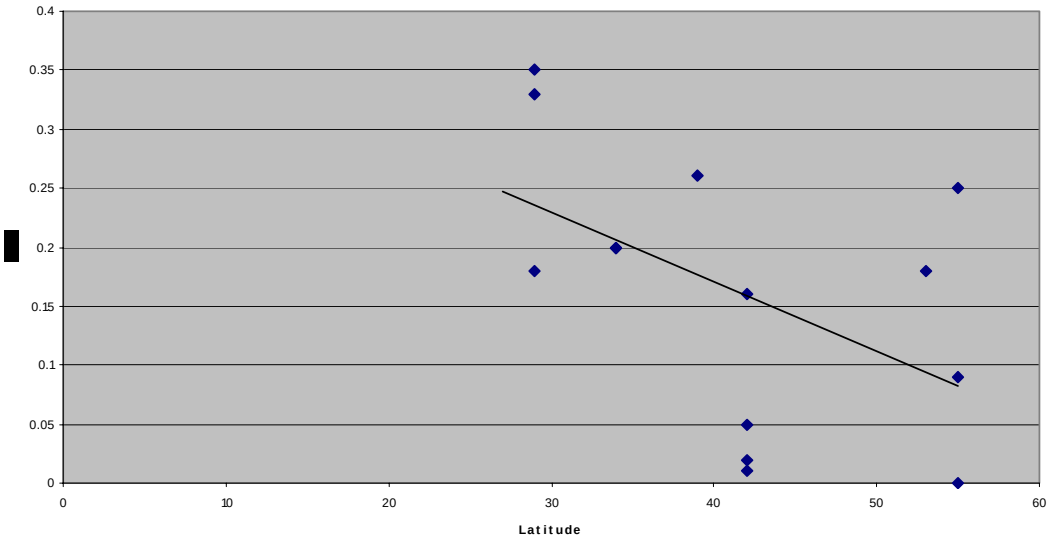
where I_p is the incidence of BCC in the whole population, and I_u its incidence in people who have not been exposed to the sun, existing data can be used to calculate PAF. Armstrong used the incidence of disease (in that case, melanoma) in people with black skin as an estimate of I_u in white people in the same population. We have already noted the paucity of population data on the incidence of BCC due to destructive treatment modes and lack of a disease register. However, Munyao's thirty year retrospective study of all BCC's reported to the Kenya Cancer Registry, gives a mean annual incidence rate in white populations of 58.5 per million, compared to 0.065 per million in black populations (*2*). This would give an attributable fraction (using the above formula) of 0.999. Also, using data comparing incidence rates for BCC in Hispanic compared to Anglo populations (*3*) (using the incidence rate for BCC in the Hispanic group as I_u), the estimated PAF would be 0.87.

A lower estimate of PAF of 0.50 was used in this assessment, based on case-control studies but recognizing the difficulty of obtaining accurate UVR exposure measurement in such studies. An upper estimate of 0.9 was used based on the above calculation.

Basal cell carcinoma is rare in African Americans and it appears that most of those who do develop BCC are of lighter skin colour (*4*). Basal cell carcinoma was absent in a skin survey in the North Solomon's - an area that has some of the most deeply pigmented people in the world (*5*). However, unlike SCC, BCC in deeply pigmented persons usually occurs on sun-exposed areas, primarily the head and neck regions and appears to be mainly related to UVR exposure (*6,7*).

There are no available data to calculate population attributable fraction in those of medium and dark pigmentation, but the disease is considered to have the same causal relationship with UVR exposure and thus the same PAF for all pigment groups.

Figure A3.4 PAF for BCC and history of sunburn or intermittent sun exposure



Points on the plot are drawn from calculations based on the studies listed in Table A3.9.

Table A3.9 Case control studies of BCC and UVR exposure measured as sunburn or intermittent sun exposure

No.	Reference	Odds ratio (95% CI)	Exposure measure
8	Foote, 2001	1.26 (0.9-1.77)	Sunburn
9	Gallagher, 1995	2.6 (1.1-6.5)	Intermittent exposure
		4.5 (1.7-12.3)	Sunburn – child
10	Hunter, 1990	1.9 (1.5-2.4)	Sunburn
11	Kennedy, 2003	1.6 (1.1-2.2)	Sunburn - child
12	Kricker, 1995	1.74 (1.03-2.95)	Intermittent exposure
13	Kricker, 1995	1.85 (1.09-3.13)	Intermittent exposure
		1.24 (0.69-2.24)	Sunburn
14	Rosso, 1996	1.47 (1.18-1.83)	Intermittent exposure
		1.45 (1-2.12)	Sunburn – child
		1.05 (0.86-1.42)	Sunburn – adult/ever
15	Zanetti, 1996	1.68 (1.17-2.39)	Sunburn – child
		1.3 (0.95-1.78)	Sunburn – adult/ever

Additional other studies were examined but either presented insufficient information to calculate the PAF, or used different exposure measurements, e.g occupational exposure, fair skin. Graphs were drawn of PAF and latitude using each different method of exposure measurement – the one presented here shows the most commonly measured type of exposure. The mortality rate was calculated from the incidence rate using the ratios presented in Table A3.10 (derived from data in the Australian Burden of Disease Study) (*16*).

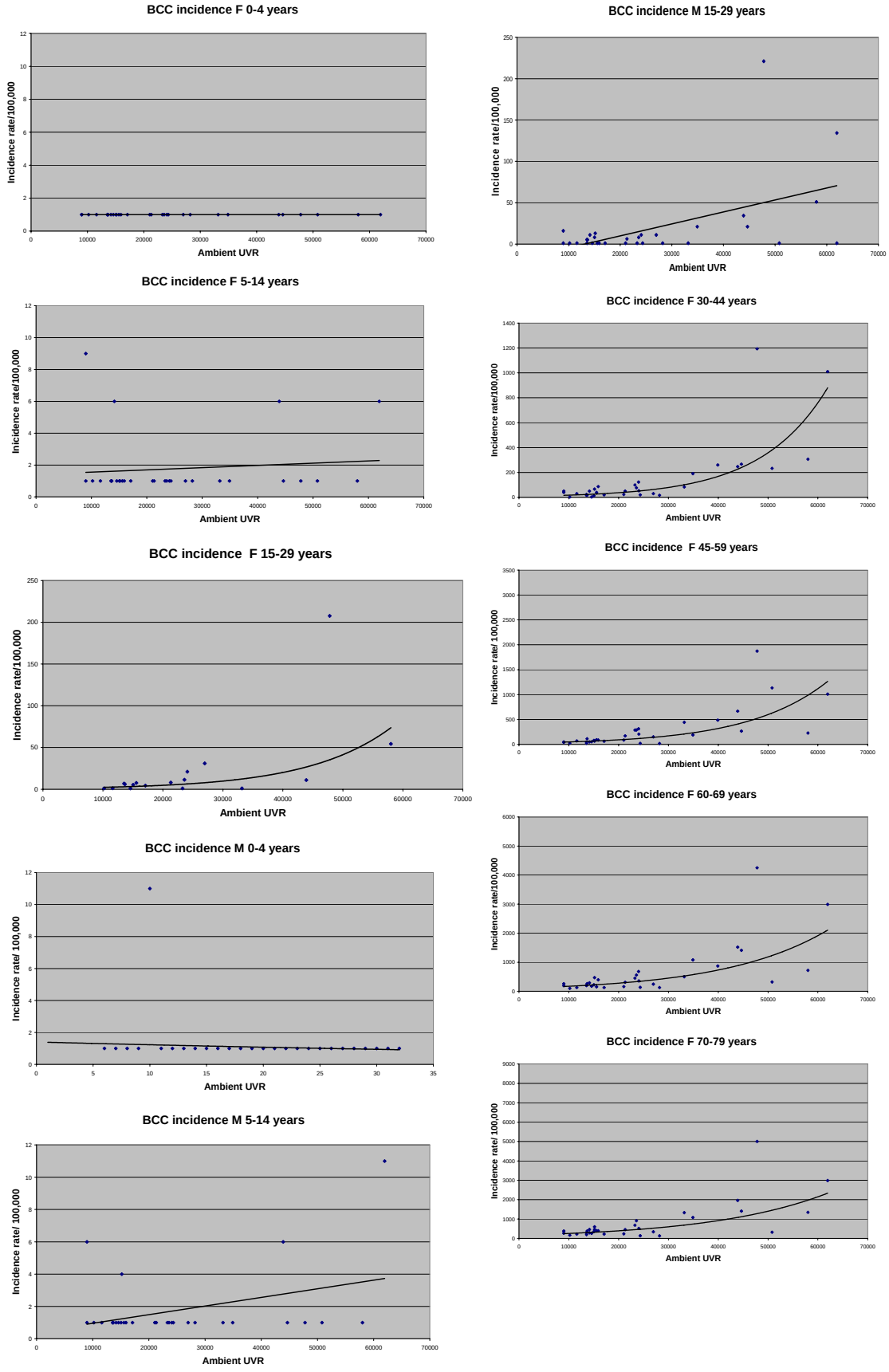
Table A3.10 Incidence to mortality ratios for BCC

Ratio of incidence to mortality	AGE								
	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
Males	0	0	0	0	5716.7	7771.1	4868.616	2621.6	766.9
Females	0	0	0	0	0	10344.2	5881.3	4645.0	1083.4

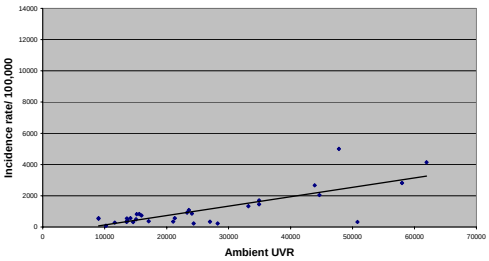
Note: The mortality rate was derived by dividing the incidence rate by this incidence to mortality ratio except those cells with a zero, where the mortality rate was taken as zero.

Incidence data from published epidemiological literature were used to develop dose-response curves which are presented in Figure A3.5.

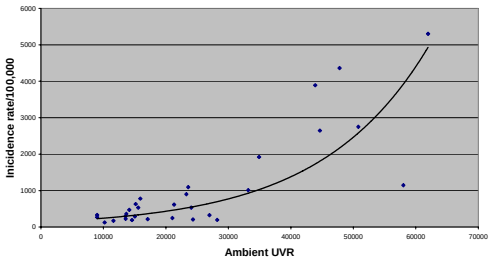
Figure A3.5 Variation in BCC incidence by annual ambient UVR



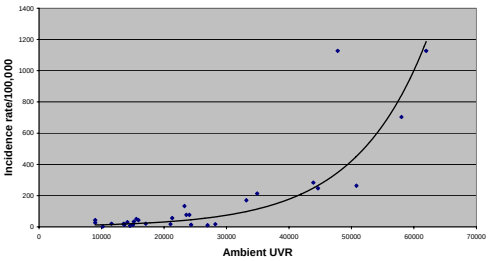
BCC incidence F 80+ years



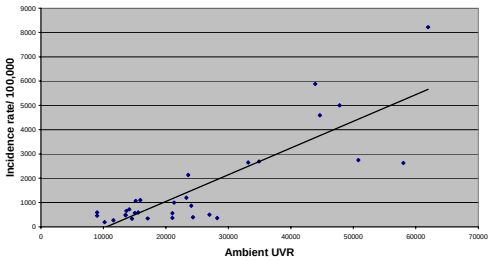
BCC incidence M 60-69 years



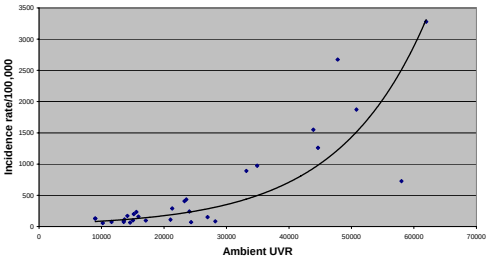
BCC incidence M 30-44 years



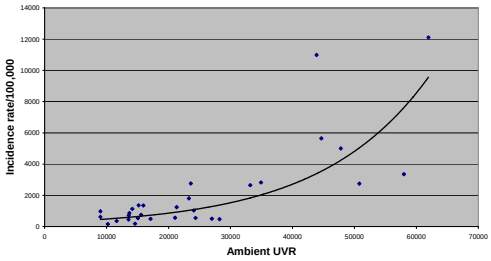
BCC incidence M 70-79 years



BCC incidence M 45-59 years



BCC incidence M 80+ years



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16. **Mathers, C. et al.** The burden of disease and injury in Australia. Canberra, Australian Institute of Health and Welfare, 1999, pp. 245.

Section 4: Worksheet for: Photoageing/solar keratoses

Case definition and sequelae: Includes actinic keratosis (solar keratosis), wrinkling, actinic lentigines, progression to squamous cell carcinoma

The disability weights for those aspects of photoageing that attract a disability are listed in Table A3.12. No studies list a disability weight for removal of a solar keratosis, so that this was inferred by comparison with the disability weight for localized BCC (0.05 from the Dutch study and the Australian Burden of Disease Study) and that for dental caries (0.01 in the Global Burden of Disease Study).

Table A3.12 Disability weights for aspects of photoageing

Disease phase/treatment	Disability weight
Progression to SCC, removal	0.070 (Australian BoD study)
Removal of solar keratosis	0.02 (inferred, see text)

There are no ecologic and few case-control studies on the contribution sun exposure makes to "photoageing". However, it is clear that wrinkles are a product of both normal ageing and photoageing. Griffiths estimates that 85% of wrinkling is due to the effects of sun-exposure (*1*). Photoageing also includes actinic lentigines and solar keratoses. In terms of the global burden of disease, we are only interested in solar keratoses –despite their lack of an inherent disability there is a premalignant potential, which causes them to be removed and a possibility of malignant transformation. Frost et al (*2*) examined the prevalence of solar keratoses in relation to a number of different measures of past UVR exposure – sunburns <20 years, sunburns >20years, occupational exposure, lifetime exposure and recreational exposure. The calculated PAFs using these different measures of exposure range from –0.35 for recreational exposure, to 0.57 for sunburn occurring below the age of 20 years.

Photoageing is by definition due to UVR exposure. Solar keratoses are recognizably distinct from other keratoses, eg arsenical keratosis and are a feature of severe sun damage. In view of this, we have used a PAF of 1.0 in this analysis, ie burden of disease due to photoageing is fully attributed to UVR exposure. Table A3.13 shows the estimated prevalence per cent of solar keratoses in lightly pigmented population, by latitudinal band.

Table A3.13 Prevalence per cent of solar keratoses in lightly pigmented populations, by latitude

	Male								Female							
	Age (years)								Age (years)							
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0	0	1	5	24	33	40	36	0	0	0	2.5	12	16.5	20	18
10-20	0	0	0	4.4	21	30	37	35	0	0	0	2.2	10.5	15	18.5	17
20-30	0	0	0	4	18.9	23	31	27	0	0	0	2	9.5	11.5	15.5	13.5
30-40	0	0	0	3.8	15.4	18	27	24	0	0	0	1.9	8	9	13.5	12
40-50	0	0	0	3.2	10	12	17	15	0	0	0	1.6	5	6	8.6	7.5
50-60	0	0	0	0.8	2.5	5	8	5	0	0	0	0.4	1.3	2.5	4	2.5
60-70	0	0	0	0.3	0.8	1.5	3.5	2.5	0	0	0	0.15	0.4	0.75	1.75	1.25

References

1. **Griffiths, C.E.** Dowling Oration delivered at the Royal College of Physicians, London, Friday 5 June 1998. Retinoids: renaissance and reformation. *Clinical and Experimental Dermatology. 24* (4): 329-335 (1999).
2. **Frost, C.A. et al.** The prevalence and determinants of solar keratoses at a subtropical latitude (Queensland, Australia). *British Journal of Dermatology. 139* (6): 1033-1039 (1998).

Worksheet for: Sunburn

There are no disability weights already calculated for sunburn. Table A3.14 lists disability weights for sunburn that have been inferred by comparison to other minor disabilities in either the Dutch study or the Global Burden of Disease Study.

Table A3.14 Disability weights for sunburn

Disease state	Disability weight
Painful sunburn	0.01 (similar acute tonsillitis, Dutch study)
Blistering sunburn	0.158 (<20% burn,short term, GBD)

All sunburn is considered to be attributable to excess UVR exposure, i.e. PAF = 1.0. Tables A3.15 – A3.17 show the estimated incidence rate (%) of sunburn by latitudinal band.

Table A3.15 Incidence rate (%) of sunburn by latitude for lightly pigmented populations (Male = Female)

	Age (years)							
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	25.0	67.5	63.3	46.7	38.3	10.0	5.0	0.0
10-20	25.0	65.0	63.3	46.7	38.3	10.0	5.0	0.0
20-30	20.0	62.5	63.3	46.7	38.3	10.0	5.0	0.0
30-40	20.0	57.5	63.3	46.7	38.3	10.0	5.0	0.0
40-50	15.0	51.0	60.0	46.7	38.3	10.0	5.0	0.0
50-60	10.0	45.0	57.0	42.0	36.0	10.0	5.0	0.0
60-70	5.0	25.0	36.3	31.7	26.0	10.0	5.0	0.0

Table A3.16 Incidence rate (%) of sunburn by latitude for populations of medium pigmentation

	Age (years)							
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	12.5	32.5	31.7	23.3	19.2	5.0	2.5	0.0
10-20	12.5	32.5	31.7	23.3	19.2	5.0	2.5	0.0
20-30	10.0	31.3	31.7	23.3	19.2	5.0	2.5	0.0
30-40	10.0	28.8	31.7	23.3	19.2	5.0	2.5	0.0
40-50	7.5	25.5	30.0	23.3	19.2	5.0	2.5	0.0
50-60	5.0	22.5	28.5	21.0	18.0	5.0	2.5	0.0
60-70	2.5	12.5	18.2	15.8	13.0	5.0	2.5	0.0

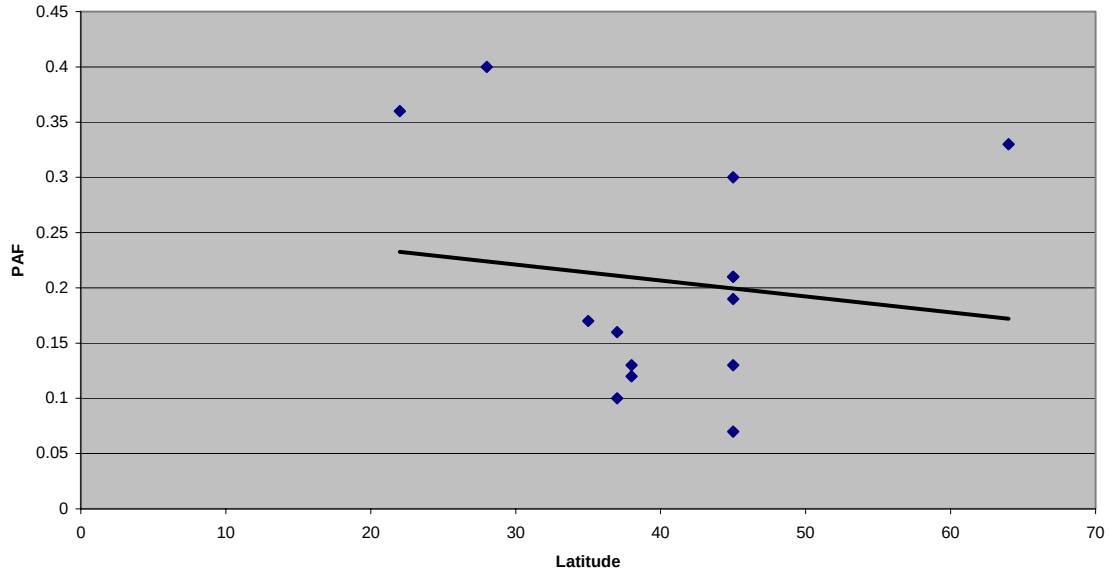
Table A3.17 Incidence rate %) of sunburn by latitude for deeply pigmented populations

	Age (years)							
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	2.5	6.8	6.3	4.7	3.8	1.0	0.5	0.0
10-20	2.5	6.5	6.3	4.7	3.8	1.0	0.5	0.0
20-30	2.0	6.3	6.3	4.7	3.8	1.0	0.5	0.0
30-40	2.0	5.8	6.3	4.7	3.8	1.0	0.5	0.0
40-50	1.5	5.1	6.0	4.7	3.8	1.0	0.5	0.0
50-60	1.0	4.5	5.7	4.2	3.6	1.0	0.5	0.0
60-70	0.5	2.5	3.6	3.2	2.6	1.0	0.5	0.0

Section 5: Worksheet for Cortical Cataract

Population attributable fractions derived from the epidemiological literature were graphed against the latitude of the study location (Figure A3.6). There was a non-significant latitudinal gradient (p = 0.62) with a mean of 0.19 and an intercept of 0.26. A PAF of 0.20 was applied to the estimates of burden of disease due to cortical cataract. While the inaccuracy of sun exposure measurement in studies of skin cancer led us to use a higher PAF than the mean PAF derived from case-control studies for the skin disorders associated with UVR exposure, more detailed exposure measurements have been used in many of the cataract studies, so that the PAF used is closer to the mean of data presented in Figure A3.6.

Figure A3.6 Cortical cataract and UVR exposure by latitude



The studies from which Figure A3.6 were derived are listed in Table A3.18.

Table A3.18 Case control and cohort studies on the association between cortical cataract and UVR exposure

No.	Reference	Odds ratio (95% CI)	Exposure measure
1	AREDS, 2001	1.33 (0.98-1.82)	Cumulative ocular exposure
2	Collman, 1988	1.53 (0.21-7.19)	Average sun exposure
3	Cruickshanks, 1992	F 0.94 (0.70-1.26) M 1.36 (1.02-1.79)	Average annual exposure
4	Delcourt, 2000	2.48 (1.24-4.99)	Cumulative hours of sunshine
5	Graziosi, 1996	1.73 (1.03-2.93)	Sunlight index
6	Katoh, 2001	2.91 (1.13-9.62)	Time spent outdoors, diff ages
7	McCarty, 1999	1.44 (1.21-1.73)	Cumulative ocular exposure
8	McCarty, 2000	PAF = 0.10 (0.085-0.12)	
9	Mohan, 1989	0.78 (0.68-0.90)	Amount of cloud cover
10	Rosmini, 1994	2.26 (1.14-4.46)	Sunlight index
11	West, 1998	1.57 (1.04-2.38)	Cumulative ocular exposure
12	Wong, 1993	2.1 (0.6-7.9)	Sunlight index

References

1. **AREDS.** Risk factors associated with age-related nuclear and cortical cataract : a case-control study in the Age-Related Eye Disease Study, AREDS Report No. 5. *Ophthalmology. 108* (8): 1400-1408. (2001).
2. **Collman, G.W. et al.** Sunlight and other risk factors for cataracts: an epidemiologic study. *American Journal of Public Health. 78* (11): 1459-1462. (1988).
3. **Cruickshanks, K.J. et al.** Ultraviolet light exposure and lens opacities: the Beaver Dam Eye Study. *American Journal of Public Health. 82* (12): 1658-1662 (1992).
4. **Delcourt, C. et al.** Light exposure and the risk of cortical, nuclear, and posterior subcapsular cataracts: the Pathologies Oculaires Liees a l'Age (POLA) study. *Archives of Ophthalmology. 118* (3): 385-392 (2000).
5. **Graziosi, P. et al.** Location and severity of cortical opacities in different regions of the lens in age-related cataract. *Investigative Ophthalmology and Visual Science. 37* (8): 1698-1703. (1996).
6. **Katoh, N. et al.** Cortical lens opacification in Iceland. Risk factor analysis -- Reykjavik Eye Study. *Acta Ophthalmologica Scandinavica. 79* (2): 154-159. (2001).
7. **McCarty, C.A. et al.** The epidemiology of cataract in Australia. *American Journal of Ophthalmology. 128* (4): 446-465 (1999).
8. **McCarty, C.A. et al.** Attributable risk estimates for cataract to prioritize medical and public health action. *Investigative Ophthalmology and Visual Science. 41* (12): 3720-3725 (2000).
9. **Mohan, M. et al.** India-US case-control study of age-related cataracts. India-US Case-Control Study Group. *Archives of Ophthalmology. 107* (5): 670-676. (1989).
10. **Rosmini, F. et al.** A dose-response effect between a sunlight index and age-related cataracts. Italian-American Cataract Study Group. *Annals of Epidemiology. 4* (4): 266-270. (1994).
11. **West, S.K. et al.** Sunlight exposure and risk of lens opacities in a population-based study: the Salisbury Eye Evaluation project. *JAMA. 280* (8): 714-718 (1998).
12. **Wong, L. et al.** Sunlight exposure, antioxidant status, and cataract in Hong Kong fishermen. *Journal of Epidemiology and Community Health. 47* (1): 46-49 (1993).

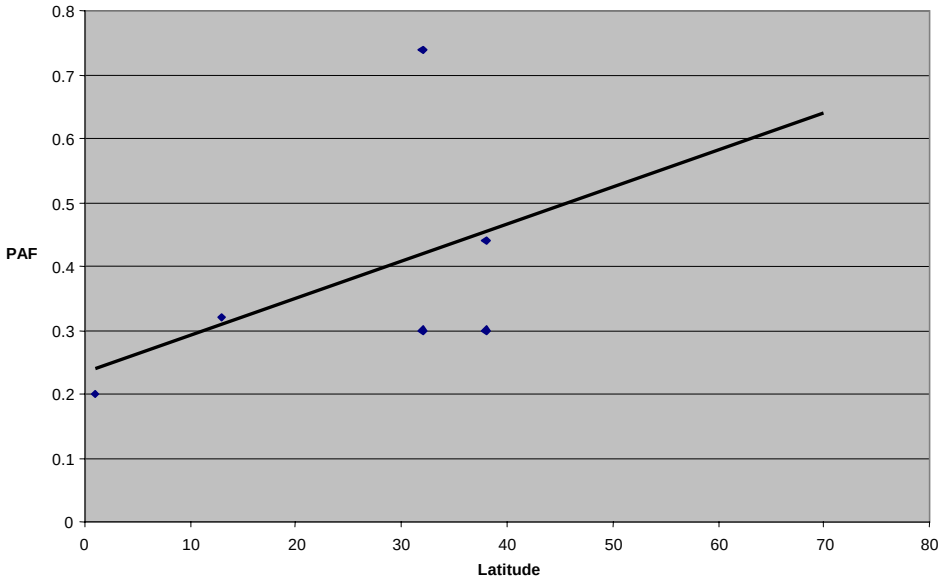
Section 6: Worksheet for Pterygium

Case definition and sequelae: H11.0 (excludes pseudopterygium)
Disability weight: There are no disability weights already calculated for pterygium. After discussion with clinical experts, we assigned a disability weight of 0.081 (similar weight to dental caries, Global Burden of Disease, 1990 (*1*))

Figure A3.7 presents the PAF calculated from case-control studies, and related to latitude (p = 0.35, intercept = 0.23).

The positive gradient of this line is somewhat counter-intuitive. It is largely influenced by a hospital-based (rather than population-based) case-control study in Singapore (*2*) from which we have estimated a PAF of 0.2 based on an odds ratio of 1.31 (95% CI 1.09 to 1.57) for sunlight exposure ten years ago – a measure subject to considerable recall inaccuracy. It could reasonably be omitted from this graph, which is otherwise based on population-based case-control studies. If this were omitted, there would be little latitudinal variation in the PAFs (p = 0.79) with a mean of 0.42 and an intercept of 0.33. The other outlying figure is from Threlfall et al (*3*), from which a PAF of 0.74 was calculated from an odds ratio of 6.77 (95% CI 2.60-19.68) using daily ocular radiation dose as the measure of UVR exposure. Most other studies use an averaged annular ocular dose as the measure of UVR exposure.

Figure A3.7 Pterygium and UVR exposure



On the basis of the above discussion, a PAF of 0.42 was used as a lower estimate of population attributable fraction and a PAF of 0.74 was used as an upper estimate. Studies from which these data are derived are listed in Table A3.19.

Tab1e A3.19 Studies on pterygium and UVR exposure

No.	Reference	Odds ratio (95% CI)	Exposure measure
4	Luthra, 2001	1.87 (1.52-2.29)	Outdoor job location
5	McCarty, 2000	1.63 (1.18-2.25)	Mean annual ocular UVB
2	Saw, 2000	1.31 (1.09-1.57)	Sunlight exposure
6	Taylor, 1989	3.06 (1.77-5.31)	Mean annual ocular UVB
3	Threlfall, 1999	6.77 (2.6-19.68)	Average daily ocular dose
		2.31 (1.28-4.25)	Av. Daily global solar energy
		2.63 (1.49-4.71)	Daily hours sunshine

Table A3.20 shows the estimated prevalence (%) of pterygium by latitudinal band.

Table A3.20 Prevalence (%) of pterygium by latitude

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0	0	1	5	24	33	40	36	0	0	0	2.5	12	16.5	20	18
10-20	0	0	0	4.4	21	30	37	35	0	0	0	2.2	10.5	15	18.5	17
20-30	0	0	0	4	18.9	23	31	27	0	0	0	2	9.5	11.5	15.5	13.5
30-40	0	0	0	3.8	15.4	18	27	24	0	0	0	1.9	8	9	13.5	12
40-50	0	0	0	3.2	10	12	17	15	0	0	0	1.6	5	6	8.6	7.5
50-60	0	0	0	0.8	2.5	5	8	5	0	0	0	0.4	1.3	2.5	4	2.5
60-70	0	0	0	0.3	0.8	1.5	3.5	2.5	0	0	0	0.15	0.4	0.75	1.75	1.25

References

1. **Murray, C. & Lopez, A.** The Global Burden of Disease: A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. *Global Burden of Disease and Injury Series*, Harvard School of Public Health. Harvard University Press, 1996.
2. **Saw, S.M. et al.** Risk factors for the development of pterygium in Singapore: a hospital-based case-control study. *Acta Ophthalmologica Scandinavica. 78* (2): 216-220 (2000).
3. **Threlfall, T.J. & English, D.R.** Sun exposure and pterygium of the eye: a dose-response curve. *American Journal of Ophthalmology. 128* (3): 280-287 (1999).
4. **Luthra, R. et al.** Frequency and risk factors for pterygium in the Barbados Eye Study. *Archives of Ophthalmology. 119* (12): 1827-1832. (2001).
5. **McCarty, C.A. et al.** Epidemiology of pterygium in Victoria, Australia. *British Journal of Ophthalmology. 84* (3): 289-292 (2000).
6. **Taylor, H.R. et al.** Corneal changes associated with chronic UV irradiation. *Archives of Ophthalmology. 107* (10): 1481-1484 (1989).

Section 7: Worksheet for Carcinoma of the conjunctiva and carcinoma of the cornea

ICD 10 classification: C 69.0, C69.1

There are no calculated disability weights for the various phases and treatments of carcinoma of the cornea and conjunctiva. The disability weights presented below were inferred by comparison with disability weights for similar disorders, in consultation with clinical experts. The disability weights are listed in Table A3.21.

Table A3.21 Disability weights for the disease phases and treatments of carcinoma of the cornea and conjunctiva

Disease phases/treatments	Disability weights
Primary treatment – local resection	0.190 (same as melanoma, primary resection)
Primary treatment – extensive resection	0.298 (injury to the eyes, long term, Australian BOD study)
Advanced disease – enucleation	0.430 (same as melanoma, extensive resection)
Enucleation (long term)	0.2 (more than an amputated arm, but less than an amputated foot, GBD)

While cancers of the cornea and conjunctiva are squamous cell carcinomas, one might expect the disability weight to be higher in a disorder involving a critical, sensitive and cosmetically obvious organ, such as an eye, compared to skin involvement. The above weights were imputed based on discussion with clinicians (personal communication, Prof L Hirst).

Sun found links between SCCC and UVB exposure of a similar magnitude to SCC of the eyelid (*1*). The PAF calculated from the single relevant study by Lee et al (using as a UV exposure measure cumulative exposure at ≤ 30° for ≥ 50 years), gave a PAF of 0.62, based on an odds ratio of 3.9 (1.0-14.8) (*2*). After discussion within this working group it was decided to use the same PAF as for SCC. Notably, there has been a huge increase in the incidence of SCCC with HIV in Africa – PAF for HIV has been estimated at 0.66 (*3*).

Tables A3.22 – A3.24 shows the estimated incidence rate of SCCC per million population, by latitudinal band and categories of skin pigmentation.

Table A3.22 Incidence rate of SCCC per million – lightly pigmented populations

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0.0	0.7	1.9	5.5	12.0	15.0	17.0	19.0	0.0	0.2	1.5	4.5	8.0	11.0	13.0	15.0
10-20	0.0	0.2	0.8	3.5	8.2	10.2	13.8	15.5	0.0	0.1	0.7	3.3	8.0	10.0	13.0	15.0
20-30	0.0	0.0	0.4	1.8	5.3	7.5	11.3	13.0	0.0	0.0	0.4	1.5	4.0	5.5	6.5	7.5
30-40	0.0	0.0	0.3	1.2	4.0	5.5	7.0	8.0	0.0	0.0	0.2	0.9	3.0	5.0	6.5	7.0
40-50	0.0	0.0	0.1	0.5	1.2	2.5	3.0	5.0	0.0	0.0	0.1	0.3	0.8	2.0	2.5	4.0
50-60	0.0	0.0	0.0	0.2	0.5	1.0	1.5	2.5	0.0	0.0	0.0	0.2	0.4	0.9	1.3	2.3
60-70	0.0	0.0	0.0	0.1	0.3	0.7	1.2	2.2	0.0	0.0	0.0	0.1	0.2	0.6	1.2	1.9

Table A3.23 Incidence rate of SCCC per million –populations of medium pigmentation

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0.0	0.1	0.7	3.3	8.0	10.0	13.0	15.0	0.0	0.1	0.6	3.2	7.0	9.0	12.0	14.0
10-20	0.0	0.1	0.6	2.5	6.3	8.5	9.5	11.5	0.0	0.1	0.5	1.2	4.0	5.5	6.5	7.0
20-30	0.0	0.0	0.5	2.2	5.5	7.5	8.0	10.0	0.0	0.0	0.2	1.0	3.8	5.2	6.2	6.8
30-40	0.0	0.0	0.2	0.8	3.0	4.8	6.2	6.8	0.0	0.0	0.1	0.6	2.8	4.6	6.0	6.5
40-50	0.0	0.0	0.1	0.2	0.6	1.3	2.0	3.2	0.0	0.0	0.1	0.2	0.5	1.2	1.8	2.8
50-60	0.0	0.0	0.0	0.1	0.2	0.6	1.2	1.9	0.0	0.0	0.0	0.1	0.3	0.5	0.6	0.8
60-70	0.0	0.0	0.0	0.1	0.2	0.4	0.5	0.9	0.0	0.0	0.0	0.1	0.2	0.4	0.5	0.9

Table A3.24 Incidence rate of SCCC per million –deeply pigmented populations

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0.0	0.1	0.3	3.2	6.5	8.0	9.8	14.0	0.0	0.1	0.3	1.4	4.3	5.5	6.7	8.2
10-20	0.0	0.0	0.2	1.2	4.2	6.8	8.2	11.0	0.0	0.0	0.2	0.9	3.6	4.2	5.5	6.8
20-30	0.0	0.0	0.1	0.6	2.5	4.1	5.1	6.5	0.0	0.0	0.1	0.5	1.6	2.6	3.8	5.0
30-40	0.0	0.0	0.1	0.4	0.8	2.3	3.5	4.3	0.0	0.0	0.1	0.3	0.6	1.3	2.6	3.9
40-50	0.0	0.0	0.0	0.1	0.3	0.7	1.5	1.9	0.0	0.0	0.1	0.1	0.3	0.6	0.8	1.2
50-60	0.0	0.0	0.0	0.1	0.2	0.4	0.7	0.9	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.7
60-70	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.5	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4

References

1. **Sun, E.C. et al.** Epidemiology of squamous cell conjunctival cancer. *Cancer Epidemiology, Biomarkers and Prevention. 6* (2): 73-77 (1997).
2. **Lee, G.A. et al.** Risk factors in the development of ocular surface epithelial dysplasia. *Ophthalmology. 101* (2): 360-364 (1994).
3. **Waddell, K.M. et al.** Carcinoma of the conjunctiva and HIV infection in Uganda and Malawi. *British Journal of Ophthalmology. 80* (6): 503-508 (1996).

Section 8: Worksheet for Reactivation of herpes labialis

ICD-10 classification: B00.1

Disability weight: 0.005 (less than acute nasopharyngitis 0.014 (Australian BOD study), more than 0)

Young et al (*1*) examined the association of UVR exposure with recurrent herpes labialis in a population of blood donors in Southern Wisconsin, USA. 'Cases' gave a history of having had more than one cold sore and had a herpes virus antibody titre ≥8. The control group reported that they had never had a cold sore. Cases reported more UVR exposure assessed by estimated time outdoors during childhood and as an adult, occupational exposure, history of severe sunburns and use of a sunlamp. Depending on the measure of UVR exposure the calculated PAF was 0.15 (dark tan during childhood), 0.14 (dark tan as an adult), and 0.25 (outdoor job during childhood). Young et al (*2*) listed the lower lip as the most frequent site of development of observed lesions (58.9%) consistent with a causative role of UVR exposure. Of new lesions developing during the observation period (season of observation not defined) 20% were identified as being due to sun exposure.

We know that self-reported sun exposure in the past is difficult to quantify accurately. In addition, in studying recurrent lesions of herpes simplex cases are asked to recall details of the number of cold sores they have had and to make a judgment about whether UVR exposure was the causative factor, or involved in the causation.

What is clear is that UVR exposure has a causative role in the reactivation of herpes labialis. We have used the calculated PAF of 0.25 as a lower estimate, based on the literature presented (the highest PAF presented, but in case-control studies which are likely to underestimate the association due to inaccuracy in the exposure measure) and an upper estimate of 0.50 to provide an adjustment for the inaccuracy inherent in exposure measures which are a proxy for actual UVR exposure.

Tables A3.25-27 present the estimates of prevalence of persons with recurrent herpes labialis by different pigmentation groups and by latitudinal band.

Table A3.25 Prevalence (%) of persons with recurrent herpes labialis, lightly pigmented populations (male = female)

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0	22	45	42	38	36	30	28	0	22	45	42	38	36	30	28
10-20	0	20	40	38	36	35	30	26	0	20	40	38	36	35	30	26
20-30	0	17	35	35	34	32	30	24	0	17	35	35	34	32	30	24
30-40	0	15	30	33	32	30	28	22	0	15	30	33	32	30	28	22
40-50	0	11	23	28	29	26	24	20	0	11	23	28	29	26	24	20
50-60	0	9	19	25	26	22	20	15	0	9	19	25	26	22	20	15
60-70	0	8	16	19.5	22	20	15	10	0	8	16	19.5	22	20	15	10

Table A3.26 Prevalence (%) of persons with recurrent herpes labialis, medium pigmented populations (male = female)

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0	8.8	18	16.8	15.2	14.4	12	11.2	0	8.8	18	16.8	15.2	14.4	12	11.2
10-20	0	8	16	15.2	14.4	14	12	10.4	0	8	16	15.2	14.4	14	12	10.4
20-30	0	6.8	14	14	13.6	12.8	12	9.6	0	6.8	14	14	13.6	12.8	12	9.6
30-40	0	6	12	13.2	12.8	12	11.2	8.8	0	6	12	13.2	12.8	12	11.2	8.8
40-50	0	4.4	9.2	11.2	11.6	10.4	9.6	8	0	4.4	9.2	11.2	11.6	10.4	9.6	8
50-60	0	3.6	7.6	10	10.4	8.8	8	6	0	3.6	7.6	10	10.4	8.8	8	6
60-70	0	3.2	6.4	7.8	8.8	8	6	4	0	3.2	6.4	7.8	8.8	8	6	4

Table A3.27 Prevalence (%) of persons with recurrent herpes labialis, deeply pigmented populations (male = female)

	Male								Female							
	Age(years)															
Latitude (degrees)	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+
0-10	0	22	45	42	38	36	30	28	0	22	45	42	38	36	30	28
10-20	0	20	40	38	36	35	30	26	0	20	40	38	36	35	30	26
20-30	0	17	35	35	34	32	30	24	0	17	35	35	34	32	30	24
30-40	0	15	30	33	32	30	28	22	0	15	30	33	32	30	28	22
40-50	0	11	23	28	29	26	24	20	0	11	23	28	29	26	24	20
50-60	0	9	19	25	26	22	20	15	0	9	19	25	26	22	20	15
60-70	0	8	16	19.5	22	20	15	10	0	8	16	19.5	22	20	15	10

References

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2. **Young, S.K. et al.** A clinical study for the control of facial mucocutaneous herpes virus infections. I. Characterization of natural history in a professional school population. *Oral Surgery, Oral Medicine, Oral Pathology. 41* (4): 498-507 (1976).

Section 9: Worksheet for hypovitaminosis D, rickets, osteomalacia and osteoporosis

ICD 10 classification: E55, E 55.9 and M 83.9
No studies list disability weights for rickets, osteomalacia or specifically for the sequelae of osteoporosis. As noted in Table A3.17, we have inferred disability weights from other studies for similar conditions (see Table A3.24)

Table A3.24 Disability weights for disorders of vitamin D deficiency

Disease phase	Disability weight
Hypovitaminosis D	0.00
Rickets (0-4 years)	0.3 (between mild and moderate rheumatoid arthritis, Australian BoD study)
Rickets + sequelae (5-59) Osteomalacia	0.2 (mild rheumatoid arthritis, Australian BoD study)
Osteoporosis sequelae	0.1 (more than chronic back pain, less than Grade 2 osteoarthritis, Australian BoD study)

Annex 4 WHO subregions by latitude

The population of each region was divided according to 10 degree bands of latitude – 0-10, 10-20, 20-30, 30-40, 40-50, 50-60, 60-70. The population of those countries which fitted neatly into a latitude band were summed. For those countries which overlapped two or more bands of latitude, the proportion of the population within each band was estimated by reference to maps of population density[7], as outlined below. Distribution of pigmentation is assumed to be even throughout the country.

Tables A4.1 and A4.2 show how countries have been categorized for the purpose of this assessment.

[7] www.esri.com/data/online/esri/wothphysic.html

Table A4.1 WHO subregions and countries by latitude

Sub-region	Latitude (degrees)	States, percentage
AFR D	0-10 degrees	Cameroon, Equatorial Guinea, Gabon, Ghana, Liberia, Sao Tome and Principe, Seychelles, Sierra Leone, Angola 50%, Benin 90%, Nigeria 50%, Guinea 50%, Togo
	10-20 degrees	Cape Verde, Chad, Comoros, Gambia, Guinea-Bissau, Mauritius, Niger, Senegal, Angola 50%, Benin 10%, Burkina Faso, guinea 50%, Madagascar 50%, Mauritania 50%, Nigeria 50%, Mali
	20-30 degrees	Algeria 10%, Madagascar 50%, Mauritania 50%
	30-40 degrees	Algeria 90%
AFR E	0-10 degrees	Burundi, Central African Republic, Congo, Cote D'Ivoire, Kenya, Rwanda, Democratic Republic of Congo 95%, Ethiopia 50%, Tanzania
	10-20 degrees	Eritrea, Malawi, Zimbabwe, Botswana 10%, Democratic Republic of Congo 5%, Mozambique 70%, Namibia 20%, Ethiopia 50%
	20-30 degrees	Lesotho, Swaziland, Zambia, Botswana 90%, Mozambique 30%, Namibia 80%, South Africa80%
	30-40 degrees	South Africa 20%
AMR A	20-30 degrees	Cuba, USA 3%
	30-40 degrees	USA 55%
	40-50 degrees	USA 42%
	50-60 degrees	Canada 99%
	60-70 degrees	Canada 1%
AMR B	0-10 degrees	Colombia, Guyana, Panama, Suriname, Brazil 5%, Costa Rica 50%, Venezuela 30%
	10-20 degrees	Antigua and Barbuda, Barbados, Belize, Dominica, Dominican Republic, El Salvador, Grenada, Honduras, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Mexico 59%, Venezuela 70%, Brazil 30%, Costa Rica 50%, Chile 2%, Trinidad and Tobago
	20-30 degrees	Bahamas, Paraguay, Argentina 20%, Brazil 60%, Chile 17%, Mexico 40%
	30-40 degrees	Uruguay, Argentina 79%, Brazil 5%, Chile 80%, Mexico 1%
	40-50 degrees	Argentina 1%, Chile 1%
AMR D	0-10 degrees	Ecuador, Peru 50%
	10-20 degrees	Guatemala, Haiti, Nicaragua, Bolivia 90%, Peru 50%
	20-30 degrees	Bolivia 10%
EMR B	10-20 degrees	Oman 60%, Saudi Arabia 20%
	20-30 degrees	Bahrain, Kuwait, Qatar, United Arab Emirates, Iran 20%, Libya 50%, Morocco 10%, Oman 40%, Saudi Arabia 70%
	30-40 degrees	Cyprus, Jordan, Lebanon, Syrian Arab Republic, Iran 80%, Libya 50%, Morocco 90%, Saudi Arabia 10%, Tunisia
EMR D	0-10 degrees	Somalia, Sudan 20%
	10-20 degrees	Djibouti, Yemen, Sudan 79%
	20-30 degrees	Egypt 50%, Pakistan 50%, Sudan 1%
	30-40 degrees	Afghanistan, Iraq, Pakistan 50%, Egypt 50%
EUR A	30-40 degrees	Israel, Malta, Greece 50%, Italy 20%, Portugal 50%, Spain 50%
	40-50 degrees	Andorra, Austria, Belgium, Croatia, France, Luxembourg, Monaco, San Marino, Slovenia, Czech Republic 50%, Germany 40%, Greece 50%, Italy 80%, Portugal 50%, Spain 50%, Switzerland
	50-60 degrees	Denmark, Ireland, Netherlands, United Kingdom, Czech Republic 50%, Germany 60%, Norway 70%, Sweden 70%
	60-70 degrees	Finland, Iceland, Norway 30%, Sweden 30%
EUR B	30-40 degrees	Tajikistan, Armenia 40%, Azerbaijan 40%, Turkey 60%, Turkmenistan 60%, Uzbekistan 40%
	40-50 degrees	Albania, Bosnia-Herzegovina, Bulgaria, Georgia, Kyrgyzstan, Romania, Slovakia, Macedonia, Armenia 60%, Azerbaijan 60%, Turkey 40%, Turkmenistan 40%, Uzbekistan 60%, Yugoslavia
	50-60 degrees	Poland
EUR C	40-50 degrees	Hungary, Kazakhstan, Russian Federation 5%, Ukraine 70%, Moldova
	50-60 degrees	Belarus, Latvia, Russian Federation 90%, Ukraine 30%, Lithuania
	60-70 degrees	Estonia, Russian Federation 5%
SEAR B	0-10 degrees	Indonesia, Sri Lanka
	10-20 degrees	Thailand
SEAR D	0-10 degrees	Maldives, India 5%
	10-20 degrees	Bangladesh, Bhutan, India 40%, Myanmar 70%, Nepal
	20-30 degrees	India 45%, Myanmar 30%
	30-40 degrees	Democratic People's Republic of Korea 50%, India 10%
	40-50 degrees	Democratic People's Republic of Korea 50%
WPR A	0-10 degrees	Brunei, Singapore
	10-20 degrees	Australia 5%
	20-30 degrees	Australia 20%
	30-40 degrees	Australia 70%, New Zealand, Japan 90%
	40-50 degrees	Australia 5%, Japan 10%
WPR B	0-10 degrees	Kiribati, Malaysia, Marshall Is, Federated States of Micronesia, Nauru, Palau, Solomon Is, Tuvalu, Viet Nam 20%, Philippines 80%
	10-20 degrees	Cambodia, Cook Is, Fiji, Lao People's Democratic Republic, Niue, Papua New Guinea, Samoa, Tonga, Viet Nam 30%, Philippines 20%, Vanuatu
	20-30 degrees	China 25%, Viet Nam 50%
	30-40 degrees	Republic of Korea, China 70%
	40-50 degrees	Mongolia, China 5%

Table A 4.2 WHO subregions and their matching

Region code	WHO member states	Sub-region
RO 1	Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo	AFR D
	Djibouti, Somalia, Sudan	EMR D
RO 2	Botswana, Burundi, Central African Republic, Congo, Cote D'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, Namibia, Rwanda, South Africa, Swaziland, Uganda, United Republic of Tanzania, Zambia, Zimbabwe	AFR E
RO 3	Canada, United States of America	AMR A
RO 4	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela	AMR B
	Cuba	AMR A
RO 5	Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru	AMR D
RO 6	Bahrain, Iran (Islamic Republic Of), Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia	EMR B
	Cyprus	EUR A
RO 7	Egypt, Iraq, Morocco, Yemen	EMR D
RO 8	Andorra, Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Israel, Italy, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, United Kingdom	EUR A
RO 9	Albania, Bosnia and Herzegovina, Bulgaria, Georgia, Poland, Romania, Slovakia, The Former Yugoslav Republic of Macedonia, Turkey, Yugoslavia	EUR B
RO 10	Armenia, Azerbaijan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan	EUR B
RO 11	Belarus, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Republic of Moldova, Russian Federation, Ukraine	EUR C
RO 12	Indonesia, Sri Lanka, Thailand	SEAR B
	Malaysia, Philippines	WPR B
	Brunei Darussalam, Singapore	WPR A
RO 13	Bangladesh, Bhutan, India, Maldives, Nepal	SEAR D
	Afghanistan, Pakistan	EMR D
RO 14	Australia, Japan, New Zealand	WPR A
RO 15	China, Mongolia, Republic of Korea	WPR B
	DPR Korea	SEAR D
RO 16	Cambodia, Lao People's Democratic Republic, Viet Nam	WPR B
	Myanmar	SEAR D
RO 17	Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu	WPR B

Annex 5 Distribution of skin pigmentation

Section 1: Skin pigmentation groupings

Populations were broken down by pigmentation into three groups – lightly pigmented, medium pigmentation, deeply pigmented[8]. Table A5.1 outlines the types of terms used in the race/ethnicity description and how these were allocated to different pigment groups.

Table A 5.1 Skin pigmentation terms

Lightly pigmented	Medium pigmentation	Deeply pigmented
European	Asian	Native African
White	Euro-African	Melanesian
Chinese	Indian	Afro-Caribbean
Greek	Mulatto	Black
Azerbaijani	American Indian	Tutsi
Arab	Polynesian	Twa
Japanese	Hispanic	Bush Creole
Uzbek	Mestizo	Somali
Tajik	Korean	Sotho
Iranian	Malay	Other African tribes
Turkish	Micronesian	

These are approximate estimates. It is very difficult to categorise accurately by race/ethnicity, as there is great individual variation within racial and ethnic groups. Pigmentation grouping is considered to be constant across all age groups within a country.

Section 2: Sub regional distribution of skin pigmentation

Table A5.2 summarizes the proportion of total population of each WHO subregion in each pigmentation group and latitude band.

Table A5.2 Subregional distribution of skin pigmentation

AFR D

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.04%	0.22%	41.04%	41.29%
10-20	0.04%	2.51%	42.29%	44.83%
20-30	0.00%	2.16%	2.08%	4.24%
30-40	0.00%	9.64%	0.00%	9.64%
Total	0.07%	14.52%	85.41%	100.00%

AFR E

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.14%	0.13%	59.43%	59.70%
10-20	0.06%	0.01%	22.03%	22.10%
20-30	1.41%	1.08%	13.32%	15.81%
30-40	0.33%	0.26%	1.79%	2.39%
Total	1.94%	1.48%	96.58%	100.00%

[8] Information on race/ethnicity for each country was based on http://www.infoplease.com/ipa/A0855617.html

AMR A

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
20-30	3.28%	2.12%	0.70%	6.10%
30-40	35.80%	6.21%	5.73%	47.74%
40-50	27.34%	4.74%	4.37%	36.45%
50-60	8.36%	1.25%	0.00%	9.61%
60-70	0.08%	0.01%	0.00%	0.10%
Total	74.87%	14.33%	10.80%	100.00%

AMR B

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	3.87%	10.24%	0.78%	14.89%
10-20	9.40%	24.33%	2.16%	35.90%
20-30	16.17%	18.85%	1.49%	36.51%
30-40	11.25%	1.12%	0.21%	12.58%
40-50	0.12%	0.00%	0.00%	0.12%
Total	40.81%	54.55%	4.64%	100.00%

AMR D

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	4.12%	30.71%	0.89%	35.72%
10-20	5.25%	45.90%	11.95%	53.11%
20-30	0.12%	1.05%	0.00%	1.17%
Total	9.49%	77.66%	12.84%	100.00%

EMR B

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
10-20	3.13%	0.30%	0.05%	3.48%
20-30	22.07%	2.29%	0.03%	24.39%
30-40	70.46%	1.67%	0.00%	72.13%
Total	95.66%	4.26%	0.08%	100.00%

EMR D

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.85%	0.47%	3.54%	4.86%
10-20	7.71%	0.95%	4.11%	12.78%
20-30	0.03%	34.18%	0.05%	34.26%
30-40	13.93%	34.17%	0.00%	48.10%
Total	22.53%	69.78%	7.70%	100.00%

EUR A

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
30-40	11.54%	0.08%	0.11%	11.72%
40-50	49.08%	0.58%	0.43%	50.09%
50-60	35.46%	0.43%	0.00%	35.89%
60-70	2.30%	0.00%	0.00%	2.30%
Total	98.38%	1.08%	0.54%	100.00%

EUR B

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
30-40	29.06%	0.00%	0.00%	29.06%
40-50	52.68%	0.39%	0.00%	53.07%
50-60	17.87%	0.00%	0.00%	17.87%
Total	99.61%	0.39%	0.00%	100.00%

EUR C

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
40-50	29.84%	0.00%	0.00%	29.84%
50-60	66.61%	0.00%	0.00%	66.61%
60-70	3.56%	0.00%	0.00%	3.56%
Total	100%	0.00%	0.00%	100.00%

SEAR B

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.00%	79.00%	0.00%	79.00%
10-20	2.94%	18.06%	0.00%	21.00%
Total	2.94%	97.06%	0.00%	100.00%

SEAR D

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.00%	4.11%	0.00%	4.11%
10-20	0.08%	35.23%	0.00%	35.31%
20-30	0.03%	50.42%	0.00%	50.46%
30-40	0.00%	9.15%	0.00%	9.15%
40-50	0.00	0.97%	0.00%	0.97%
Total	0.11%	99.89%	0.00%	100.00%

WPR A

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	1.83%	0.71%	0.00%	2.54%
10-20	0.58%	0.02%	0.01%	0.62%
20-30	2.34%	0.10%	0.02%	2.46%
30-40	84.77%	0.65%	0.09%	85.50%
40-50	8.85%	0.02%	0.01%	8.88%
Total	98.37%	1.51%	0.12%	100.00%

WPR B

Latitude (degrees)	Lightly pigmented	Intermediate pigmentation	Deeply pigmented	Total
0-10	0.57%	5.92%	0.03%	6.52%
10-20	0.11%	3.65%	0.31%	4.07%
20-30	19.61%	4.22%	0.00%	23.83%
30-40	53.54%	7.70%	0.00%	61.25%
40-50	3.83%	0.50%	0.00%	4.33%
Total	77.67%	21.99%	0.34%	100.00%

Annex 6 Estimation of disease incidence/prevalence for diseases with scanty epidemiological data

The following steps/hypotheses were taken for estimating diseases with scanty epidemiological data:

- For each disease, a complete, systematic review of the literature was undertaken. Grids of latitude band versus age group were drawn up for each gender and each pigment group (if there were gender or pigment group differences in incidence, prevalence or mortality).
- Studies outlining disease incidence (or prevalence or mortality) were sorted by latitude.
- For latitude bands in which there were a number of different incidence rates, these were averaged, for each pigment group.
- Data on populations other than lightly pigmented populations were rare – from the few available, incidence rates were compared to those in lightly pigmented populations to derive a multiplication factor which was then applied to the rates for lightly pigmented populations to derive rates for medium and deeply pigmented persons.
- DISMOD II requires at least three types of input data out of mortality rate, incidence rate, case-fatality rate, remission rate, and prevalence. Such data was not always available. In addition, if only a summary age-standardized rate is available, it is difficult derive age-specific rates that conform to a particular known age distribution using DISMOD e.g. zero prevalence of pterygium before 15 years, uncommon before 25 years, then increasingly common until 80+ years, then falling prevalence. DISMOD was used mainly when the age-specific incidence rate, case-fatality rate and remission rate were known, to generate the mortality rate, or when a summary mortality rate was known to derive an age-specific rate (given a known age-specific incidence rate and one other input). DISMOD was also used to adjust age-specific rates into those required for use in the DALY template.

For some of the remaining latitude bands, summary figures were available, eg age-standardized rates. By graphing the known rates (from the procedure above) within each age group and then each latitude band, incidence rates that were compatible with the summary rates and fitted the age and latitude distribution of the known rates were derived. Where a graph of incidence rate for an age group, across the different bands of latitude suggested that the incidence rate in the 0-10 latitude band was infinitely large, this was adjusted down. Similarly, where a graph of incidence by age group in a particular latitude band suggested an infinitely large incidence rate in the oldest age group, this was adjusted down, to be in keeping with the known age distributions.

Example – Sunburn see Table A6.1 (*1-5*)

Distribution was developed for white populations (lightly pigmented). Figures for males and females in all age groups in the latitude bands, 10-20, 20-30, 40-50 and 60-70 degrees were derived from the literature in the following way:

- Each study providing incidence figures was allocated to the latitude band in which the study was undertaken.
- Age groups were adjusted (using DISMOD if necessary) to be comparable across all studies and compatible with those required for the BoD calculation
- The incidence rates for each age group and gender within a latitude band were averaged and that figure entered in the table below.

- Data for missing cells was extrapolated from graphs drawn from available data, epidemiological evidence of age and latitude distribution of disease. For sunburn, for example, good data were only available for two latitude bands, with data available only for a few age groups at other latitudes. Using the latitude bands for which data were available for all ages as the age distribution, and the latitudinal pattern for those age groups where those data were available, missing cells were filled. These estimates are relatively rough and carry an important uncertainty.

Table A 6.1 outlines the resulting estimates for sunburn, as an example, following the method described above.

Table A 6.1 Sunburn (any), annual incidence (percent) by age and latitudinal position

Fair-skinned populations. Male incidence = Female incidence

Age group	Latitude (degrees)						
(years)	0-10	10-20	20-30	30-40	40-50	50-60	60-70
0-4	25.00	25.00	20.00	20.00	15.00	10.00	5.00
5-14	77.50	75.00	72.50	71.00	52.50	45.00	38.00
15-29	85.00	80.00	75.00	68.33	63.67	55.00	49.33
30-44	58.33	55.00	50.00	50.00	48.33	45.00	44.33
45-59	31.67	31.67	30.00	30.00	30.00	30.00	30.00
60-69	10.00	10.00	10.00	10.00	10.00	10.00	10.00
70-79	10.00	10.00	10.00	10.00	10.00	10.00	10.00
80+	10.00	10.00	10.00	10.00	10.00	10.00	10.00

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Annex 7 Summary results for the year 2000

Table A.7.1 Deaths due to UVR-related diseases - World

World	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	48	72	855	3243	8346	8065	8506	6034	39	52	645	2392	5085	5807	8196	7769	65 154
SCC	0	0	0	30	1072	2149	2401	2847	0	0	0	0	459	682	1255	2640	13 535
BCC	0	0	0	96	249	471	840	513	0	0	0	0	226	155	201	490	3 241
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	48	72	855	3 369	9 667	10 685	11 747	9394	39	52	645	2392	5570	6644	9652	10 899	81 930

Table A.7.2 Deaths due to excessive UVR exposure – upper estimates

World	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	43	67	768	2920	7 510	7 259	7 657	5 432	35	46	581	2152	4 577	5 228	7 379	6 993	58 645
SCC	0	0	0	21	750	1 504	1 681	1 993	0	0	0	0	321	477	879	1 848	9 474
BCC	0	0	0	86	224	424	756	462	0	0	0	0	203	140	181	441	2 921
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	43	67	768	3027	8 484	9 188	10 094	7 886	35	46	581	2 152	5 101	5 845	8 439	9 282	71 039

Table A.7.3 Deaths due to excessive UVR exposure – lower estimates

World	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	24	37	427	1 622	4 172	4 033	4 254	3 018	20	26	323	1 196	2 543	2 905	4 100	3 885	32 581
SCC	0	0	0	15	536	1 075	1 201	1 424	0	0	0	0	230	341	628	1 320	6 767
BCC	0	0	0	48	125	236	420	257	0	0	0	0	113	78	101	245	1 623
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	24	36	428	1685	4834	5343	5874	4697	20	26	323	1196	2785	3 322	4 826	5 450	40 970

Table A.7.4 Deaths due to UVR-related diseases - AFR D

AFR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	7	4	48	88	327	458	573	304	6	3	20	52	222	669	864	317	3 962
SCC	0	0	0	1	23	42	41	27	0	0	0	0	12	15	20	27	208
BCC	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	1	6
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	7	4	48	89	351	501	615	332	6	3	20	52	235	684	884	345	4 176

Table A7.5 Deaths due to excessive UVR exposure - upper estimates

AFR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	6	4	43	79	294	412	516	274	5	3	18	47	200	602	778	285	3 566
SCC	0	0	0	1	16	29	29	19	0	0	0	0	8	11	14	19	146
BCC	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	1	5
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6	4	43	80	311	443	545	293	5	3	18	47	209	613	792	305	3 717

Table A.7.6 Deaths due to excessive UVR exposure – lower estimates

AFR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	4	2	24	44	164	229	287	152	3	2	10	26	111	335	432	159	1 981
SCC	0	0	0	1	12	21	21	14	0	0	0	0	6	8	10	14	104
BCC	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	1	3
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4	2	24	45	176	251	308	166	3	2	10	26	118	342	442	173	2 088

Table A.7.7 Deaths due to UVR-related diseases - AFR E

AFR E	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	12	4	185	300	599	575	399	229	1	1	66	163	314	800	1298	469	5 415
SCC	0	0	0	1	25	44	43	24	0	0	0	0	13	16	21	32	219
BCC	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	1	7
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	12	4	185	302	625	620	443	254	1	1	66	163	328	816	1319	502	5 641

Table A7.8 Deaths due to excessive UVR exposure - upper estimates

AFR E	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	11	4	167	270	539	518	359	206	1	1	59	147	283	720	1168	422	4 874
SCC	0	0	0	1	18	31	30	17	0	0	0	0	9	11	15	22	153
BCC	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	1	6
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	11	4	167	272	558	549	390	224	1	1	59	147	293	731	1183	445	5 033

Table A.7.9 Deaths due to excessive UVR exposure – lower estimates

AFR E	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	6	2	93	150	300	288	200	115	1	1	33	82	157	400	649	235	2 708
SCC	0	0	0	1	13	22	22	12	0	0	0	0	7	8	11	16	110
BCC	0	0	0	1	1	1	1	1	0	0	0	0	1	0	0	1	4
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	6	2	93	151	313	310	222	127	1	1	33	82	164	408	660	251	2 821

Table A.7.10 Deaths due to UVR-related diseases - AMR A

AMR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	105	745	1 947	1 715	2 014	1 730	2	2	56	385	831	728	1031	1405	12 698
SCC	0	0	0	1	49	101	160	384	0	0	0	0	19	30	92	342	1 178
BCC	0	0	0	3	14	36	87	68	0	0	0	0	14	10	18	77	327
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	105	749	2 010	1 852	2 261	2 182	2	2	56	385	864	768	1141	1824	14 203

Table A7.11 Deaths due to excessive UVR exposure - upper estimates

AMR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	95	671	1752	1544	1813	1557	2	2	50	347	748	655	928	1265	11428
SCC	0	0	0	1	34	71	112	269	0	0	0	0	13	21	64	239	825
BCC	0	0	0	3	13	32	78	61	0	0	0	0	13	9	16	69	294
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	95	674	1799	1647	2003	1887	2	2	50	347	774	685	1009	1573	12547

Table A.7.12 Deaths due to excessive UVR exposure – lower estimates

AMR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	53	373	974	858	1007	865	1	1	28	193	416	364	516	703	6349
SCC	0	0	0	1	25	51	80	192	0	0	0	0	10	15	46	171	589
BCC	0	0	0	2	7	18	44	34	0	0	0	0	7	5	9	39	164
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	53	375	1005	926	1131	1091	1	1	28	193	432	384	571	912	7102

Table A.7.13 Deaths due to UVR-related diseases - AMR B

AMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	3	16	84	293	704	610	590	429	9	3	60	233	364	368	506	497	4 769
SCC	0	0	0	4	128	233	272	250	0	0	0	0	63	83	139	279	1 451
BCC	0	0	0	17	36	39	69	65	0	0	0	0	32	17	18	36	329
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	16	84	314	868	882	931	744	9	3	60	233	459	468	663	812	6 549

Table A7.14 Deaths due to excessive UVR exposure - upper estimates

AMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	3	14	76	264	634	549	531	386	8	3	54	210	328	331	455	447	4 292
SCC	0	0	0	3	90	163	190	175	0	0	0	0	44	58	97	195	1 016
BCC	0	0	0	15	32	35	62	59	0	0	0	0	29	15	16	32	296
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3	14	76	282	756	747	784	620	8	3	54	210	401	405	569	675	5 604

Table A.7.15 Deaths due to excessive UVR exposure – lower estimates

AMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	2	8	42	147	352	305	295	215	5	2	30	117	182	184	253	249	2 385
SCC	0	0	0	2	64	117	136	125	0	0	0	0	32	42	70	140	726
BCC	0	0	0	9	18	20	35	33	0	0	0	0	16	9	9	18	165
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	8	42	157	434	441	466	372	5	2	30	117	230	234	332	406	3 275

Table A.7.16 Deaths due to UVR-related diseases - AMR D

AMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	2	3	8	13	46	46	67	48	0	0	7	20	48	56	74	58	496
SCC	0	0	0	1	20	38	41	29	0	0	0	0	10	13	19	33	204
BCC	0	0	0	3	5	3	5	8	0	0	0	0	4	2	2	2	34
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	3	8	17	71	87	113	85	0	0	7	20	62	71	95	93	734

Table A7.17 Deaths due to excessive UVR exposure - upper estimates

AMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	2	3	7	12	41	41	60	43	0	0	6	18	43	50	67	52	446
SCC	0	0	0	1	14	27	29	20	0	0	0	0	7	9	13	23	143
BCC	0	0	0	3	5	3	5	7	0	0	0	0	4	2	2	2	31
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	3	7	15	60	71	94	71	0	0	6	18	54	61	82	77	620

Table A.7.18 Deaths due to excessive UVR exposure – lower estimates

AMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	2	4	7	23	23	34	24	0	0	4	10	24	28	37	29	248
SCC	0	0	0	1	10	19	21	15	0	0	0	0	5	7	10	17	102
BCC	0	0	0	2	3	2	3	4	0	0	0	0	2	1	1	1	17
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	2	4	9	36	44	57	43	0	0	4	10	31	36	48	47	367

Table A.7.19 Deaths due to UVR-related diseases - EMR B

EMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	24	61	55	117	149	48	0	1	69	11	45	35	100	11	726
SCC	0	0	0	1	50	83	91	82	0	0	0	0	17	24	38	60	446
BCC	0	0	0	9	20	22	36	25	0	0	0	0	11	7	7	11	148
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	24	71	125	222	276	155	0	1	69	11	73	66	145	82	1320

Table A7.20 Deaths due to excessive UVR exposure - upper estimates

EMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	22	55	50	105	134	43	0	1	62	10	41	32	90	10	653
SCC	0	0	0	1	35	58	64	57	0	0	0	0	12	17	27	42	312
BCC	0	0	0	8	18	20	32	23	0	0	0	0	10	6	6	10	133
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	22	64	103	183	230	123	0	1	62	10	62	55	123	62	1099

Table A.7.21 Deaths due to excessive UVR exposure – lower estimates

EMR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	12	31	28	59	75	24	0	1	35	6	23	18	50	6	363
SCC	0	0	0	1	25	42	46	41	0	0	0	0	9	12	19	30	223
BCC	0	0	0	5	10	11	18	13	0	0	0	0	6	4	4	6	74
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	12	36	63	111	138	78	0	1	35	6	37	33	73	41	660

Table A.7.22 Deaths due to UVR-related diseases - EMR D

EMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	43	79	270	215	31	16	6	16	49	81	124	148	94	36	1210
SCC	0	0	0	2	60	106	104	80	0	0	0	0	29	36	47	64	528
BCC	0	0	0	11	16	14	20	18	0	0	0	0	14	7	5	7	112
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	43	92	346	335	155	114	6	16	49	81	167	191	146	107	1850

Table A7.23 Deaths due to excessive UVR exposure - upper estimates

EMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	39	71	243	194	28	14	5	14	44	73	112	133	85	32	1089
SCC	0	0	0	1	42	74	73	56	0	0	0	0	20	25	33	45	370
BCC	0	0	0	10	14	13	18	16	0	0	0	0	13	6	5	6	101
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	39	82	299	280	119	87	5	14	44	73	145	165	122	84	1559

Table A.7.24 Deaths due to excessive UVR exposure – lower estimates

EMR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	22	40	135	108	16	8	3	8	25	41	62	74	47	18	605
SCC	0	0	0	1	30	53	52	40	0	0	0	0	15	18	24	32	264
BCC	0	0	0	6	8	7	10	9	0	0	0	0	7	4	3	4	56
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	22	46	173	168	78	57	3	8	25	41	84	96	73	54	925

Table A.7.25 Deaths due to UVR-related diseases - EUR A

EUR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	2	121	716	1 661	1 660	2 102	1 716	0	1	100	505	1 126	1 072	1 710	2 598	15 091
SCC	0	0	0	1	39	112	167	438	0	0	0	0	13	32	109	351	1262
BCC	0	0	0	3	14	52	118	75	0	0	0	0	14	15	30	98	419
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	2	121	720	1 714	1 824	2 387	2 229	0	1	100	505	1 153	1 119	1 849	3 047	16 772

Table A7.26 Deaths due to excessive UVR exposure - upper estimates

EUR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	2	109	644	1 495	1 494	1 892	1 544	0	1	90	455	1 013	965	1 539	2 338	13 582
SCC	0	0	0	1	27	78	117	307	0	0	0	0	9	22	76	246	883
BCC	0	0	0	3	13	47	106	68	0	0	0	0	13	14	27	88	377
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	2	109	648	1 535	1 619	2 115	1 919	0	1	90	455	1 035	1 001	1 642	2 672	14 842

Table A.7.27 Deaths due to excessive UVR exposure – lower estimates

EUR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	1	61	358	831	830	1 051	858	0	1	50	253	563	536	855	1 299	7 546
SCC	0	0	0	1	20	56	84	219	0	0	0	0	7	16	55	176	631
BCC	0	0	0	2	7	26	59	38	0	0	0	0	7	8	15	49	210
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	1	61	360	857	912	1 194	1 115	0	1	50	253	577	560	925	1 524	8 386

Table A.7.28 Deaths due to UVR-related diseases - EUR B

EUR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	3	64	222	477	497	464	307	7	4	28	180	352	328	537	592	4 062
SCC	0	0	0	1	23	57	65	88	0	0	0	0	10	21	46	81	392
BCC	0	0	0	2	8	23	41	16	0	0	0	0	8	8	13	20	139
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	3	64	225	508	577	570	411	7	4	28	180	370	357	596	693	4 593

Table A7.29 Deaths due to excessive UVR exposure - upper estimates

EUR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	3	58	200	429	447	418	276	6	4	25	162	317	295	483	533	3 656
SCC	0	0	0	1	16	40	46	62	0	0	0	0	7	15	32	57	274
BCC	0	0	0	2	7	21	37	14	0	0	0	0	7	7	12	18	125
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	3	58	202	453	508	500	352	6	4	25	162	331	317	527	608	4 055

Table A.7.30 Deaths due to excessive UVR exposure – lower estimates

EUR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	2	32	111	239	249	232	154	4	2	14	90	176	164	269	296	2 031
SCC	0	0	0	1	12	29	33	44	0	0	0	0	5	11	23	41	196
BCC	0	0	0	1	4	12	21	8	0	0	0	0	4	4	7	10	70
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	2	32	113	254	289	285	206	4	2	14	90	185	179	298	347	2 297

Table A.7.31 Deaths due to UVR-related diseases - EUR C

EUR C	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	4	39	386	1093	1060	1007	435	2	0	72	418	900	924	1202	976	8 518
SCC	0	0	0	0	15	43	47	85	0	0	0	0	5	15	49	104	363
BCC	0	0	0	1	6	22	38	14	0	0	0	0	7	9	16	31	144
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	4	39	387	1 114	1 125	1 092	534	2	0	72	418	912	948	1 267	1 111	9 025

Table A7.32 Deaths due to excessive UVR exposure - upper estimates

EUR C	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	4	35	347	984	954	906	392	2	0	65	376	810	832	1082	878	7 666
SCC	0	0	0	0	11	30	33	60	0	0	0	0	4	11	34	73	254
BCC	0	0	0	1	5	20	34	13	0	0	0	0	6	8	14	28	130
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	4	35	348	1000	1004	973	464	2	0	65	376	820	850	1131	979	8 050

Table A.7.33 Deaths due to excessive UVR exposure – lower estimates

EUR C	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	2	20	193	547	530	504	218	1	0	36	209	450	462	601	488	4 259
SCC	0	0	0	0	8	22	24	43	0	0	0	0	3	8	25	52	182
BCC	0	0	0	1	3	11	19	7	0	0	0	0	4	5	8	16	72
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	2	20	194	557	563	546	267	1	0	36	209	456	474	634	556	4 513

Table A.7.34 Deaths due to UVR-related diseases - SEAR B

SEAR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	0	3	8	85	177	105	51	0	0	17	62	123	129	226	100	1 087
SCC	0	0	0	3	85	166	174	114	0	0	0	0	44	61	81	128	856
BCC	0	0	0	7	13	11	17	19	0	0	0	0	14	8	6	9	104
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	3	18	183	354	296	184	0	0	17	62	181	198	313	237	2 047

Table A7.35 Deaths due to excessive UVR exposure - upper estimates

SEAR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	0	3	7	77	159	95	46	0	0	15	56	111	116	203	90	978
SCC	0	0	0	2	60	116	122	80	0	0	0	0	31	43	57	90	599
BCC	0	0	0	6	12	10	15	17	0	0	0	0	13	7	5	8	94
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	3	16	148	285	232	143	0	0	15	56	154	166	266	188	1 671

Table A.7.36 Deaths due to excessive UVR exposure – lower estimates

SEAR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	0	2	4	43	89	53	26	0	0	9	31	62	65	113	50	544
SCC	0	0	0	2	43	83	87	57	0	0	0	0	22	31	41	64	428
BCC	0	0	0	4	7	6	9	10	0	0	0	0	7	4	3	5	52
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	2	9	92	177	148	92	0	0	9	31	91	99	157	119	1 024

Table A.7.37 Deaths due to UVR-related diseases - SEAR D

SEAR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	18	34	87	132	384	187	268	183	4	11	48	77	251	212	122	69	2 087
SCC	0	0	0	7	246	474	491	390	0	0	0	0	107	153	218	338	2 424
BCC	0	0	0	13	28	33	50	41	0	0	0	0	30	18	16	24	253
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	18	34	87	152	658	694	809	614	4	11	48	77	388	383	356	431	4 764

Table A7.38 Deaths due to excessive UVR exposure - upper estimates

SEAR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	16	31	78	119	346	168	241	165	4	10	43	69	226	191	110	62	1878
SCC	0	0	0	5	172	332	344	273	0	0	0	0	75	107	153	237	1697
BCC	0	0	0	12	25	30	45	37	0	0	0	0	27	16	14	22	228
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	16	31	78	135	543	530	630	475	4	10	43	69	328	314	277	320	3803

Table A.7.39 Deaths due to excessive UVR exposure – lower estimates

SEAR D	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	9	17	44	66	192	94	134	92	2	6	24	39	126	106	61	35	1044
SCC	0	0	0	4	123	237	246	195	0	0	0	0	54	77	109	169	1212
BCC	0	0	0	7	14	17	25	21	0	0	0	0	15	9	8	12	127
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9	17	44	76	329	347	405	307	2	6	24	39	194	192	178	216	2382

Table A.7.40 Deaths due to UVR-related diseases - WPR A

WPR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	2	0	17	102	320	351	454	409	0	2	20	76	160	142	237	483	2 775
SCC	0	0	0	0	30	78	106	219	0	0	0	0	11	22	62	198	726
BCC	0	0	0	2	10	32	66	41	0	0	0	0	9	8	14	50	232
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	0	17	104	360	461	626	669	0	2	20	76	180	172	313	731	3 733

Table A7.41 Deaths due to excessive UVR exposure - upper estimates

WPR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	2	0	15	92	288	316	409	368	0	2	18	68	144	128	213	435	2498
SCC	0	0	0	0	21	55	74	153	0	0	0	0	8	15	43	139	508
BCC	0	0	0	2	9	29	59	37	0	0	0	0	8	7	13	45	209
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	0	15	94	318	399	542	558	0	2	18	68	160	150	269	618	3215

Table A.7.42 Deaths due to excessive UVR exposure – lower estimates

WPR A	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	1	0	9	51	160	176	227	205	0	1	10	38	80	71	119	242	1 388
SCC	0	0	0	0	15	39	53	110	0	0	0	0	6	11	31	99	363
BCC	0	0	0	1	5	16	33	21	0	0	0	0	5	4	7	25	116
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	9	52	180	231	313	335	0	1	10	38	90	86	157	366	1 867

Table A.7.43 Deaths due to UVR-related diseases - WPR B

WPR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	27	98	378	397	283	129	2	8	33	129	225	196	195	158	2 258
SCC	0	0	0	7	279	572	599	637	0	0	0	0	106	161	314	603	3 278
BCC	0	0	0	24	77	182	291	121	0	0	0	0	67	46	56	123	987
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	27	129	734	1151	1173	887	2	8	33	129	398	403	565	884	6 523

Table A7.44 Deaths due to excessive UVR exposure - upper estimates

WPR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	24	88	340	357	255	116	2	7	30	116	203	176	176	142	2032
SCC	0	0	0	5	195	400	419	446	0	0	0	0	74	113	220	422	2295
BCC	0	0	0	22	69	164	262	109	0	0	0	0	60	41	50	111	888
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	24	115	605	922	936	671	2	7	30	116	337	331	446	675	5215

Table A.7.45 Deaths due to excessive UVR exposure – lower estimates

WPR B	Male								Female								
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	Total
Melanoma	0	0	14	49	189	199	142	65	1	4	17	65	113	98	98	79	1 129
SCC	0	0	0	4	140	286	300	319	0	0	0	0	53	81	157	302	1 639
BCC	0	0	0	12	39	91	146	61	0	0	0	0	34	23	28	62	494
Photoageing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sunburn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cataract	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pterygium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SCCC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	14	65	367	576	587	444	1	4	17	65	199	202	283	442	3 262

Table A7.46 WORLD Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	1.672	2.839	29.077	82.916	135.536	76.633	45.235	13.235	1.386	1.974	23.064	63.533	88.094	59.349	47.895	17.810	690.248
SCC	0.000	0.008	0.032	1.616	25.269	34.687	27.057	15.651	0.000	0.002	0.022	0.806	11.965	12.829	15.427	16.521	161.892
BCC	0.001	0.008	0.338	4.393	8.388	10.164	10.671	3.406	0.000	0.002	0.126	2.051	7.119	4.132	3.351	3.833	57.983
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Sunburn	6.481	38.940	55.049	33.914	13.294	1.816	0.490	0.000	6.090	36.530	52.350	32.767	13.196	1.981	0.659	0.000	293.557
Cataract	0.000	0.000	0.315	210.700	554.598	344.143	118.149	17.350	0.000	0.000	0.000	254.103	590.764	355.502	169.433	31.144	2646.201
Pterygium	0.000	0.000	0.304	5.204	13.359	6.427	3.964	0.909	0.000	0.000	0.000	2.635	7.078	3.662	2.535	0.706	46.783
SCCC	0.000	0.044	0.234	0.429	0.457	0.175	0.072	0.017	0.000	0.036	0.131	0.263	0.351	0.161	0.083	0.025	2.478
RHL	0.000	8.587	22.409	19.083	11.750	4.408	2.145	0.491	0.000	8.068	21.264	18.327	11.585	4.742	2.805	0.935	136.599
TOTAL	8.154	50.426	107.849	359.244	764.107	479.490	208.506	51.363	7.476	46.612	96.957	375.011	731.441	443.220	242.830	71.366	4044.052

Table A7.47 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

World	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	1.505	2.555	26.170	74.625	121.982	68.970	40.712	11.912	1.248	1.776	20.757	57.179	79.285	53.414	43.106	16.029	621.225
SCC	0.000	0.004	0.015	0.730	12.249	17.162	13.764	8.978	0.000	0.001	0.011	0.390	5.637	6.214	8.199	9.400	82.754
BCC	0.001	0.007	0.304	3.954	7.549	9.147	9.604	3.065	0.000	0.002	0.113	1.846	6.407	3.719	3.016	3.450	52.184
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Sunburn	6.481	38.940	55.049	33.914	13.294	1.816	0.490	0.000	6.090	36.530	52.350	32.767	13.196	1.981	0.659	0.000	293.557
Cataract	0.000	0.000	0.063	42.140	110.920	68.829	23.630	3.470	0.000	0.000	0.000	50.821	118.153	71.100	33.887	6.229	529.242
Pterygium	0.000	0.000	0.225	3.851	9.886	4.756	2.934	0.673	0.000	0.000	0.000	1.950	5.238	2.710	1.876	0.522	34.621
SCCC	0.000	0.031	0.164	0.300	0.320	0.123	0.050	0.012	0.000	0.025	0.092	0.184	0.246	0.113	0.058	0.018	1.736
RHL	0.000	4.293	11.204	9.542	5.875	2.204	1.073	0.245	0.000	4.034	10.632	9.163	5.793	2.371	1.402	0.468	68.299
TOTAL	7.99	45.83	93.29	170.05	283.51	174.04	92.980	28.66	7.34	42.37	83.96	154.82	235.24	142.48	92.84	36.51	1691.93

Table A7.48 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

World	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.836	1.419	14.539	41.458	67.768	38.317	22.618	6.618	0.693	0.987	11.532	31.766	44.047	29.675	23.948	8.905	345.126
SCC	0.000	0.003	0.011	0.521	8.748	12.258	9.830	6.413	0.000	0.001	0.008	0.279	4.026	4.438	5.856	6.714	59.106
BCC	0.000	0.004	0.169	2.197	4.194	5.082	5.336	1.703	0.000	0.001	0.063	1.026	3.559	2.066	1.675	1.917	28.992
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Sunburn	6.481	38.940	55.049	33.914	13.294	1.816	0.490	0.000	6.090	36.530	52.350	32.767	13.196	1.981	0.659	0.000	293.557
Cataract	0.000	0.000	0.063	42.140	110.920	68.829	23.630	3.470	0.000	0.000	0.000	50.821	118.153	71.100	33.887	6.229	529.242
Pterygium	0.000	0.000	0.128	2.186	5.611	2.699	1.665	0.382	0.000	0.000	0.000	1.107	2.973	1.538	1.065	0.296	19.650
SCCC	0.000	0.022	0.117	0.215	0.229	0.088	0.036	0.009	0.000	0.018	0.066	0.132	0.176	0.081	0.042	0.013	1.244
RHL	0.000	2.147	5.602	4.771	2.937	1.102	0.536	0.123	0.000	2.017	5.316	4.582	2.896	1.185	0.701	0.234	34.149
TOTAL	7.317	42.535	75.769	128.391	215.157	131.228	64.864	19.022	6.783	39.554	69.335	123.006	190.315	112.926	68.475	24.700	1319.377

Table A7.49 AFR D Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.241	0.164	1.625	2.249	5.129	4.079	2.854	0.721	0.217	0.106	0.709	1.351	3.610	6.502	4.975	0.830	35.362
SCC	0.000	0.000	0.001	0.038	0.520	0.654	0.447	0.150	0.000	0.000	0.000	0.014	0.290	0.277	0.240	0.178	2.809
BCC	0.000	0.000	0.001	0.016	0.022	0.016	0.015	0.006	0.000	0.000	0.001	0.009	0.022	0.011	0.006	0.004	0.129
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.145	0.655	0.733	0.302	0.088	0.010	0.002	0.000	0.142	0.643	0.725	0.305	0.092	0.012	0.003	0.000	3.857
Cataract	0.000	0.000	0.000	42.164	71.717	28.480	9.610	1.364	0.000	0.000	0.000	27.608	63.502	35.868	14.751	2.508	297.572
Pterygium	0.000	0.000	0.081	0.520	1.270	0.629	0.347	0.073	0.000	0.000	0.000	0.268	0.684	0.363	0.215	0.050	4.500
SCCC	0.000	0.001	0.005	0.020	0.021	0.008	0.003	0.001	0.000	0.001	0.005	0.011	0.018	0.007	0.003	0.001	0.105
RHL	0.000	0.873	1.780	0.944	0.456	0.158	0.059	0.012	0.000	0.855	1.763	0.957	0.483	0.179	0.072	0.016	8.607
TOTAL	0.386	1.693	4.226	46.253	79.223	34.034	13.337	2.327	0.359	1.605	3.203	30.523	68.701	43.219	20.265	3.587	352.941

Table A7.50 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

AFR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.217	0.147	1.462	2.024	4.616	3.671	2.569	0.649	0.195	0.096	0.638	1.216	3.249	5.852	4.478	0.747	31.826
SCC	0.000	0.000	0.000	0.003	0.045	0.057	0.039	0.013	0.000	0.000	0.000	0.001	0.025	0.024	0.021	0.015	0.243
BCC	0.000	0.000	0.001	0.014	0.020	0.014	0.013	0.005	0.000	0.000	0.001	0.008	0.020	0.010	0.006	0.004	0.116
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.145	0.655	0.733	0.302	0.088	0.010	0.002	0.000	0.142	0.643	0.725	0.305	0.092	0.012	0.003	0.000	3.857
Cataract	0.000	0.000	0.000	8.433	14.343	5.696	1.922	0.273	0.000	0.000	0.000	5.522	12.700	7.174	2.950	0.502	59.515
Pterygium	0.000	0.000	0.060	0.385	0.939	0.465	0.257	0.054	0.000	0.000	0.000	0.198	0.506	0.269	0.159	0.037	3.329
SCCC	0.000	0.001	0.004	0.014	0.015	0.006	0.002	0.001	0.000	0.001	0.004	0.008	0.013	0.005	0.002	0.001	0.074
RHL	0.000	0.436	0.890	0.472	0.228	0.079	0.030	0.006	0.000	0.427	0.882	0.478	0.242	0.090	0.036	0.008	4.304
TOTAL	0.362	1.239	3.150	11.647	20.294	9.998	4.834	1.001	0.337	1.167	2.250	7.736	16.847	13.436	7.655	1.314	103.264

Table A7.51 Burden of disease attributable to UVR exposure – lower estimates, in DALYs

AFR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.120	0.082	0.812	1.125	2.565	2.039	1.427	0.361	0.108	0.053	0.354	0.675	1.805	3.251	2.488	0.415	17.680
SCC	0.000	0.000	0.000	0.002	0.032	0.040	0.027	0.009	0.000	0.000	0.000	0.001	0.018	0.017	0.015	0.011	0.172
BCC	0.000	0.000	0.001	0.008	0.011	0.008	0.007	0.003	0.000	0.000	0.000	0.004	0.011	0.005	0.003	0.002	0.063
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.145	0.655	0.733	0.302	0.088	0.010	0.002	0.000	0.142	0.643	0.725	0.305	0.092	0.012	0.003	0.000	3.857
Cataract	0.000	0.000	0.000	8.433	14.343	5.696	1.922	0.273	0.000	0.000	0.000	5.522	12.700	7.174	2.950	0.502	59.515
Pterygium	0.000	0.000	0.034	0.218	0.533	0.264	0.146	0.031	0.000	0.000	0.000	0.112	0.287	0.153	0.091	0.021	1.890
SCCC	0.000	0.001	0.003	0.010	0.011	0.004	0.002	0.001	0.000	0.001	0.003	0.006	0.009	0.004	0.002	0.001	0.053
RHL	0.000	0.218	0.445	0.236	0.114	0.039	0.015	0.003	0.000	0.214	0.441	0.239	0.121	0.045	0.018	0.004	2.152
TOTAL	0.265	0.956	2.028	10.334	17.697	8.100	3.548	0.681	0.250	0.911	1.523	6.864	15.043	10.661	5.570	0.956	85.382

Table A7.52 AFR E Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.425	0.150	6.200	7.697	9.329	5.360	1.987	0.548	0.039	0.034	2.294	4.180	5.151	7.674	7.447	1.241	59.756
SCC	0.000	0.000	0.001	0.052	0.610	0.713	0.482	0.136	0.000	0.000	0.001	0.022	0.344	0.314	0.272	0.215	3.162
BCC	0.000	0.000	0.002	0.023	0.034	0.021	0.016	0.005	0.000	0.000	0.001	0.010	0.027	0.012	0.006	0.005	0.162
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.136	0.612	0.671	0.265	0.076	0.008	0.002	0.000	0.134	0.610	0.672	0.266	0.081	0.010	0.002	0.000	3.545
Cataract	0.000	0.000	0.000	28.194	55.391	36.066	13.694	1.970	0.000	0.000	0.000	35.969	57.211	30.688	15.985	3.418	278.586
Pterygium	0.000	0.000	0.135	0.595	1.407	0.652	0.358	0.070	0.000	0.000	0.000	0.300	0.752	0.382	0.233	0.058	4.942
SCCC	0.000	0.035	0.123	0.099	0.033	0.007	0.002	0.001	0.000	0.029	0.056	0.051	0.022	0.006	0.002	0.001	0.467
RHL	0.000	1.118	2.251	1.181	0.543	0.176	0.067	0.013	0.000	1.100	2.224	1.174	0.571	0.204	0.086	0.021	10.729
TOTAL	0.561	1.915	9.383	38.106	67.423	43.003	16.608	2.743	0.173	1.773	5.248	41.972	64.159	39.290	24.033	4.959	361.349

Table A7.53 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

AFR E	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.383	0.135	5.580	6.927	8.396	4.824	1.788	0.493	0.035	0.030	2.065	3.762	4.636	6.907	6.702	1.117	53.780
SCC	0.000	0.000	0.000	0.017	0.196	0.229	0.155	0.044	0.000	0.000	0.000	0.007	0.116	0.106	0.092	0.073	1.035
BCC	0.000	0.000	0.001	0.021	0.030	0.019	0.014	0.005	0.000	0.000	0.001	0.009	0.024	0.011	0.006	0.005	0.146
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.136	0.612	0.671	0.265	0.076	0.008	0.002	0.000	0.134	0.610	0.672	0.266	0.081	0.010	0.002	0.000	3.545
Cataract	0.000	0.000	0.000	5.639	11.078	7.213	2.739	0.394	0.000	0.000	0.000	7.194	11.442	6.138	3.197	0.684	55.718
Pterygium	0.000	0.000	0.100	0.440	1.041	0.483	0.265	0.052	0.000	0.000	0.000	0.222	0.556	0.283	0.173	0.043	3.658
SCCC	0.000	0.025	0.086	0.069	0.023	0.005	0.001	0.001	0.000	0.020	0.039	0.036	0.015	0.004	0.001	0.001	0.327
RHL	0.000	0.559	1.125	0.590	0.271	0.088	0.033	0.006	0.000	0.550	1.112	0.587	0.286	0.102	0.043	0.011	5.363
TOTAL	0.519	1.331	7.563	13.968	21.111	12.869	4.997	0.995	0.169	1.210	3.889	12.083	17.156	13.561	10.216	1.934	123.572

Table A7.54 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

AFR E	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.213	0.075	3.100	3.848	4.664	2.680	0.993	0.274	0.020	0.017	1.147	2.090	2.576	3.837	3.723	0.621	29.878
SCC	0.000	0.000	0.000	0.012	0.139	0.163	0.110	0.031	0.000	0.000	0.000	0.005	0.083	0.076	0.066	0.052	0.737
BCC	0.000	0.000	0.001	0.012	0.017	0.011	0.008	0.003	0.000	0.000	0.000	0.005	0.013	0.006	0.003	0.003	0.082
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.136	0.612	0.671	0.265	0.076	0.008	0.002	0.000	0.134	0.610	0.672	0.266	0.081	0.010	0.002	0.000	3.545
Cataract	0.000	0.000	0.000	5.639	11.078	7.213	2.739	0.394	0.000	0.000	0.000	7.194	11.442	6.138	3.197	0.684	55.718
Pterygium	0.000	0.000	0.057	0.250	0.591	0.274	0.151	0.030	0.000	0.000	0.000	0.126	0.316	0.160	0.098	0.024	2.077
SCCC	0.000	0.018	0.062	0.050	0.017	0.004	0.001	0.001	0.000	0.015	0.028	0.026	0.011	0.003	0.001	0.001	0.234
RHL	0.000	0.279	0.563	0.295	0.136	0.044	0.017	0.003	0.000	0.275	0.556	0.294	0.143	0.051	0.022	0.005	2.683
TOTAL	0.349	0.984	4.454	10.371	16.718	10.397	4.021	0.736	0.154	0.917	2.403	10.006	14.665	10.281	7.112	1.390	94.954

Table A7.55 AMR A Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.031	0.040	3.658	19.531	32.651	16.767	10.997	3.829	0.080	0.075	2.158	10.977	15.257	7.847	6.213	3.136	133.247
SCC	0.000	0.000	0.001	0.040	1.101	1.580	1.733	2.056	0.000	0.000	0.001	0.030	0.462	0.546	1.091	2.040	10.681
BCC	0.000	0.000	0.016	0.147	0.477	0.781	1.097	0.446	0.000	0.000	0.004	0.073	0.429	0.263	0.303	0.595	4.631
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Sunburn	0.268	1.761	2.594	2.253	1.059	0.135	0.048	0.000	0.256	1.681	2.505	2.215	1.084	0.149	0.064	0.000	16.072
Cataract	0.000	0.000	0.000	0.710	2.438	1.392	0.686	0.149	0.000	0.000	0.000	0.461	2.721	1.486	0.865	0.260	11.168
Pterygium	0.000	0.000	0.000	0.053	0.151	0.069	0.073	0.028	0.000	0.000	0.000	0.040	0.127	0.060	0.077	0.044	0.722
SCCC	0.000	0.000	0.002	0.008	0.015	0.007	0.004	0.002	0.000	0.000	0.001	0.006	0.012	0.007	0.006	0.003	0.073
RHL	0.000	0.330	0.931	1.240	0.947	0.330	0.221	0.077	0.000	0.311	0.888	1.205	0.958	0.361	0.286	0.149	8.234
TOTAL	0.299	2.131	7.206	24.047	38.970	21.162	14.939	6.634	0.336	2.067	5.557	15.043	21.163	10.810	8.976	6.287	185.627

Table A7.56 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

AMR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.028	0.036	3.292	17.578	29.386	15.090	9.897	3.446	0.072	0.067	1.942	9.879	13.731	7.062	5.591	2.823	119.920
SCC	0.000	0.000	0.001	0.027	0.755	1.083	1.189	1.410	0.000	0.000	0.000	0.020	0.317	0.374	0.748	1.400	7.324
BCC	0.000	0.000	0.015	0.132	0.429	0.703	0.987	0.401	0.000	0.000	0.003	0.066	0.386	0.237	0.273	0.536	4.168
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Sunburn	0.268	1.761	2.594	2.253	1.059	0.135	0.048	0.000	0.256	1.681	2.505	2.215	1.084	0.149	0.064	0.000	16.072
Cataract	0.000	0.000	0.000	0.142	0.488	0.278	0.137	0.030	0.000	0.000	0.000	0.092	0.544	0.297	0.173	0.052	2.233
Pterygium	0.000	0.000	0.000	0.039	0.112	0.051	0.054	0.021	0.000	0.000	0.000	0.030	0.094	0.045	0.057	0.032	0.535
SCCC	0.000	0.000	0.001	0.006	0.011	0.005	0.003	0.001	0.000	0.000	0.001	0.004	0.008	0.005	0.004	0.002	0.051
RHL	0.000	0.165	0.465	0.620	0.473	0.165	0.110	0.038	0.000	0.156	0.444	0.602	0.479	0.180	0.143	0.074	4.114
TOTAL	0.296	1.962	6.372	20.862	32.844	17.611	12.505	5.394	0.328	1.904	4.895	12.944	16.756	8.440	7.124	4.979	155.216

Table A7.57 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

AMR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.016	0.020	1.829	9.766	16.326	8.383	5.499	1.915	0.040	0.037	1.079	5.489	7.628	3.923	3.106	1.568	66.624
SCC	0.000	0.000	0.000	0.020	0.540	0.774	0.849	1.007	0.000	0.000	0.000	0.015	0.226	0.267	0.535	1.000	5.233
BCC	0.000	0.000	0.008	0.073	0.238	0.390	0.548	0.223	0.000	0.000	0.002	0.037	0.214	0.132	0.151	0.298	2.314
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Sunburn	0.268	1.761	2.594	2.253	1.059	0.135	0.048	0.000	0.256	1.681	2.505	2.215	1.084	0.149	0.064	0.000	16.072
Cataract	0.000	0.000	0.000	0.142	0.488	0.278	0.137	0.030	0.000	0.000	0.000	0.092	0.544	0.297	0.173	0.052	2.233
Pterygium	0.000	0.000	0.000	0.022	0.063	0.029	0.031	0.012	0.000	0.000	0.000	0.017	0.053	0.025	0.032	0.018	0.302
SCCC	0.000	0.000	0.001	0.004	0.008	0.004	0.002	0.001	0.000	0.000	0.001	0.003	0.006	0.004	0.003	0.002	0.037
RHL	0.000	0.083	0.233	0.310	0.237	0.083	0.055	0.019	0.000	0.078	0.222	0.301	0.240	0.090	0.072	0.037	2.060
TOTAL	0.284	1.864	4.669	12.655	19.090	10.177	7.249	3.254	0.296	1.796	3.809	8.205	10.108	4.978	4.207	3.035	95.674

Table A7.58 AMR B Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.103	0.614	2.805	7.230	11.123	5.629	3.048	0.920	0.323	0.116	2.082	5.907	6.233	3.680	2.844	1.098	53.755
SCC	0.000	0.000	0.002	0.158	2.778	3.520	2.805	1.327	0.000	0.000	0.001	0.053	1.493	1.442	1.612	1.689	16.880
BCC	0.000	0.001	0.042	0.777	1.217	0.845	0.872	0.433	0.000	0.000	0.020	0.357	0.994	0.460	0.303	0.286	6.607
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Sunburn	0.584	3.237	4.562	2.290	0.781	0.093	0.025	0.000	0.561	3.125	4.524	2.374	0.837	0.108	0.033	0.000	23.134
Cataract	0.000	0.000	0.000	18.827	16.616	5.164	1.899	0.315	0.000	0.000	0.000	8.473	24.458	10.048	4.187	0.769	90.756
Pterygium	0.000	0.000	0.004	0.079	0.209	0.098	0.067	0.019	0.000	0.000	0.000	0.045	0.126	0.063	0.051	0.017	0.778
SCCC	0.000	0.001	0.010	0.028	0.033	0.012	0.005	0.001	0.000	0.001	0.008	0.021	0.028	0.011	0.006	0.002	0.167
RHL	0.000	0.633	1.748	1.272	0.702	0.243	0.117	0.029	0.000	0.604	1.712	1.302	0.743	0.278	0.152	0.047	9.582
TOTAL	0.687	4.486	9.185	30.754	33.555	15.656	8.869	3.053	0.884	3.846	8.347	18.582	35.015	16.141	9.224	3.922	202.206

Table A7.59 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

AMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.092	0.553	2.524	6.507	10.011	5.066	2.743	0.828	0.291	0.105	1.874	5.317	5.610	3.312	2.560	0.988	48.381
SCC	0.000	0.000	0.001	0.099	1.738	2.202	1.755	0.830	0.000	0.000	0.001	0.033	0.936	0.903	1.010	1.059	10.567
BCC	0.000	0.001	0.038	0.699	1.095	0.760	0.785	0.389	0.000	0.000	0.018	0.321	0.895	0.414	0.273	0.257	5.945
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Sunburn	0.584	3.237	4.562	2.290	0.781	0.093	0.025	0.000	0.561	3.125	4.524	2.374	0.837	0.108	0.033	0.000	23.134
Cataract	0.000	0.000	0.000	3.765	3.323	1.033	0.380	0.063	0.000	0.000	0.000	1.695	4.892	2.010	0.837	0.154	18.152
Pterygium	0.000	0.000	0.003	0.058	0.154	0.072	0.050	0.014	0.575	0.000	0.000	0.003	0.058	0.154	0.072	0.050	1.263
SCCC	0.000	0.001	0.007	0.020	0.023	0.008	0.004	0.001	0.000	0.001	0.006	0.015	0.020	0.008	0.004	0.001	0.117
RHL	0.000	0.316	0.874	0.636	0.351	0.121	0.059	0.015	0.000	0.302	0.856	0.651	0.372	0.139	0.076	0.023	4.791
TOTAL	0.676	4.108	8.021	14.167	17.572	9.407	5.832	2.149	1.427	3.533	7.279	10.459	13.723	7.099	4.901	2.546	112.897

Table A7.60 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

AMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.051	0.307	1.402	3.615	5.562	2.815	1.524	0.460	0.162	0.058	1.041	2.954	3.117	1.840	1.422	0.549	26.879
SCC	0.000	0.000	0.001	0.071	1.241	1.573	1.253	0.593	0.000	0.000	0.001	0.024	0.668	0.645	0.721	0.756	7.547
BCC	0.000	0.000	0.021	0.388	0.609	0.422	0.436	0.216	0.000	0.000	0.010	0.178	0.497	0.230	0.151	0.143	3.301
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Sunburn	0.584	3.237	4.562	2.290	0.781	0.093	0.025	0.000	0.561	3.125	4.524	2.374	0.837	0.108	0.033	0.000	23.134
Cataract	0.000	0.000	0.000	3.765	3.323	1.033	0.380	0.063	0.000	0.000	0.000	1.695	4.892	2.010	0.837	0.154	18.152
Pterygium	0.000	0.000	0.002	0.033	0.088	0.041	0.028	0.008	0.000	0.000	0.000	0.019	0.053	0.026	0.021	0.007	0.326
SCCC	0.000	0.001	0.005	0.014	0.017	0.006	0.003	0.001	0.000	0.001	0.004	0.011	0.014	0.006	0.003	0.001	0.084
RHL	0.000	0.158	0.437	0.318	0.175	0.061	0.029	0.007	0.000	0.151	0.428	0.325	0.186	0.070	0.038	0.012	2.395
TOTAL	0.635	3.703	6.442	10.587	11.892	6.096	3.709	1.357	0.723	3.335	6.008	7.630	10.367	4.986	3.262	1.636	82.365

Table A7.61 AMR D Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.059	0.135	0.273	0.300	0.707	0.427	0.342	0.108	0.000	0.000	0.236	0.491	0.803	0.542	0.430	0.142	4.995
SCC	0.000	0.000	0.001	0.062	0.574	0.733	0.574	0.177	0.000	0.000	0.001	0.028	0.342	0.314	0.278	0.245	3.329
BCC	0.000	0.000	0.004	0.137	0.167	0.065	0.062	0.051	0.000	0.000	0.003	0.064	0.135	0.056	0.029	0.020	0.793
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.099	0.467	0.583	0.240	0.077	0.009	0.002	0.000	0.096	0.451	0.577	0.251	0.081	0.010	0.003	0.000	2.946
Cataract	0.000	0.000	0.000	1.428	6.009	6.302	3.222	0.532	0.000	0.000	0.000	0.856	5.037	6.457	4.361	0.934	35.138
Pterygium	0.000	0.000	0.018	0.142	0.375	0.199	0.121	0.032	0.000	0.000	0.000	0.074	0.199	0.109	0.072	0.022	1.363
SCCC	0.000	0.001	0.003	0.007	0.008	0.003	0.001	0.000	0.000	0.000	0.003	0.006	0.007	0.003	0.001	0.000	0.043
RHL	0.000	0.113	0.266	0.149	0.076	0.028	0.012	0.003	0.000	0.108	0.261	0.156	0.081	0.031	0.014	0.004	1.302
TOTAL	0.158	0.716	1.148	2.465	7.993	7.766	4.336	0.903	0.096	0.559	1.081	1.926	6.685	7.522	5.188	1.367	49.909

Table A7.62 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

AMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.053	0.121	0.245	0.270	0.636	0.384	0.308	0.097	0.000	0.000	0.212	0.442	0.722	0.487	0.387	0.128	4.492
SCC	0.000	0.000	0.000	0.029	0.264	0.337	0.264	0.081	0.000	0.000	0.000	0.013	0.158	0.145	0.128	0.113	1.532
BCC	0.000	0.000	0.004	0.123	0.151	0.059	0.056	0.046	0.000	0.000	0.003	0.057	0.121	0.051	0.027	0.018	0.716
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.099	0.467	0.583	0.240	0.077	0.009	0.002	0.000	0.096	0.451	0.577	0.251	0.081	0.010	0.003	0.000	2.946
Cataract	0.000	0.000	0.000	0.286	1.202	1.260	0.644	0.106	0.000	0.000	0.000	0.171	1.007	1.291	0.872	0.187	7.026
Pterygium	0.000	0.000	0.013	0.105	0.277	0.148	0.090	0.023	0.000	0.000	0.000	0.055	0.147	0.081	0.053	0.016	1.008
SCCC	0.000	0.001	0.002	0.005	0.006	0.002	0.001	0.000	0.000	0.000	0.002	0.004	0.005	0.002	0.001	0.000	0.030
RHL	0.000	0.056	0.133	0.075	0.038	0.014	0.006	0.001	0.000	0.054	0.130	0.078	0.041	0.015	0.007	0.002	0.650
TOTAL	0.152	0.645	0.980	1.133	2.651	2.213	1.371	0.354	0.096	0.505	0.924	1.071	2.282	2.082	1.478	0.464	18.400

Table A7.63 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

AMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.030	0.067	0.136	0.150	0.353	0.213	0.171	0.054	0.000	0.000	0.118	0.246	0.401	0.271	0.215	0.071	2.496
SCC	0.000	0.000	0.000	0.020	0.188	0.241	0.189	0.058	0.000	0.000	0.000	0.009	0.113	0.104	0.092	0.081	1.095
BCC	0.000	0.000	0.002	0.068	0.084	0.033	0.031	0.026	0.000	0.000	0.002	0.032	0.067	0.028	0.015	0.010	0.398
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	0.099	0.467	0.583	0.240	0.077	0.009	0.002	0.000	0.096	0.451	0.577	0.251	0.081	0.010	0.003	0.000	2.946
Cataract	0.000	0.000	0.000	0.286	1.202	1.260	0.644	0.106	0.000	0.000	0.000	0.171	1.007	1.291	0.872	0.187	7.026
Pterygium	0.000	0.000	0.008	0.060	0.157	0.084	0.051	0.013	0.000	0.000	0.000	0.031	0.084	0.046	0.030	0.009	0.573
SCCC	0.000	0.001	0.002	0.004	0.004	0.002	0.001	0.000	0.000	0.000	0.002	0.003	0.004	0.002	0.001	0.000	0.022
RHL	0.000	0.028	0.066	0.037	0.019	0.007	0.003	0.001	0.000	0.027	0.065	0.039	0.020	0.008	0.003	0.001	0.324
TOTAL	0.129	0.563	0.797	0.865	2.084	1.849	1.092	0.258	0.096	0.478	0.764	0.782	1.777	1.760	1.231	0.359	14.880

Table A7.64 EMR B Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.005	0.005	0.830	1.568	0.867	1.095	0.736	0.089	0.006	0.029	2.375	0.274	0.842	0.382	0.565	0.031	9.699
SCC	0.000	0.000	0.001	0.073	1.147	1.307	0.999	0.445	0.000	0.000	0.001	0.029	0.433	0.430	0.465	0.375	5.705
BCC	0.000	0.001	0.030	0.418	0.680	0.464	0.459	0.169	0.000	0.000	0.011	0.133	0.363	0.175	0.110	0.086	3.099
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Sunburn	0.338	2.138	2.520	1.154	0.363	0.043	0.011	0.000	0.323	2.047	2.417	1.045	0.319	0.042	0.012	0.000	12.772
Cataract	0.000	0.000	0.000	12.008	11.509	3.585	1.188	0.151	0.000	0.000	0.000	12.835	8.428	2.369	0.788	0.113	52.974
Pterygium	0.000	0.000	0.000	0.028	0.072	0.032	0.021	0.005	0.000	0.000	0.000	0.013	0.031	0.015	0.011	0.003	0.231
SCCC	0.000	0.000	0.003	0.006	0.009	0.003	0.001	0.000	0.000	0.000	0.002	0.004	0.006	0.003	0.001	0.000	0.038
RHL	0.000	0.375	0.903	0.619	0.316	0.105	0.050	0.010	0.000	0.355	0.856	0.553	0.274	0.102	0.052	0.012	4.582
TOTAL	0.343	2.519	4.296	15.939	15.030	6.670	3.485	0.874	0.329	2.431	5.662	14.920	10.755	3.545	2.022	0.625	89.445

Table A7.65 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

EMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.004	0.004	0.747	1.411	0.781	0.985	0.662	0.080	0.006	0.026	2.138	0.247	0.758	0.344	0.509	0.027	8.729
SCC	0.000	0.000	0.001	0.051	0.798	0.910	0.696	0.310	0.000	0.000	0.001	0.020	0.302	0.300	0.324	0.262	3.975
BCC	0.000	0.001	0.027	0.376	0.612	0.418	0.413	0.152	0.000	0.000	0.010	0.120	0.326	0.158	0.099	0.077	2.789
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Sunburn	0.338	2.138	2.520	1.154	0.363	0.043	0.011	0.000	0.323	2.047	2.417	1.045	0.319	0.042	0.012	0.000	12.772
Cataract	0.000	0.000	0.000	2.402	2.302	0.717	0.238	0.030	0.000	0.000	0.000	2.567	1.686	0.474	0.158	0.023	10.597
Pterygium	0.000	0.000	0.000	0.021	0.053	0.023	0.016	0.004	0.000	0.000	0.000	0.009	0.023	0.011	0.008	0.002	0.170
SCCC	0.000	0.000	0.002	0.004	0.006	0.002	0.001	0.000	0.000	0.000	0.001	0.003	0.004	0.002	0.001	0.000	0.027
RHL	0.000	0.187	0.451	0.310	0.158	0.052	0.025	0.005	0.000	0.177	0.428	0.277	0.137	0.051	0.026	0.006	2.290
TOTAL	0.342	2.330	3.757	5.794	5.140	3.186	2.082	0.586	0.329	2.250	4.995	4.322	3.614	1.409	1.155	0.402	41.694

Table A7.66 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

EMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.002	0.002	0.415	0.784	0.434	0.547	0.368	0.045	0.003	0.014	1.188	0.137	0.421	0.191	0.283	0.015	4.849
SCC	0.000	0.000	0.001	0.037	0.570	0.650	0.497	0.221	0.000	0.000	0.001	0.015	0.216	0.214	0.232	0.187	2.841
BCC	0.000	0.000	0.015	0.209	0.340	0.232	0.230	0.084	0.000	0.000	0.005	0.067	0.181	0.088	0.055	0.043	1.549
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Sunburn	0.338	2.138	2.520	1.154	0.363	0.043	0.011	0.000	0.323	2.047	2.417	1.045	0.319	0.042	0.012	0.000	12.772
Cataract	0.000	0.000	0.000	2.402	2.302	0.717	0.238	0.030	0.000	0.000	0.000	2.567	1.686	0.474	0.158	0.023	10.597
Pterygium	0.000	0.000	0.000	0.012	0.030	0.013	0.009	0.002	0.000	0.000	0.000	0.005	0.013	0.006	0.005	0.001	0.096
SCCC	0.000	0.000	0.002	0.003	0.005	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.000	0.019
RHL	0.000	0.094	0.226	0.155	0.079	0.026	0.013	0.003	0.000	0.089	0.214	0.138	0.068	0.026	0.013	0.003	1.147
TOTAL	0.340	2.234	3.188	4.821	4.190	2.266	1.387	0.390	0.326	2.150	3.826	4.010	2.966	1.070	0.777	0.277	34.215

Table A7.67 EMR D Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.031	0.049	1.416	1.972	4.114	2.060	0.177	0.041	0.208	0.590	1.690	2.041	2.070	1.521	0.559	0.093	18.632
SCC	0.000	0.002	0.007	0.272	1.994	2.348	1.678	0.523	0.000	0.000	0.005	0.151	1.141	0.987	0.797	0.523	10.428
BCC	0.000	0.001	0.022	0.513	0.549	0.300	0.251	0.120	0.000	0.000	0.012	0.194	0.444	0.183	0.089	0.054	2.732
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Sunburn	0.543	2.627	2.794	1.273	0.384	0.043	0.010	0.000	0.519	2.519	2.624	1.189	0.383	0.046	0.011	0.000	14.965
Cataract	0.000	0.000	0.000	20.586	52.611	26.164	8.165	1.167	0.000	0.000	0.000	18.685	52.209	27.937	12.001	1.841	221.366
Pterygium	0.000	0.000	0.011	0.605	1.367	0.568	0.352	0.080	0.000	0.000	0.000	0.293	0.715	0.313	0.209	0.047	4.560
SCCC	0.000	0.001	0.009	0.022	0.025	0.009	0.003	0.001	0.000	0.000	0.005	0.013	0.021	0.008	0.004	0.001	0.122
RHL	0.000	0.500	1.066	0.692	0.337	0.109	0.044	0.009	0.000	0.476	1.000	0.646	0.337	0.115	0.049	0.010	5.390
TOTAL	0.574	3.180	5.325	25.936	61.381	31.601	10.680	1.941	0.727	3.585	5.336	23.212	57.320	31.110	13.719	2.569	278.196

Table A7.68 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

EMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.028	0.044	1.274	1.774	3.703	1.854	0.159	0.037	0.187	0.531	1.521	1.837	1.863	1.369	0.503	0.084	16.768
SCC	0.000	0.001	0.004	0.156	1.145	1.348	0.964	0.300	0.000	0.000	0.003	0.088	0.665	0.575	0.464	0.305	6.018
BCC	0.000	0.001	0.020	0.461	0.494	0.270	0.226	0.108	0.000	0.000	0.011	0.174	0.399	0.165	0.080	0.048	2.457
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Sunburn	0.543	2.627	2.794	1.273	0.384	0.043	0.010	0.000	0.519	2.519	2.624	1.189	0.383	0.046	0.011	0.000	14.965
Cataract	0.000	0.000	0.000	4.117	10.522	5.233	1.633	0.233	0.000	0.000	0.000	3.737	10.442	5.587	2.400	0.368	44.272
Pterygium	0.000	0.000	0.008	0.448	1.011	0.420	0.261	0.059	0.000	0.000	0.000	0.217	0.529	0.232	0.155	0.035	3.375
SCCC	0.000	0.001	0.006	0.015	0.018	0.006	0.002	0.001	0.000	0.000	0.004	0.009	0.015	0.006	0.003	0.001	0.085
RHL	0.000	0.250	0.533	0.346	0.169	0.055	0.022	0.004	0.000	0.238	0.500	0.323	0.169	0.058	0.025	0.005	2.697
TOTAL	0.571	2.924	4.639	8.591	17.446	9.229	3.277	0.742	0.706	3.288	4.663	7.574	14.465	8.038	3.641	0.846	90.638

Table A7.69 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

EMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.016	0.025	0.708	0.986	2.057	1.030	0.088	0.020	0.104	0.295	0.845	1.021	1.035	0.760	0.280	0.046	9.316
SCC	0.000	0.001	0.003	0.112	0.818	0.963	0.688	0.214	0.000	0.000	0.002	0.063	0.475	0.411	0.331	0.218	4.299
BCC	0.000	0.000	0.011	0.256	0.274	0.150	0.125	0.060	0.000	0.000	0.006	0.097	0.222	0.092	0.045	0.027	1.365
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Sunburn	0.543	2.627	2.794	1.273	0.384	0.043	0.010	0.000	0.519	2.519	2.624	1.189	0.383	0.046	0.011	0.000	14.965
Cataract	0.000	0.000	0.000	4.117	10.522	5.233	1.633	0.233	0.000	0.000	0.000	3.737	10.442	5.587	2.400	0.368	44.272
Pterygium	0.000	0.000	0.004	0.254	0.574	0.239	0.148	0.034	0.000	0.000	0.000	0.123	0.301	0.132	0.088	0.020	1.917
SCCC	0.000	0.001	0.005	0.011	0.013	0.005	0.002	0.001	0.000	0.000	0.003	0.007	0.011	0.004	0.002	0.001	0.061
RHL	0.000	0.125	0.267	0.173	0.084	0.027	0.011	0.002	0.000	0.119	0.250	0.161	0.084	0.029	0.012	0.003	1.347
TOTAL	0.559	2.779	3.792	7.183	14.726	7.690	2.705	0.564	0.623	2.933	3.730	6.398	12.953	7.061	3.169	0.683	77.543

Table A7.70 EUR A Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.044	0.083	4.219	18.658	27.022	16.018	11.370	3.652	0.000	0.040	3.804	13.954	19.808	11.453	10.264	5.731	146.120
SCC	0.000	0.000	0.001	0.026	0.884	1.774	1.852	2.326	0.000	0.000	0.001	0.023	0.335	0.585	1.303	2.089	11.199
BCC	0.000	0.000	0.014	0.119	0.472	1.120	1.487	0.488	0.000	0.000	0.004	0.062	0.445	0.406	0.500	0.743	5.860
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Sunburn	0.250	1.797	3.581	3.239	1.677	0.284	0.093	0.000	0.236	1.703	3.412	3.162	1.687	0.315	0.133	0.000	21.569
Cataract	0.000	0.000	0.000	0.890	0.720	0.305	0.139	0.031	0.000	0.000	0.000	1.013	0.965	0.580	0.390	0.141	5.174
Pterygium	0.000	0.000	0.000	0.047	0.124	0.082	0.081	0.024	0.000	0.000	0.000	0.027	0.078	0.056	0.070	0.032	0.621
SCCC	0.000	0.000	0.001	0.006	0.010	0.007	0.004	0.002	0.000	0.000	0.001	0.004	0.008	0.008	0.006	0.003	0.060
RHL	0.000	0.300	1.060	1.508	1.263	0.569	0.345	0.099	0.000	0.281	0.999	1.457	1.258	0.625	0.485	0.217	10.466
TOTAL	0.294	2.180	8.878	24.537	32.314	20.324	15.538	6.724	0.236	2.024	8.221	19.722	24.679	14.174	13.267	9.065	202.177

Table A7.71 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

EUR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.040	0.075	3.797	16.792	24.320	14.416	10.233	3.287	0.000	0.036	3.424	12.558	17.827	10.307	9.237	5.158	131.507
SCC	0.000	0.000	0.001	0.018	0.618	1.241	1.296	1.627	0.000	0.000	0.000	0.016	0.235	0.409	0.912	1.461	7.834
BCC	0.000	0.000	0.013	0.107	0.425	1.008	1.339	0.439	0.000	0.000	0.003	0.056	0.400	0.366	0.450	0.668	5.274
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Sunburn	0.250	1.797	3.581	3.239	1.677	0.284	0.093	0.000	0.236	1.703	3.412	3.162	1.687	0.315	0.133	0.000	21.569
Cataract	0.000	0.000	0.000	0.178	0.144	0.061	0.028	0.006	0.000	0.000	0.000	0.203	0.193	0.116	0.078	0.028	1.035
Pterygium	0.000	0.000	0.000	0.035	0.091	0.061	0.060	0.018	0.000	0.000	0.000	0.020	0.058	0.041	0.052	0.023	0.459
SCCC	0.000	0.000	0.001	0.004	0.007	0.005	0.003	0.001	0.000	0.000	0.001	0.003	0.006	0.006	0.004	0.002	0.042
RHL	0.000	0.150	0.530	0.754	0.631	0.285	0.173	0.049	0.000	0.140	0.499	0.728	0.629	0.313	0.243	0.108	5.232
TOTAL	0.290	2.022	7.925	21.171	28.055	17.526	13.392	5.529	0.236	1.879	7.339	16.766	21.130	12.019	11.225	7.557	174.060

Table A7.72 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

EUR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.022	0.042	2.110	9.329	13.511	8.009	5.685	1.826	0.000	0.020	1.902	6.977	9.904	5.726	5.132	2.866	73.061
SCC	0.000	0.000	0.000	0.013	0.442	0.886	0.925	1.162	0.000	0.000	0.000	0.012	0.168	0.292	0.651	1.043	5.594
BCC	0.000	0.000	0.007	0.059	0.236	0.560	0.744	0.244	0.000	0.000	0.002	0.031	0.222	0.203	0.250	0.371	2.929
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Sunburn	0.250	1.797	3.581	3.239	1.677	0.284	0.093	0.000	0.236	1.703	3.412	3.162	1.687	0.315	0.133	0.000	21.569
Cataract	0.000	0.000	0.000	0.178	0.144	0.061	0.028	0.006	0.000	0.000	0.000	0.203	0.193	0.116	0.078	0.028	1.035
Pterygium	0.000	0.000	0.000	0.020	0.052	0.035	0.034	0.010	0.000	0.000	0.000	0.011	0.033	0.023	0.029	0.013	0.260
SCCC	0.000	0.000	0.001	0.003	0.005	0.004	0.002	0.001	0.000	0.000	0.001	0.002	0.004	0.004	0.003	0.002	0.030
RHL	0.000	0.075	0.265	0.377	0.316	0.142	0.086	0.025	0.000	0.070	0.250	0.364	0.314	0.156	0.121	0.054	2.615
TOTAL	0.272	1.914	5.966	13.262	16.525	10.146	7.764	3.376	0.236	1.793	5.567	10.782	12.620	6.981	6.513	4.486	108.201

Table A7.73 EUR B Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.122	2.157	5.581	7.874	4.578	2.398	0.632	0.255	0.141	0.959	4.580	6.029	3.283	3.003	1.355	42.947
SCC	0.000	0.000	0.001	0.026	0.530	0.897	0.725	0.468	0.000	0.000	0.001	0.021	0.248	0.381	0.558	0.491	4.347
BCC	0.000	0.000	0.017	0.100	0.256	0.500	0.520	0.106	0.000	0.000	0.005	0.054	0.246	0.218	0.209	0.156	2.387
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Sunburn	0.253	1.622	2.689	1.597	0.654	0.100	0.027	0.000	0.243	1.558	2.586	1.587	0.679	0.118	0.040	0.000	13.753
Cataract	0.000	0.000	0.000	0.827	3.060	3.675	2.074	0.322	0.000	0.000	0.000	1.448	5.603	4.942	2.673	0.512	25.136
Pterygium	0.000	0.000	0.000	0.028	0.060	0.034	0.026	0.005	0.000	0.000	0.000	0.019	0.043	0.026	0.024	0.006	0.271
SCCC	0.000	0.000	0.001	0.004	0.005	0.003	0.001	0.000	0.000	0.000	0.001	0.003	0.004	0.003	0.002	0.001	0.028
RHL	0.000	0.272	0.832	0.768	0.507	0.209	0.104	0.019	0.000	0.259	0.791	0.754	0.520	0.242	0.149	0.037	5.463
TOTAL	0.253	2.016	5.700	8.964	13.020	10.065	5.935	1.582	0.498	1.958	4.343	8.483	13.422	9.278	6.703	2.590	94.810

Table A7.74 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

EUR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.110	1.941	5.023	7.086	4.120	2.158	0.569	0.229	0.127	0.863	4.122	5.426	2.955	2.703	1.220	38.652
SCC	0.000	0.000	0.001	0.018	0.371	0.628	0.507	0.327	0.000	0.000	0.000	0.015	0.174	0.267	0.391	0.343	3.042
BCC	0.000	0.000	0.015	0.090	0.231	0.450	0.468	0.095	0.000	0.000	0.004	0.048	0.222	0.196	0.188	0.140	2.147
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Sunburn	0.253	1.622	2.689	1.597	0.654	0.100	0.027	0.000	0.243	1.558	2.586	1.587	0.679	0.118	0.040	0.000	13.753
Cataract	0.000	0.000	0.000	0.165	0.612	0.735	0.415	0.064	0.000	0.000	0.000	0.290	1.121	0.988	0.535	0.102	5.027
Pterygium	0.000	0.000	0.000	0.021	0.044	0.025	0.020	0.004	0.000	0.000	0.000	0.014	0.032	0.019	0.018	0.005	0.202
SCCC	0.000	0.000	0.001	0.003	0.004	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.001	0.020
RHL	0.000	0.136	0.416	0.384	0.254	0.105	0.052	0.009	0.000	0.129	0.396	0.377	0.260	0.121	0.075	0.019	2.733
TOTAL	0.253	1.868	5.066	7.334	9.330	6.234	3.708	1.098	0.472	1.814	3.850	6.472	7.967	4.731	3.996	1.862	66.054

Table A7.75 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

EUR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.061	1.078	2.790	3.937	2.289	1.199	0.316	0.127	0.071	0.480	2.290	3.014	1.641	1.502	0.678	21.473
SCC	0.000	0.000	0.000	0.013	0.265	0.448	0.362	0.234	0.000	0.000	0.000	0.011	0.124	0.191	0.279	0.245	2.172
BCC	0.000	0.000	0.008	0.050	0.128	0.250	0.260	0.053	0.000	0.000	0.002	0.027	0.123	0.109	0.105	0.078	1.193
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Sunburn	0.253	1.622	2.689	1.597	0.654	0.100	0.027	0.000	0.243	1.558	2.586	1.587	0.679	0.118	0.040	0.000	13.753
Cataract	0.000	0.000	0.000	0.165	0.612	0.735	0.415	0.064	0.000	0.000	0.000	0.290	1.121	0.988	0.535	0.102	5.027
Pterygium	0.000	0.000	0.000	0.012	0.025	0.014	0.011	0.002	0.000	0.000	0.000	0.008	0.018	0.011	0.010	0.003	0.114
SCCC	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.001	0.014
RHL	0.000	0.068	0.208	0.192	0.127	0.052	0.026	0.005	0.000	0.065	0.198	0.189	0.130	0.061	0.037	0.009	1.367
TOTAL	0.253	1.751	3.987	4.854	5.825	3.959	2.361	0.704	0.370	1.694	3.267	4.421	5.261	3.186	2.554	1.148	45.591

Table A7.76 EUR C Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.141	1.293	9.362	17.962	10.007	5.372	0.874	0.055	0.000	2.496	10.586	15.228	9.469	6.977	2.212	92.034
SCC	0.000	0.000	0.000	0.009	0.345	0.686	0.543	0.453	0.000	0.000	0.000	0.010	0.136	0.275	0.600	0.627	3.684
BCC	0.000	0.000	0.007	0.050	0.200	0.485	0.495	0.089	0.000	0.000	0.002	0.029	0.222	0.236	0.269	0.241	2.325
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Sunburn	0.125	1.170	2.335	1.821	0.867	0.146	0.037	0.000	0.119	1.124	2.286	1.860	0.995	0.211	0.079	0.000	13.175
Cataract	0.000	0.000	0.000	1.863	7.625	15.882	6.625	0.671	0.000	0.000	0.000	1.786	8.550	15.198	9.894	1.652	69.746
Pterygium	0.000	0.000	0.000	0.017	0.039	0.029	0.022	0.004	0.000	0.000	0.000	0.009	0.022	0.021	0.024	0.006	0.193
SCCC	0.000	0.000	0.000	0.002	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.002	0.003	0.003	0.002	0.001	0.019
RHL	0.000	0.191	0.656	0.817	0.620	0.271	0.124	0.020	0.000	0.182	0.635	0.825	0.704	0.387	0.264	0.072	5.768
TOTAL	0.125	1.502	4.291	13.964	27.719	27.573	13.280	2.136	0.174	1.306	5.419	15.116	25.907	25.862	18.160	4.848	187.382

Table A7.77 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

EUR C	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.127	1.164	8.426	16.166	9.006	4.835	0.786	0.049	0.000	2.247	9.527	13.705	8.522	6.280	1.991	82.831
SCC	0.000	0.000	0.000	0.007	0.241	0.480	0.380	0.317	0.000	0.000	0.000	0.007	0.095	0.193	0.420	0.439	2.579
BCC	0.000	0.000	0.007	0.045	0.180	0.436	0.445	0.080	0.000	0.000	0.002	0.026	0.200	0.212	0.242	0.217	2.092
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Sunburn	0.125	1.170	2.335	1.821	0.867	0.146	0.037	0.000	0.119	1.124	2.286	1.860	0.995	0.211	0.079	0.000	13.175
Cataract	0.000	0.000	0.000	0.373	1.525	3.176	1.325	0.134	0.000	0.000	0.000	0.357	1.710	3.040	1.979	0.330	13.949
Pterygium	0.000	0.000	0.000	0.012	0.029	0.022	0.017	0.003	0.000	0.000	0.000	0.006	0.017	0.015	0.018	0.005	0.144
SCCC	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.001	0.001	0.013
RHL	0.000	0.096	0.328	0.408	0.310	0.136	0.062	0.010	0.000	0.091	0.318	0.412	0.352	0.193	0.132	0.036	2.884
TOTAL	0.125	1.393	3.834	11.116	19.378	13.468	7.163	1.355	0.168	1.215	4.853	12.205	17.123	12.450	9.202	3.056	118.105

Table A7.78 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

EUR C	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.070	0.646	4.681	8.981	5.003	2.686	0.437	0.027	0.000	1.248	5.293	7.614	4.735	3.489	1.106	46.016
SCC	0.000	0.000	0.000	0.005	0.172	0.343	0.272	0.227	0.000	0.000	0.000	0.005	0.068	0.138	0.300	0.314	1.844
BCC	0.000	0.000	0.004	0.025	0.100	0.242	0.247	0.045	0.000	0.000	0.001	0.014	0.111	0.118	0.135	0.121	1.163
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Sunburn	0.125	1.170	2.335	1.821	0.867	0.146	0.037	0.000	0.119	1.124	2.286	1.860	0.995	0.211	0.079	0.000	13.175
Cataract	0.000	0.000	0.000	0.373	1.525	3.176	1.325	0.134	0.000	0.000	0.000	0.357	1.710	3.040	1.979	0.330	13.949
Pterygium	0.000	0.000	0.000	0.007	0.016	0.012	0.009	0.001	0.000	0.000	0.000	0.004	0.009	0.009	0.010	0.003	0.080
SCCC	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.001	0.001	0.010
RHL	0.000	0.048	0.164	0.204	0.155	0.068	0.031	0.005	0.000	0.045	0.159	0.206	0.176	0.097	0.066	0.018	1.442
TOTAL	0.125	1.288	3.149	7.140	11.875	9.056	4.668	0.874	0.146	1.169	3.694	7.749	10.731	8.411	6.110	1.929	78.116

Table A7.79 SEAR B Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.021	0.014	0.105	0.215	1.205	1.665	0.534	0.117	0.000	0.001	0.587	1.586	2.086	1.267	1.294	0.253	10.950
SCC	0.000	0.000	0.000	0.087	1.722	2.374	1.680	0.600	0.000	0.000	0.000	0.012	0.944	0.975	0.895	0.766	10.055
BCC	0.000	0.000	0.012	0.334	0.446	0.240	0.221	0.125	0.000	0.000	0.009	0.182	0.440	0.206	0.107	0.072	2.394
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Sunburn	0.315	1.611	2.428	1.220	0.390	0.049	0.012	0.000	0.303	1.558	2.369	1.231	0.414	0.056	0.014	0.000	11.970
Cataract	0.000	0.000	0.000	21.465	38.685	20.695	8.194	1.330	0.000	0.000	0.000	21.642	42.318	24.050	9.756	1.787	189.922
Pterygium	0.000	0.000	0.014	0.065	0.167	0.090	0.052	0.012	0.000	0.000	0.000	0.033	0.089	0.051	0.031	0.008	0.612
SCCC	0.000	0.001	0.009	0.027	0.029	0.010	0.004	0.001	0.000	0.001	0.007	0.025	0.027	0.011	0.005	0.001	0.158
RHL	0.000	0.301	0.909	0.635	0.313	0.115	0.046	0.010	0.000	0.288	0.877	0.633	0.329	0.130	0.055	0.015	4.656
TOTAL	0.336	1.927	3.478	24.054	42.962	25.241	10.744	2.195	0.303	1.848	3.849	25.347	46.652	26.749	12.159	2.903	230.747

Table A7.80 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

SEAR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.019	0.012	0.095	0.194	1.085	1.498	0.480	0.106	0.000	0.001	0.529	1.427	1.878	1.141	1.165	0.228	9.858
SCC	0.000	0.000	0.000	0.023	0.456	0.628	0.445	0.159	0.000	0.000	0.000	0.003	0.255	0.263	0.241	0.207	2.680
BCC	0.000	0.000	0.011	0.300	0.401	0.216	0.199	0.113	0.000	0.000	0.008	0.164	0.396	0.185	0.096	0.065	2.154
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Sunburn	0.315	1.611	2.428	1.220	0.390	0.049	0.012	0.000	0.303	1.558	2.369	1.231	0.414	0.056	0.014	0.000	11.970
Cataract	0.000	0.000	0.000	4.293	7.737	4.139	1.639	0.266	0.000	0.000	0.000	4.328	8.464	4.810	1.951	0.357	37.984
Pterygium	0.000	0.000	0.010	0.048	0.124	0.066	0.038	0.009	0.000	0.000	0.000	0.024	0.066	0.038	0.023	0.006	0.452
SCCC	0.000	0.001	0.006	0.019	0.020	0.007	0.003	0.001	0.000	0.001	0.005	0.018	0.019	0.008	0.004	0.001	0.111
RHL	0.000	0.151	0.455	0.318	0.157	0.058	0.023	0.005	0.000	0.144	0.439	0.317	0.164	0.065	0.027	0.007	2.330
TOTAL	0.334	1.775	3.006	6.421	10.375	6.664	2.840	0.659	0.303	1.704	3.350	7.515	11.661	6.569	3.523	0.872	67.569

Table A7.81 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

SEAR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.010	0.007	0.053	0.108	0.603	0.832	0.267	0.059	0.000	0.000	0.294	0.793	1.043	0.634	0.647	0.126	5.476
SCC	0.000	0.000	0.000	0.017	0.326	0.449	0.318	0.113	0.000	0.000	0.000	0.002	0.182	0.188	0.172	0.148	1.915
BCC	0.000	0.000	0.006	0.167	0.223	0.120	0.111	0.063	0.000	0.000	0.005	0.091	0.220	0.103	0.053	0.036	1.198
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Sunburn	0.315	1.611	2.428	1.220	0.390	0.049	0.012	0.000	0.303	1.558	2.369	1.231	0.414	0.056	0.014	0.000	11.970
Cataract	0.000	0.000	0.000	4.293	7.737	4.139	1.639	0.266	0.000	0.000	0.000	4.328	8.464	4.810	1.951	0.357	37.984
Pterygium	0.000	0.000	0.006	0.027	0.070	0.038	0.022	0.005	0.000	0.000	0.000	0.014	0.037	0.021	0.013	0.003	0.256
SCCC	0.000	0.001	0.005	0.014	0.015	0.005	0.002	0.001	0.000	0.001	0.004	0.013	0.014	0.006	0.003	0.001	0.079
RHL	0.000	0.075	0.227	0.159	0.078	0.029	0.011	0.003	0.000	0.072	0.219	0.158	0.082	0.032	0.014	0.004	1.163
TOTAL	0.325	1.694	2.726	6.011	9.447	5.664	2.383	0.510	0.303	1.631	2.891	6.633	10.461	5.853	2.869	0.676	60.071

Table A7.82 SEAR D Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.625	1.306	2.975	3.290	6.184	1.675	1.331	0.412	0.146	0.442	1.682	1.991	4.158	2.146	0.701	0.172	29.236
SCC	0.000	0.002	0.009	0.454	6.085	8.008	5.852	2.247	0.000	0.001	0.006	0.214	2.933	3.029	2.831	2.286	33.957
BCC	0.000	0.001	0.036	0.608	0.946	0.705	0.639	0.276	0.000	0.000	0.020	0.329	0.948	0.472	0.261	0.195	5.436
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	1.345	7.467	9.859	4.807	1.630	0.199	0.046	0.000	1.267	6.988	9.106	4.446	1.558	0.208	0.052	0.000	48.978
Cataract	0.000	0.000	0.000	30.057	213.938	133.818	42.188	6.755	0.000	0.000	0.000	92.722	235.484	120.470	60.565	11.023	947.020
Pterygium	0.000	0.000	0.035	2.691	7.222	3.519	2.140	0.492	0.000	0.000	0.000	1.253	3.493	1.852	1.206	0.307	24.210
SCCC	0.000	0.003	0.044	0.121	0.143	0.054	0.020	0.004	0.000	0.003	0.025	0.058	0.100	0.044	0.019	0.004	0.642
RHL	0.000	1.182	3.050	2.154	1.186	0.422	0.177	0.037	0.000	1.093	2.784	1.968	1.121	0.436	0.197	0.046	15.853
TOTAL	1.970	9.961	16.008	44.182	237.334	148.400	52.393	10.223	1.413	8.527	13.623	102.981	249.795	128.657	65.832	14.033	1105.332

Table A7.83 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

SEAR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.563	1.176	2.677	2.961	5.566	1.508	1.198	0.371	0.131	0.398	1.514	1.792	3.742	1.932	0.631	0.155	26.315
SCC	0.000	0.000	0.001	0.066	0.890	1.172	0.856	0.329	0.000	0.000	0.001	0.031	0.431	0.445	0.416	0.336	4.974
BCC	0.000	0.001	0.032	0.547	0.852	0.635	0.575	0.249	0.000	0.000	0.018	0.296	0.853	0.425	0.235	0.176	4.894
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	1.345	7.467	9.859	4.807	1.630	0.199	0.046	0.000	1.267	6.988	9.106	4.446	1.558	0.208	0.052	0.000	48.978
Cataract	0.000	0.000	0.000	6.011	42.788	26.764	8.438	1.351	0.000	0.000	0.000	18.544	47.097	24.094	12.113	2.205	189.405
Pterygium	0.000	0.000	0.026	1.991	5.344	2.604	1.583	0.364	0.000	0.000	0.000	0.927	2.585	1.370	0.892	0.227	17.913
SCCC	0.000	0.002	0.031	0.085	0.100	0.038	0.014	0.003	0.000	0.002	0.018	0.041	0.070	0.031	0.013	0.003	0.449
RHL	0.000	0.591	1.525	1.077	0.593	0.211	0.089	0.019	0.000	0.547	1.392	0.984	0.560	0.218	0.098	0.023	7.927
TOTAL	1.908	9.237	14.151	17.545	57.763	33.131	12.799	2.686	1.398	7.935	12.049	27.061	56.896	28.723	14.450	3.125	300.855

Table A7.84 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

SEAR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.313	0.653	1.487	1.645	3.092	0.838	0.666	0.206	0.073	0.221	0.841	0.995	2.079	1.073	0.350	0.086	14.618
SCC	0.000	0.000	0.001	0.047	0.636	0.837	0.612	0.235	0.000	0.000	0.001	0.022	0.308	0.318	0.297	0.240	3.554
BCC	0.000	0.000	0.018	0.304	0.473	0.353	0.319	0.138	0.000	0.000	0.010	0.165	0.474	0.236	0.131	0.098	2.719
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sunburn	1.345	7.467	9.859	4.807	1.630	0.199	0.046	0.000	1.267	6.988	9.106	4.446	1.558	0.208	0.052	0.000	48.978
Cataract	0.000	0.000	0.000	6.011	42.788	26.764	8.438	1.351	0.000	0.000	0.000	18.544	47.097	24.094	12.113	2.205	189.405
Pterygium	0.000	0.000	0.015	1.130	3.033	1.478	0.899	0.207	0.000	0.000	0.000	0.526	1.467	0.778	0.507	0.129	10.169
SCCC	0.000	0.002	0.022	0.061	0.072	0.027	0.010	0.002	0.000	0.002	0.013	0.029	0.050	0.022	0.010	0.002	0.321
RHL	0.000	0.296	0.762	0.538	0.296	0.105	0.044	0.009	0.000	0.273	0.696	0.492	0.280	0.109	0.049	0.012	3.961
TOTAL	1.658	8.418	12.164	14.543	52.020	30.601	11.034	2.148	1.340	7.484	10.667	25.219	53.313	26.838	13.509	2.772	273.725

Table A7.85 WPR A Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.083	0.000	0.622	2.830	5.487	3.565	2.658	0.986	0.000	0.092	0.839	2.318	3.032	1.598	1.495	1.110	26.715
SCC	0.000	0.000	0.001	0.019	0.686	1.230	1.178	1.174	0.000	0.000	0.000	0.015	0.278	0.410	0.746	1.201	6.938
BCC	0.000	0.000	0.010	0.074	0.322	0.689	0.832	0.267	0.000	0.000	0.002	0.037	0.283	0.220	0.227	0.383	3.346
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Sunburn	0.137	0.835	1.580	1.119	0.711	0.115	0.035	0.000	0.130	0.794	1.515	1.103	0.716	0.125	0.047	0.000	8.962
Cataract	0.000	0.000	0.000	0.549	1.175	0.510	0.226	0.041	0.000	0.000	0.000	0.668	1.212	0.555	0.267	0.090	5.293
Pterygium	0.000	0.000	0.000	0.025	0.105	0.059	0.054	0.017	0.000	0.000	0.000	0.022	0.102	0.061	0.067	0.033	0.545
SCCC	0.000	0.000	0.002	0.005	0.014	0.007	0.004	0.001	0.000	0.000	0.001	0.004	0.011	0.007	0.005	0.002	0.063
RHL	0.000	0.144	0.553	0.590	0.606	0.275	0.156	0.044	0.000	0.135	0.524	0.575	0.603	0.295	0.205	0.090	4.795
TOTAL	0.220	0.979	2.773	5.267	9.231	6.546	5.208	2.556	0.130	1.021	2.881	4.774	6.360	3.350	3.129	2.953	57.378

Table A7.86 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

WPR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.075	0.000	0.560	2.547	4.938	3.208	2.392	0.887	0.000	0.083	0.755	2.086	2.729	1.438	1.346	0.999	24.043
SCC	0.000	0.000	0.000	0.013	0.479	0.859	0.823	0.821	0.000	0.000	0.000	0.011	0.195	0.286	0.522	0.839	4.848
BCC	0.000	0.000	0.009	0.066	0.289	0.620	0.749	0.240	0.000	0.000	0.002	0.033	0.254	0.198	0.204	0.345	3.009
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Sunburn	0.137	0.835	1.580	1.119	0.711	0.115	0.035	0.000	0.130	0.794	1.515	1.103	0.716	0.125	0.047	0.000	8.962
Cataract	0.000	0.000	0.000	0.110	0.235	0.102	0.045	0.008	0.000	0.000	0.000	0.134	0.242	0.111	0.053	0.018	1.058
Pterygium	0.000	0.000	0.000	0.018	0.077	0.044	0.040	0.013	0.000	0.000	0.000	0.017	0.075	0.045	0.050	0.025	0.404
SCCC	0.000	0.000	0.001	0.004	0.010	0.005	0.003	0.001	0.000	0.000	0.001	0.003	0.008	0.005	0.004	0.001	0.044
RHL	0.000	0.072	0.277	0.295	0.303	0.138	0.078	0.022	0.000	0.068	0.262	0.287	0.301	0.147	0.102	0.045	2.397
TOTAL	0.212	0.907	2.432	4.228	7.167	5.187	4.230	2.018	0.130	0.945	2.535	3.706	4.643	2.434	2.398	2.316	45.486

Table A7.87 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

WPR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.042	0.000	0.311	1.415	2.743	1.782	1.329	0.493	0.000	0.046	0.419	1.159	1.516	0.799	0.748	0.555	13.357
SCC	0.000	0.000	0.000	0.010	0.342	0.614	0.588	0.586	0.000	0.000	0.000	0.008	0.139	0.205	0.373	0.599	3.464
BCC	0.000	0.000	0.005	0.037	0.161	0.344	0.416	0.134	0.000	0.000	0.001	0.018	0.141	0.110	0.114	0.192	1.673
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Sunburn	0.137	0.835	1.580	1.119	0.711	0.115	0.035	0.000	0.130	0.794	1.515	1.103	0.716	0.125	0.047	0.000	8.962
Cataract	0.000	0.000	0.000	0.110	0.235	0.102	0.045	0.008	0.000	0.000	0.000	0.134	0.242	0.111	0.053	0.018	1.058
Pterygium	0.000	0.000	0.000	0.010	0.044	0.025	0.023	0.007	0.000	0.000	0.000	0.009	0.043	0.025	0.028	0.014	0.228
SCCC	0.000	0.000	0.001	0.003	0.007	0.004	0.002	0.001	0.000	0.000	0.001	0.002	0.006	0.004	0.003	0.001	0.032
RHL	0.000	0.036	0.138	0.148	0.151	0.069	0.039	0.011	0.000	0.034	0.131	0.144	0.151	0.074	0.051	0.022	1.199
TOTAL	0.179	0.871	2.040	2.908	4.519	3.151	2.542	1.266	0.130	0.874	2.067	2.609	3.077	1.532	1.487	1.445	30.694

Table A7.88 WPR B Summary estimates - Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.003	0.015	0.901	2.434	5.881	3.709	1.433	0.306	0.057	0.308	1.151	3.295	3.788	1.985	1.127	0.405	26.798
SCC	0.000	0.002	0.006	0.298	6.293	8.863	6.507	3.569	0.000	0.000	0.004	0.184	2.583	2.863	3.738	3.796	38.706
BCC	0.000	0.003	0.124	1.079	2.600	3.932	3.705	0.825	0.000	0.001	0.032	0.519	2.121	1.213	0.930	0.993	18.077
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Sunburn	1.943	12.941	18.118	12.332	4.536	0.581	0.139	0.000	1.759	11.728	17.032	11.734	4.269	0.571	0.167	0.000	97.850
Cataract	0.000	0.000	0.315	31.131	73.103	62.105	20.238	2.552	0.000	0.000	0.000	29.938	83.066	74.852	32.951	6.096	416.347
Pterygium	0.000	0.000	0.006	0.310	0.794	0.366	0.249	0.049	0.000	0.000	0.000	0.238	0.617	0.289	0.244	0.073	3.235
SCCC	0.000	0.001	0.022	0.074	0.109	0.043	0.019	0.003	0.000	0.001	0.016	0.055	0.084	0.040	0.021	0.005	0.493
RHL	0.000	2.256	6.403	6.513	3.877	1.397	0.624	0.109	0.000	2.022	5.950	6.121	3.604	1.356	0.738	0.199	41.169
TOTAL	1.946	15.218	25.950	54.774	97.951	81.446	33.152	7.473	1.816	14.060	24.185	52.409	100.826	83.507	40.149	11.657	646.519

Table A7.89 Burden of disease attributable to UVR exposure – upper estimates, in DALYs (000)

WPR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.003	0.013	0.811	2.190	5.293	3.338	1.289	0.275	0.051	0.278	1.036	2.966	3.410	1.786	1.015	0.364	24.118
SCC	0.000	0.001	0.004	0.201	4.251	5.988	4.396	2.411	0.000	0.000	0.003	0.124	1.735	1.923	2.511	2.549	26.097
BCC	0.000	0.003	0.112	0.971	2.340	3.539	3.335	0.743	0.000	0.001	0.029	0.467	1.909	1.091	0.837	0.893	16.270
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Sunburn	1.943	12.941	18.118	12.332	4.536	0.581	0.139	0.000	1.759	11.728	17.032	11.734	4.269	0.571	0.167	0.000	97.850
Cataract	0.000	0.000	0.063	6.226	14.621	12.421	4.048	0.510	0.000	0.000	0.000	5.988	16.613	14.970	6.590	1.219	83.269
Pterygium	0.000	0.000	0.004	0.229	0.588	0.271	0.184	0.036	0.000	0.000	0.000	0.176	0.457	0.214	0.181	0.054	2.394
SCCC	0.000	0.001	0.015	0.052	0.076	0.030	0.013	0.002	0.000	0.001	0.011	0.039	0.059	0.028	0.015	0.004	0.345
RHL	0.000	1.128	3.202	3.257	1.939	0.699	0.312	0.054	0.000	1.011	2.975	3.061	1.802	0.678	0.369	0.100	20.587
TOTAL	1.946	14.087	22.384	26.061	34.402	27.317	13.954	4.091	1.810	13.019	21.086	24.880	30.948	21.599	11.918	5.273	274.774

Table A7.90 Burden of disease attributable to UVR exposure – lower estimates, in DALYs (000)

WPR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.002	0.007	0.450	1.217	2.940	1.855	0.716	0.153	0.028	0.154	0.575	1.648	1.894	0.992	0.564	0.202	13.397
SCC	0.000	0.001	0.003	0.144	3.037	4.277	3.140	1.722	0.000	0.000	0.002	0.088	1.239	1.374	1.793	1.821	18.641
BCC	0.000	0.001	0.062	0.539	1.300	1.966	1.853	0.413	0.000	0.000	0.016	0.260	1.060	0.606	0.465	0.496	9.037
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Sunburn	1.943	12.941	18.118	12.332	4.536	0.581	0.139	0.000	1.759	11.728	17.032	11.734	4.269	0.571	0.167	0.000	97.850
Cataract	0.000	0.000	0.063	6.226	14.621	12.421	4.048	0.510	0.000	0.000	0.000	5.988	16.613	14.970	6.590	1.219	83.269
Pterygium	0.000	0.000	0.002	0.130	0.334	0.154	0.104	0.021	0.000	0.000	0.000	0.100	0.259	0.121	0.102	0.031	1.358
SCCC	0.000	0.001	0.011	0.037	0.055	0.022	0.010	0.002	0.000	0.001	0.008	0.028	0.042	0.020	0.011	0.003	0.247
RHL	0.000	0.564	1.601	1.628	0.969	0.349	0.156	0.027	0.000	0.505	1.488	1.530	0.901	0.339	0.185	0.050	10.292
TOTAL	1.945	13.515	20.365	22.856	28.550	22.075	10.404	2.908	1.787	12.388	19.121	21.701	26.971	19.331	10.110	3.912	237.935

Table 7.91 WORLD Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	1.672	2.839	29.077	82.916	135.536	76.633	45.235	13.235	1.386	1.974	23.064	63.533	88.094	59.349	47.895	17.810	690.248
SCC	0.000	0.008	0.032	1.616	25.269	34.687	27.057	15.651	0.000	0.002	0.022	0.806	11.965	12.829	15.427	16.521	161.892
BCC	0.001	0.008	0.338	4.393	8.388	10.164	10.671	3.406	0.000	0.002	0.126	2.051	7.119	4.132	3.351	3.833	57.983
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Cataract	0.000	0.000	0.315	210.700	554.598	344.143	118.149	17.350	0.000	0.000	0.000	254.103	590.764	355.502	169.433	31.144	2646.201
Pterygium	0.000	0.000	0.304	5.204	13.359	6.427	3.964	0.909	0.000	0.000	0.000	2.635	7.078	3.662	2.535	0.706	46.783
SCCC	0.000	0.044	0.234	0.429	0.457	0.175	0.072	0.017	0.000	0.036	0.131	0.263	0.351	0.161	0.083	0.025	2.478
RHL	0.000	8.587	22.409	19.083	11.750	4.408	2.145	0.491	0.000	8.068	21.264	18.327	11.585	4.742	2.805	0.935	136.599
TOTAL	1.673	11.486	52.800	325.330	750.813	477.674	208.016	51.363	1.386	10.082	44.607	342.244	718.245	441.239	242.171	71.366	3750.495

Table A7.92 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

World	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	1.505	2.555	26.170	74.625	121.982	68.970	40.712	11.912	1.248	1.776	20.757	57.179	79.285	53.414	43.106	16.029	621.225
SCC	0.000	0.004	0.015	0.730	12.249	17.162	13.764	8.978	0.000	0.001	0.011	0.390	5.637	6.214	8.199	9.400	82.754
BCC	0.001	0.007	0.304	3.954	7.549	9.147	9.604	3.065	0.000	0.002	0.113	1.846	6.407	3.719	3.016	3.450	52.184
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Cataract	0.000	0.000	0.063	42.140	110.920	68.829	23.630	3.470	0.000	0.000	0.000	50.821	118.153	71.100	33.887	6.229	529.242
Pterygium	0.000	0.000	0.225	3.851	9.886	4.756	2.934	0.673	0.000	0.000	0.000	1.950	5.238	2.710	1.876	0.522	34.621
SCCC	0.000	0.031	0.164	0.300	0.320	0.123	0.050	0.012	0.000	0.025	0.092	0.184	0.246	0.113	0.058	0.018	1.736
RHL	0.000	4.293	11.204	9.542	5.875	2.204	1.073	0.245	0.000	4.034	10.632	9.163	5.793	2.371	1.402	0.468	68.299
TOTAL	1.506	6.890	38.236	136.131	270.237	172.228	92.490	28.659	1.248	5.838	31.605	122.059	222.048	140.503	92.186	36.508	1398.372

Table A7.93 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

World	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.836	1.419	14.539	41.458	67.768	38.317	22.618	6.618	0.693	0.987	11.532	31.766	44.047	29.675	23.948	8.905	345.126
SCC	0.000	0.003	0.011	0.521	8.748	12.258	9.830	6.413	0.000	0.001	0.008	0.279	4.026	4.438	5.856	6.714	59.106
BCC	0.000	0.004	0.169	2.197	4.194	5.082	5.336	1.703	0.000	0.001	0.063	1.026	3.559	2.066	1.675	1.917	28.992
Solar keratoses	0.000	0.000	0.091	0.989	1.456	1.037	0.723	0.304	0.000	0.000	0.000	0.526	1.289	0.862	0.642	0.392	8.311
Cataract	0.000	0.000	0.063	42.140	110.920	68.829	23.630	3.470	0.000	0.000	0.000	50.821	118.153	71.100	33.887	6.229	529.242
Pterygium	0.000	0.000	0.128	2.186	5.611	2.699	1.665	0.382	0.000	0.000	0.000	1.107	2.973	1.538	1.065	0.296	19.650
SCCC	0.000	0.022	0.117	0.215	0.229	0.088	0.036	0.009	0.000	0.018	0.066	0.132	0.176	0.081	0.042	0.013	1.244
RHL	0.000	2.147	5.602	4.771	2.937	1.102	0.536	0.123	0.000	2.017	5.316	4.582	2.896	1.185	0.701	0.234	34.149
TOTAL	0.836	3.595	20.720	94.477	201.863	129.412	64.374	19.022	0.693	3.024	16.985	90.239	177.119	110.945	67.816	24.700	1025.820

Table 7.94 AFR D Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.241	0.164	1.625	2.249	5.129	4.079	2.854	0.721	0.217	0.106	0.709	1.351	3.610	6.502	4.975	0.830	35.362
SCC	0.000	0.000	0.001	0.038	0.520	0.654	0.447	0.150	0.000	0.000	0.000	0.014	0.290	0.277	0.240	0.178	2.809
BCC	0.000	0.000	0.001	0.016	0.022	0.016	0.015	0.006	0.000	0.000	0.001	0.009	0.022	0.011	0.006	0.004	0.129
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	42.164	71.717	28.480	9.610	1.364	0.000	0.000	0.000	27.608	63.502	35.868	14.751	2.508	297.572
Pterygium	0.000	0.000	0.081	0.520	1.270	0.629	0.347	0.073	0.000	0.000	0.000	0.268	0.684	0.363	0.215	0.050	4.500
SCCC	0.000	0.001	0.005	0.020	0.021	0.008	0.003	0.001	0.000	0.001	0.005	0.011	0.018	0.007	0.003	0.001	0.105
RHL	0.000	0.873	1.780	0.944	0.456	0.158	0.059	0.012	0.000	0.855	1.763	0.957	0.483	0.179	0.072	0.016	8.607
TOTAL	0.241	1.038	3.493	45.951	79.135	34.024	13.335	2.327	0.217	0.962	2.478	30.218	68.609	43.207	20.262	3.587	349.084

Table A7.95 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

AFR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.217	0.147	1.462	2.024	4.616	3.671	2.569	0.649	0.195	0.096	0.638	1.216	3.249	5.852	4.478	0.747	31.826
SCC	0.000	0.000	0.000	0.003	0.045	0.057	0.039	0.013	0.000	0.000	0.000	0.001	0.025	0.024	0.021	0.015	0.243
BCC	0.000	0.000	0.001	0.014	0.020	0.014	0.013	0.005	0.000	0.000	0.001	0.008	0.020	0.010	0.006	0.004	0.116
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	8.433	14.343	5.696	1.922	0.273	0.000	0.000	0.000	5.522	12.700	7.174	2.950	0.502	59.515
Pterygium	0.000	0.000	0.060	0.385	0.939	0.465	0.257	0.054	0.000	0.000	0.000	0.198	0.506	0.269	0.159	0.037	3.329
SCCC	0.000	0.001	0.004	0.014	0.015	0.006	0.002	0.001	0.000	0.001	0.004	0.008	0.013	0.005	0.002	0.001	0.074
RHL	0.000	0.436	0.890	0.472	0.228	0.079	0.030	0.006	0.000	0.427	0.882	0.478	0.242	0.090	0.036	0.008	4.304
TOTAL	0.217	0.584	2.417	11.345	20.206	9.988	4.832	1.001	0.195	0.524	1.525	7.431	16.755	13.424	7.652	1.314	99.407

Table A7.96 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

AFR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.120	0.082	0.812	1.125	2.565	2.039	1.427	0.361	0.108	0.053	0.354	0.675	1.805	3.251	2.488	0.415	17.680
SCC	0.000	0.000	0.000	0.002	0.032	0.040	0.027	0.009	0.000	0.000	0.000	0.001	0.018	0.017	0.015	0.011	0.172
BCC	0.000	0.000	0.001	0.008	0.011	0.008	0.007	0.003	0.000	0.000	0.000	0.004	0.011	0.005	0.003	0.002	0.063
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	8.433	14.343	5.696	1.922	0.273	0.000	0.000	0.000	5.522	12.700	7.174	2.950	0.502	59.515
Pterygium	0.000	0.000	0.034	0.218	0.533	0.264	0.146	0.031	0.000	0.000	0.000	0.112	0.287	0.153	0.091	0.021	1.890
SCCC	0.000	0.001	0.003	0.010	0.011	0.004	0.002	0.001	0.000	0.001	0.003	0.006	0.009	0.004	0.002	0.001	0.053
RHL	0.000	0.218	0.445	0.236	0.114	0.039	0.015	0.003	0.000	0.214	0.441	0.239	0.121	0.045	0.018	0.004	2.152
TOTAL	0.120	0.301	1.295	10.032	17.609	8.090	3.546	0.681	0.108	0.268	0.798	6.559	14.951	10.649	5.567	0.956	81.525

Table 7.97 AFR E Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.425	0.150	6.200	7.697	9.329	5.360	1.987	0.548	0.039	0.034	2.294	4.180	5.151	7.674	7.447	1.241	59.756
SCC	0.000	0.000	0.001	0.052	0.610	0.713	0.482	0.136	0.000	0.000	0.001	0.022	0.344	0.314	0.272	0.215	3.162
BCC	0.000	0.000	0.002	0.023	0.034	0.021	0.016	0.005	0.000	0.000	0.001	0.010	0.027	0.012	0.006	0.005	0.162
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	28.194	55.391	36.066	13.694	1.970	0.000	0.000	0.000	35.969	57.211	30.688	15.985	3.418	278.586
Pterygium	0.000	0.000	0.135	0.595	1.407	0.652	0.358	0.070	0.000	0.000	0.000	0.300	0.752	0.382	0.233	0.058	4.942
SCCC	0.000	0.035	0.123	0.099	0.033	0.007	0.002	0.001	0.000	0.029	0.056	0.051	0.022	0.006	0.002	0.001	0.467
RHL	0.000	1.118	2.251	1.181	0.543	0.176	0.067	0.013	0.000	1.100	2.224	1.174	0.571	0.204	0.086	0.021	10.729
TOTAL	0.425	1.303	8.712	37.841	67.347	42.995	16.606	2.743	0.039	1.163	4.576	41.706	64.078	39.280	24.031	4.959	357.804

Table A7.98 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

AFR E	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.383	0.135	5.580	6.927	8.396	4.824	1.788	0.493	0.035	0.030	2.065	3.762	4.636	6.907	6.702	1.117	53.780
SCC	0.000	0.000	0.000	0.017	0.196	0.229	0.155	0.044	0.000	0.000	0.000	0.007	0.116	0.106	0.092	0.073	1.035
BCC	0.000	0.000	0.001	0.021	0.030	0.019	0.014	0.005	0.000	0.000	0.001	0.009	0.024	0.011	0.006	0.005	0.146
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	5.639	11.078	7.213	2.739	0.394	0.000	0.000	0.000	7.194	11.442	6.138	3.197	0.684	55.718
Pterygium	0.000	0.000	0.100	0.440	1.041	0.483	0.265	0.052	0.000	0.000	0.000	0.222	0.556	0.283	0.173	0.043	3.658
SCCC	0.000	0.025	0.086	0.069	0.023	0.005	0.001	0.001	0.000	0.020	0.039	0.036	0.015	0.004	0.001	0.001	0.327
RHL	0.000	0.559	1.125	0.590	0.271	0.088	0.033	0.006	0.000	0.550	1.112	0.587	0.286	0.102	0.043	0.011	5.363
TOTAL	0.383	0.719	6.892	13.703	21.035	12.861	4.995	0.995	0.035	0.600	3.217	11.817	17.075	13.551	10.214	1.934	120.027

Table A7.99 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

AFR E	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.213	0.075	3.100	3.848	4.664	2.680	0.993	0.274	0.020	0.017	1.147	2.090	2.576	3.837	3.723	0.621	29.878
SCC	0.000	0.000	0.000	0.012	0.139	0.163	0.110	0.031	0.000	0.000	0.000	0.005	0.083	0.076	0.066	0.052	0.737
BCC	0.000	0.000	0.001	0.012	0.017	0.011	0.008	0.003	0.000	0.000	0.000	0.005	0.013	0.006	0.003	0.003	0.082
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	5.639	11.078	7.213	2.739	0.394	0.000	0.000	0.000	7.194	11.442	6.138	3.197	0.684	55.718
Pterygium	0.000	0.000	0.057	0.250	0.591	0.274	0.151	0.030	0.000	0.000	0.000	0.126	0.316	0.160	0.098	0.024	2.077
SCCC	0.000	0.018	0.062	0.050	0.017	0.004	0.001	0.001	0.000	0.015	0.028	0.026	0.011	0.003	0.001	0.001	0.234
RHL	0.000	0.279	0.563	0.295	0.136	0.044	0.017	0.003	0.000	0.275	0.556	0.294	0.143	0.051	0.022	0.005	2.683
TOTAL	0.213	0.372	3.783	10.106	16.642	10.389	4.019	0.736	0.020	0.307	1.731	9.740	14.584	10.271	7.110	1.390	91.409

Table 7.100 AMR A Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.031	0.040	3.658	19.531	32.651	16.767	10.997	3.829	0.080	0.075	2.158	10.977	15.257	7.847	6.213	3.136	133.247
SCC	0.000	0.000	0.001	0.040	1.101	1.580	1.733	2.056	0.000	0.000	0.001	0.030	0.462	0.546	1.091	2.040	10.681
BCC	0.000	0.000	0.016	0.147	0.477	0.781	1.097	0.446	0.000	0.000	0.004	0.073	0.429	0.263	0.303	0.595	4.631
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Cataract	0.000	0.000	0.000	0.710	2.438	1.392	0.686	0.149	0.000	0.000	0.000	0.461	2.721	1.486	0.865	0.260	11.168
Pterygium	0.000	0.000	0.000	0.053	0.151	0.069	0.073	0.028	0.000	0.000	0.000	0.040	0.127	0.060	0.077	0.044	0.722
SCCC	0.000	0.000	0.002	0.008	0.015	0.007	0.004	0.002	0.000	0.000	0.001	0.006	0.012	0.007	0.006	0.003	0.073
RHL	0.000	0.330	0.931	1.240	0.947	0.330	0.221	0.077	0.000	0.311	0.888	1.205	0.958	0.361	0.286	0.149	8.234
TOTAL	0.031	0.370	4.612	21.794	37.911	21.027	14.891	6.634	0.080	0.386	3.052	12.828	20.079	10.661	8.912	6.287	169.555

Table A7.101 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

AMR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.028	0.036	3.292	17.578	29.386	15.090	9.897	3.446	0.072	0.067	1.942	9.879	13.731	7.062	5.591	2.823	119.920
SCC	0.000	0.000	0.001	0.027	0.755	1.083	1.189	1.410	0.000	0.000	0.000	0.020	0.317	0.374	0.748	1.400	7.324
BCC	0.000	0.000	0.015	0.132	0.429	0.703	0.987	0.401	0.000	0.000	0.003	0.066	0.386	0.237	0.273	0.536	4.168
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Cataract	0.000	0.000	0.000	0.142	0.488	0.278	0.137	0.030	0.000	0.000	0.000	0.092	0.544	0.297	0.173	0.052	2.233
Pterygium	0.000	0.000	0.000	0.039	0.112	0.051	0.054	0.021	0.000	0.000	0.000	0.030	0.094	0.045	0.057	0.032	0.535
SCCC	0.000	0.000	0.001	0.006	0.011	0.005	0.003	0.001	0.000	0.000	0.001	0.004	0.008	0.005	0.004	0.002	0.051
RHL	0.000	0.165	0.465	0.620	0.473	0.165	0.110	0.038	0.000	0.156	0.444	0.602	0.479	0.180	0.143	0.074	4.114
TOTAL	0.028	0.201	3.778	18.609	31.785	17.476	12.457	5.394	0.072	0.223	2.390	10.729	15.672	8.291	7.060	4.979	139.144

Table A7.102 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

AMR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.016	0.020	1.829	9.766	16.326	8.383	5.499	1.915	0.040	0.037	1.079	5.489	7.628	3.923	3.106	1.568	66.624
SCC	0.000	0.000	0.000	0.020	0.540	0.774	0.849	1.007	0.000	0.000	0.000	0.015	0.226	0.267	0.535	1.000	5.233
BCC	0.000	0.000	0.008	0.073	0.238	0.390	0.548	0.223	0.000	0.000	0.002	0.037	0.214	0.132	0.151	0.298	2.314
Solar keratoses	0.000	0.000	0.004	0.065	0.131	0.101	0.080	0.047	0.000	0.000	0.000	0.036	0.113	0.091	0.071	0.060	0.799
Cataract	0.000	0.000	0.000	0.142	0.488	0.278	0.137	0.030	0.000	0.000	0.000	0.092	0.544	0.297	0.173	0.052	2.233
Pterygium	0.000	0.000	0.000	0.022	0.063	0.029	0.031	0.012	0.000	0.000	0.000	0.017	0.053	0.025	0.032	0.018	0.302
SCCC	0.000	0.000	0.001	0.004	0.008	0.004	0.002	0.001	0.000	0.000	0.001	0.003	0.006	0.004	0.003	0.002	0.037
RHL	0.000	0.083	0.233	0.310	0.237	0.083	0.055	0.019	0.000	0.078	0.222	0.301	0.240	0.090	0.072	0.037	2.060
TOTAL	0.016	0.103	2.075	10.402	18.031	10.042	7.201	3.254	0.040	0.115	1.304	5.990	9.024	4.829	4.143	3.035	79.602

Table 7.103 AMR B Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

AMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.103	0.614	2.805	7.230	11.123	5.629	3.048	0.920	0.323	0.116	2.082	5.907	6.233	3.680	2.844	1.098	53.755
SCC	0.000	0.000	0.002	0.158	2.778	3.520	2.805	1.327	0.000	0.000	0.001	0.053	1.493	1.442	1.612	1.689	16.880
BCC	0.000	0.001	0.042	0.777	1.217	0.845	0.872	0.433	0.000	0.000	0.020	0.357	0.994	0.460	0.303	0.286	6.607
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Cataract	0.000	0.000	0.000	18.827	16.616	5.164	1.899	0.315	0.000	0.000	0.000	8.473	24.458	10.048	4.187	0.769	90.756
Pterygium	0.000	0.000	0.004	0.079	0.209	0.098	0.067	0.019	0.000	0.000	0.000	0.045	0.126	0.063	0.051	0.017	0.778
SCCC	0.000	0.001	0.010	0.028	0.033	0.012	0.005	0.001	0.000	0.001	0.008	0.021	0.028	0.011	0.006	0.002	0.167
RHL	0.000	0.633	1.748	1.272	0.702	0.243	0.117	0.029	0.000	0.604	1.712	1.302	0.743	0.278	0.152	0.047	9.582
TOTAL	0.103	1.249	4.623	28.464	32.774	15.563	8.844	3.053	0.323	0.721	3.823	16.208	34.178	16.033	9.191	3.922	179.072

Table A7.104 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

AMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.092	0.553	2.524	6.507	10.011	5.066	2.743	0.828	0.291	0.105	1.874	5.317	5.610	3.312	2.560	0.988	48.381
SCC	0.000	0.000	0.001	0.099	1.738	2.202	1.755	0.830	0.000	0.000	0.001	0.033	0.936	0.903	1.010	1.059	10.567
BCC	0.000	0.001	0.038	0.699	1.095	0.760	0.785	0.389	0.000	0.000	0.018	0.321	0.895	0.414	0.273	0.257	5.945
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Cataract	0.000	0.000	0.000	3.765	3.323	1.033	0.380	0.063	0.000	0.000	0.000	1.695	4.892	2.010	0.837	0.154	18.152
Pterygium	0.000	0.000	0.003	0.058	0.154	0.072	0.050	0.014	0.575	0.000	0.000	0.003	0.058	0.154	0.072	0.050	1.263
SCCC	0.000	0.001	0.007	0.020	0.023	0.008	0.004	0.001	0.000	0.001	0.006	0.015	0.020	0.008	0.004	0.001	0.117
RHL	0.000	0.316	0.874	0.636	0.351	0.121	0.059	0.015	0.000	0.302	0.856	0.651	0.372	0.139	0.076	0.023	4.791
TOTAL	0.092	0.871	3.459	11.877	16.791	9.314	5.807	2.149	0.866	0.408	2.755	8.085	12.886	6.991	4.868	2.546	89.763

Table A7.105 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

AMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.051	0.307	1.402	3.615	5.562	2.815	1.524	0.460	0.162	0.058	1.041	2.954	3.117	1.840	1.422	0.549	26.879
SCC	0.000	0.000	0.001	0.071	1.241	1.573	1.253	0.593	0.000	0.000	0.001	0.024	0.668	0.645	0.721	0.756	7.547
BCC	0.000	0.000	0.021	0.388	0.609	0.422	0.436	0.216	0.000	0.000	0.010	0.178	0.497	0.230	0.151	0.143	3.301
Solar keratoses	0.000	0.000	0.012	0.093	0.096	0.052	0.031	0.009	0.000	0.000	0.000	0.050	0.103	0.051	0.036	0.014	0.547
Cataract	0.000	0.000	0.000	3.765	3.323	1.033	0.380	0.063	0.000	0.000	0.000	1.695	4.892	2.010	0.837	0.154	18.152
Pterygium	0.000	0.000	0.002	0.033	0.088	0.041	0.028	0.008	0.000	0.000	0.000	0.019	0.053	0.026	0.021	0.007	0.326
SCCC	0.000	0.001	0.005	0.014	0.017	0.006	0.003	0.001	0.000	0.001	0.004	0.011	0.014	0.006	0.003	0.001	0.084
RHL	0.000	0.158	0.437	0.318	0.175	0.061	0.029	0.007	0.000	0.151	0.428	0.325	0.186	0.070	0.038	0.012	2.395
TOTAL	0.051	0.466	1.880	8.297	11.111	6.003	3.684	1.357	0.162	0.210	1.484	5.256	9.530	4.878	3.229	1.636	59.231

Table 7.106 AMR D Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

Burden of disease in DALYs(000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.059	0.135	0.273	0.300	0.707	0.427	0.342	0.108	0.000	0.000	0.236	0.491	0.803	0.542	0.430	0.142	4.995
SCC	0.000	0.000	0.001	0.062	0.574	0.733	0.574	0.177	0.000	0.000	0.001	0.028	0.342	0.314	0.278	0.245	3.329
BCC	0.000	0.000	0.004	0.137	0.167	0.065	0.062	0.051	0.000	0.000	0.003	0.064	0.135	0.056	0.029	0.020	0.793
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	1.428	6.009	6.302	3.222	0.532	0.000	0.000	0.000	0.856	5.037	6.457	4.361	0.934	35.138
Pterygium	0.000	0.000	0.018	0.142	0.375	0.199	0.121	0.032	0.000	0.000	0.000	0.074	0.199	0.109	0.072	0.022	1.363
SCCC	0.000	0.001	0.003	0.007	0.008	0.003	0.001	0.000	0.000	0.000	0.003	0.006	0.007	0.003	0.001	0.000	0.043
RHL	0.000	0.113	0.266	0.149	0.076	0.028	0.012	0.003	0.000	0.108	0.261	0.156	0.081	0.031	0.014	0.004	1.302
TOTAL	0.059	0.249	0.565	2.225	7.916	7.757	4.334	0.903	0.000	0.108	0.504	1.675	6.604	7.512	5.185	1.367	46.963

Table A7.107 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

AMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.053	0.121	0.245	0.270	0.636	0.384	0.308	0.097	0.000	0.000	0.212	0.442	0.722	0.487	0.387	0.128	4.492
SCC	0.000	0.000	0.000	0.029	0.264	0.337	0.264	0.081	0.000	0.000	0.000	0.013	0.158	0.145	0.128	0.113	1.532
BCC	0.000	0.000	0.004	0.123	0.151	0.059	0.056	0.046	0.000	0.000	0.003	0.057	0.121	0.051	0.027	0.018	0.716
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	0.286	1.202	1.260	0.644	0.106	0.000	0.000	0.000	0.171	1.007	1.291	0.872	0.187	7.026
Pterygium	0.000	0.000	0.013	0.105	0.277	0.148	0.090	0.023	0.000	0.000	0.000	0.055	0.147	0.081	0.053	0.016	1.008
SCCC	0.000	0.001	0.002	0.005	0.006	0.002	0.001	0.000	0.000	0.000	0.002	0.004	0.005	0.002	0.001	0.000	0.030
RHL	0.000	0.056	0.133	0.075	0.038	0.014	0.006	0.001	0.000	0.054	0.130	0.078	0.041	0.015	0.007	0.002	0.650
TOTAL	0.053	0.178	0.397	0.893	2.574	2.204	1.369	0.354	0.000	0.054	0.347	0.820	2.201	2.072	1.475	0.464	15.454

Table A7.108 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

AMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.030	0.067	0.136	0.150	0.353	0.213	0.171	0.054	0.000	0.000	0.118	0.246	0.401	0.271	0.215	0.071	2.496
SCC	0.000	0.000	0.000	0.020	0.188	0.241	0.189	0.058	0.000	0.000	0.000	0.009	0.113	0.104	0.092	0.081	1.095
BCC	0.000	0.000	0.002	0.068	0.084	0.033	0.031	0.026	0.000	0.000	0.002	0.032	0.067	0.028	0.015	0.010	0.398
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	0.286	1.202	1.260	0.644	0.106	0.000	0.000	0.000	0.171	1.007	1.291	0.872	0.187	7.026
Pterygium	0.000	0.000	0.008	0.060	0.157	0.084	0.051	0.013	0.000	0.000	0.000	0.031	0.084	0.046	0.030	0.009	0.573
SCCC	0.000	0.001	0.002	0.004	0.004	0.002	0.001	0.000	0.000	0.000	0.002	0.003	0.004	0.002	0.001	0.000	0.022
RHL	0.000	0.028	0.066	0.037	0.019	0.007	0.003	0.001	0.000	0.027	0.065	0.039	0.020	0.008	0.003	0.001	0.324
TOTAL	0.030	0.096	0.214	0.625	2.007	1.840	1.090	0.258	0.000	0.027	0.187	0.531	1.696	1.750	1.228	0.359	11.934

Table 7.109 EMR B Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.005	0.005	0.830	1.568	0.867	1.095	0.736	0.089	0.006	0.029	2.375	0.274	0.842	0.382	0.565	0.031	9.699
SCC	0.000	0.000	0.001	0.073	1.147	1.307	0.999	0.445	0.000	0.000	0.001	0.029	0.433	0.430	0.465	0.375	5.705
BCC	0.000	0.001	0.030	0.418	0.680	0.464	0.459	0.169	0.000	0.000	0.011	0.133	0.363	0.175	0.110	0.086	3.099
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Cataract	0.000	0.000	0.000	12.008	11.509	3.585	1.188	0.151	0.000	0.000	0.000	12.835	8.428	2.369	0.788	0.113	52.974
Pterygium	0.000	0.000	0.000	0.028	0.072	0.032	0.021	0.005	0.000	0.000	0.000	0.013	0.031	0.015	0.011	0.003	0.231
SCCC	0.000	0.000	0.003	0.006	0.009	0.003	0.001	0.000	0.000	0.000	0.002	0.004	0.006	0.003	0.001	0.000	0.038
RHL	0.000	0.375	0.903	0.619	0.316	0.105	0.050	0.010	0.000	0.355	0.856	0.553	0.274	0.102	0.052	0.012	4.582
TOTAL	0.005	0.381	1.776	14.785	14.667	6.627	3.474	0.874	0.006	0.384	3.245	13.875	10.436	3.503	2.010	0.625	76.673

Table A7.110 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

EMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.004	0.004	0.747	1.411	0.781	0.985	0.662	0.080	0.006	0.026	2.138	0.247	0.758	0.344	0.509	0.027	8.729
SCC	0.000	0.000	0.001	0.051	0.798	0.910	0.696	0.310	0.000	0.000	0.001	0.020	0.302	0.300	0.324	0.262	3.975
BCC	0.000	0.001	0.027	0.376	0.612	0.418	0.413	0.152	0.000	0.000	0.010	0.120	0.326	0.158	0.099	0.077	2.789
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Cataract	0.000	0.000	0.000	2.402	2.302	0.717	0.238	0.030	0.000	0.000	0.000	2.567	1.686	0.474	0.158	0.023	10.597
Pterygium	0.000	0.000	0.000	0.021	0.053	0.023	0.016	0.004	0.000	0.000	0.000	0.009	0.023	0.011	0.008	0.002	0.170
SCCC	0.000	0.000	0.002	0.004	0.006	0.002	0.001	0.000	0.000	0.000	0.001	0.003	0.004	0.002	0.001	0.000	0.027
RHL	0.000	0.187	0.451	0.310	0.158	0.052	0.025	0.005	0.000	0.177	0.428	0.277	0.137	0.051	0.026	0.006	2.290
TOTAL	0.004	0.192	1.237	4.640	4.777	3.143	2.071	0.586	0.006	0.203	2.578	3.277	3.295	1.367	1.143	0.402	28.922

Table A7.111 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

EMR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.002	0.002	0.415	0.784	0.434	0.547	0.368	0.045	0.003	0.014	1.188	0.137	0.421	0.191	0.283	0.015	4.849
SCC	0.000	0.000	0.001	0.037	0.570	0.650	0.497	0.221	0.000	0.000	0.001	0.015	0.216	0.214	0.232	0.187	2.841
BCC	0.000	0.000	0.015	0.209	0.340	0.232	0.230	0.084	0.000	0.000	0.005	0.067	0.181	0.088	0.055	0.043	1.549
Solar keratoses	0.000	0.000	0.009	0.065	0.067	0.036	0.020	0.005	0.000	0.000	0.000	0.034	0.059	0.027	0.018	0.005	0.345
Cataract	0.000	0.000	0.000	2.402	2.302	0.717	0.238	0.030	0.000	0.000	0.000	2.567	1.686	0.474	0.158	0.023	10.597
Pterygium	0.000	0.000	0.000	0.012	0.030	0.013	0.009	0.002	0.000	0.000	0.000	0.005	0.013	0.006	0.005	0.001	0.096
SCCC	0.000	0.000	0.002	0.003	0.005	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.000	0.019
RHL	0.000	0.094	0.226	0.155	0.079	0.026	0.013	0.003	0.000	0.089	0.214	0.138	0.068	0.026	0.013	0.003	1.147
TOTAL	0.002	0.096	0.668	3.667	3.827	2.223	1.376	0.390	0.003	0.103	1.409	2.965	2.647	1.028	0.765	0.277	21.443

Table 7.112 EMR D Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.031	0.049	1.416	1.972	4.114	2.060	0.177	0.041	0.208	0.590	1.690	2.041	2.070	1.521	0.559	0.093	18.632
SCC	0.000	0.002	0.007	0.272	1.994	2.348	1.678	0.523	0.000	0.000	0.005	0.151	1.141	0.987	0.797	0.523	10.428
BCC	0.000	0.001	0.022	0.513	0.549	0.300	0.251	0.120	0.000	0.000	0.012	0.194	0.444	0.183	0.089	0.054	2.732
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Cataract	0.000	0.000	0.000	20.586	52.611	26.164	8.165	1.167	0.000	0.000	0.000	18.685	52.209	27.937	12.001	1.841	221.366
Pterygium	0.000	0.000	0.011	0.605	1.367	0.568	0.352	0.080	0.000	0.000	0.000	0.293	0.715	0.313	0.209	0.047	4.560
SCCC	0.000	0.001	0.009	0.022	0.025	0.009	0.003	0.001	0.000	0.000	0.005	0.013	0.021	0.008	0.004	0.001	0.122
RHL	0.000	0.500	1.066	0.692	0.337	0.109	0.044	0.009	0.000	0.476	1.000	0.646	0.337	0.115	0.049	0.010	5.390
TOTAL	0.031	0.553	2.531	24.663	60.997	31.558	10.670	1.941	0.208	1.066	2.712	22.023	56.937	31.064	13.708	2.569	263.231

Table A7.113 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

EMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.028	0.044	1.274	1.774	3.703	1.854	0.159	0.037	0.187	0.531	1.521	1.837	1.863	1.369	0.503	0.084	16.768
SCC	0.000	0.001	0.004	0.156	1.145	1.348	0.964	0.300	0.000	0.000	0.003	0.088	0.665	0.575	0.464	0.305	6.018
BCC	0.000	0.001	0.020	0.461	0.494	0.270	0.226	0.108	0.000	0.000	0.011	0.174	0.399	0.165	0.080	0.048	2.457
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Cataract	0.000	0.000	0.000	4.117	10.522	5.233	1.633	0.233	0.000	0.000	0.000	3.737	10.442	5.587	2.400	0.368	44.272
Pterygium	0.000	0.000	0.008	0.448	1.011	0.420	0.261	0.059	0.000	0.000	0.000	0.217	0.529	0.232	0.155	0.035	3.375
SCCC	0.000	0.001	0.006	0.015	0.018	0.006	0.002	0.001	0.000	0.000	0.004	0.009	0.015	0.006	0.003	0.001	0.085
RHL	0.000	0.250	0.533	0.346	0.169	0.055	0.022	0.004	0.000	0.238	0.500	0.323	0.169	0.058	0.025	0.005	2.697
TOTAL	0.028	0.297	1.845	7.318	17.062	9.186	3.267	0.742	0.187	0.769	2.039	6.385	14.082	7.992	3.630	0.846	75.673

Table A7.114 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

EMR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.016	0.025	0.708	0.986	2.057	1.030	0.088	0.020	0.104	0.295	0.845	1.021	1.035	0.760	0.280	0.046	9.316
SCC	0.000	0.001	0.003	0.112	0.818	0.963	0.688	0.214	0.000	0.000	0.002	0.063	0.475	0.411	0.331	0.218	4.299
BCC	0.000	0.000	0.011	0.256	0.274	0.150	0.125	0.060	0.000	0.000	0.006	0.097	0.222	0.092	0.045	0.027	1.365
Solar keratoses	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
Cataract	0.000	0.000	0.000	4.117	10.522	5.233	1.633	0.233	0.000	0.000	0.000	3.737	10.442	5.587	2.400	0.368	44.272
Pterygium	0.000	0.000	0.004	0.254	0.574	0.239	0.148	0.034	0.000	0.000	0.000	0.123	0.301	0.132	0.088	0.020	1.917
SCCC	0.000	0.001	0.005	0.011	0.013	0.005	0.002	0.001	0.000	0.000	0.003	0.007	0.011	0.004	0.002	0.001	0.061
RHL	0.000	0.125	0.267	0.173	0.084	0.027	0.011	0.002	0.000	0.119	0.250	0.161	0.084	0.029	0.012	0.003	1.347
TOTAL	0.016	0.152	0.998	5.910	14.342	7.647	2.695	0.564	0.104	0.414	1.106	5.209	12.570	7.015	3.158	0.683	62.578

Table 7.115 EUR A Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.044	0.083	4.219	18.658	27.022	16.018	11.370	3.652	0.000	0.040	3.804	13.954	19.808	11.453	10.264	5.731	146.120
SCC	0.000	0.000	0.001	0.026	0.884	1.774	1.852	2.326	0.000	0.000	0.001	0.023	0.335	0.585	1.303	2.089	11.199
BCC	0.000	0.000	0.014	0.119	0.472	1.120	1.487	0.488	0.000	0.000	0.004	0.062	0.445	0.406	0.500	0.743	5.860
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Cataract	0.000	0.000	0.000	0.890	0.720	0.305	0.139	0.031	0.000	0.000	0.000	1.013	0.965	0.580	0.390	0.141	5.174
Pterygium	0.000	0.000	0.000	0.047	0.124	0.082	0.081	0.024	0.000	0.000	0.000	0.027	0.078	0.056	0.070	0.032	0.621
SCCC	0.000	0.000	0.001	0.006	0.010	0.007	0.004	0.002	0.000	0.000	0.001	0.004	0.008	0.008	0.006	0.003	0.060
RHL	0.000	0.300	1.060	1.508	1.263	0.569	0.345	0.099	0.000	0.281	0.999	1.457	1.258	0.625	0.485	0.217	10.466
TOTAL	0.044	0.383	5.297	21.298	30.637	20.040	15.445	6.724	0.000	0.321	4.809	16.560	22.992	13.859	13.134	9.065	180.608

Table A7.116 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

EUR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.040	0.075	3.797	16.792	24.320	14.416	10.233	3.287	0.000	0.036	3.424	12.558	17.827	10.307	9.237	5.158	131.507
SCC	0.000	0.000	0.001	0.018	0.618	1.241	1.296	1.627	0.000	0.000	0.000	0.016	0.235	0.409	0.912	1.461	7.834
BCC	0.000	0.000	0.013	0.107	0.425	1.008	1.339	0.439	0.000	0.000	0.003	0.056	0.400	0.366	0.450	0.668	5.274
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Cataract	0.000	0.000	0.000	0.178	0.144	0.061	0.028	0.006	0.000	0.000	0.000	0.203	0.193	0.116	0.078	0.028	1.035
Pterygium	0.000	0.000	0.000	0.035	0.091	0.061	0.060	0.018	0.000	0.000	0.000	0.020	0.058	0.041	0.052	0.023	0.459
SCCC	0.000	0.000	0.001	0.004	0.007	0.005	0.003	0.001	0.000	0.000	0.001	0.003	0.006	0.006	0.004	0.002	0.042
RHL	0.000	0.150	0.530	0.754	0.631	0.285	0.173	0.049	0.000	0.140	0.499	0.728	0.629	0.313	0.243	0.108	5.232
TOTAL	0.040	0.225	4.344	17.932	26.378	17.242	13.299	5.529	0.000	0.176	3.927	13.604	19.443	11.704	11.092	7.557	152.491

Table A7.117 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

EUR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.022	0.042	2.110	9.329	13.511	8.009	5.685	1.826	0.000	0.020	1.902	6.977	9.904	5.726	5.132	2.866	73.061
SCC	0.000	0.000	0.000	0.013	0.442	0.886	0.925	1.162	0.000	0.000	0.000	0.012	0.168	0.292	0.651	1.043	5.594
BCC	0.000	0.000	0.007	0.059	0.236	0.560	0.744	0.244	0.000	0.000	0.002	0.031	0.222	0.203	0.250	0.371	2.929
Solar keratoses	0.000	0.000	0.002	0.044	0.142	0.165	0.167	0.102	0.000	0.000	0.000	0.020	0.095	0.146	0.116	0.109	1.108
Cataract	0.000	0.000	0.000	0.178	0.144	0.061	0.028	0.006	0.000	0.000	0.000	0.203	0.193	0.116	0.078	0.028	1.035
Pterygium	0.000	0.000	0.000	0.020	0.052	0.035	0.034	0.010	0.000	0.000	0.000	0.011	0.033	0.023	0.029	0.013	0.260
SCCC	0.000	0.000	0.001	0.003	0.005	0.004	0.002	0.001	0.000	0.000	0.001	0.002	0.004	0.004	0.003	0.002	0.030
RHL	0.000	0.075	0.265	0.377	0.316	0.142	0.086	0.025	0.000	0.070	0.250	0.364	0.314	0.156	0.121	0.054	2.615
TOTAL	0.022	0.117	2.385	10.023	14.848	9.862	7.671	3.376	0.000	0.090	2.155	7.620	10.933	6.666	6.380	4.486	86.632

Table 7.115 EUR B Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.122	2.157	5.581	7.874	4.578	2.398	0.632	0.255	0.141	0.959	4.580	6.029	3.283	3.003	1.355	42.947
SCC	0.000	0.000	0.001	0.026	0.530	0.897	0.725	0.468	0.000	0.000	0.001	0.021	0.248	0.381	0.558	0.491	4.347
BCC	0.000	0.000	0.017	0.100	0.256	0.500	0.520	0.106	0.000	0.000	0.005	0.054	0.246	0.218	0.209	0.156	2.387
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Cataract	0.000	0.000	0.000	0.827	3.060	3.675	2.074	0.322	0.000	0.000	0.000	1.448	5.603	4.942	2.673	0.512	25.136
Pterygium	0.000	0.000	0.000	0.028	0.060	0.034	0.026	0.005	0.000	0.000	0.000	0.019	0.043	0.026	0.024	0.006	0.271
SCCC	0.000	0.000	0.001	0.004	0.005	0.003	0.001	0.000	0.000	0.000	0.001	0.003	0.004	0.003	0.002	0.001	0.028
RHL	0.000	0.272	0.832	0.768	0.507	0.209	0.104	0.019	0.000	0.259	0.791	0.754	0.520	0.242	0.149	0.037	5.463
TOTAL	0.000	0.394	3.011	7.367	12.366	9.965	5.908	1.582	0.255	0.400	1.757	6.896	12.743	9.160	6.663	2.590	81.057

Table A7.116 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

EUR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.110	1.941	5.023	7.086	4.120	2.158	0.569	0.229	0.127	0.863	4.122	5.426	2.955	2.703	1.220	38.652
SCC	0.000	0.000	0.001	0.018	0.371	0.628	0.507	0.327	0.000	0.000	0.000	0.015	0.174	0.267	0.391	0.343	3.042
BCC	0.000	0.000	0.015	0.090	0.231	0.450	0.468	0.095	0.000	0.000	0.004	0.048	0.222	0.196	0.188	0.140	2.147
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Cataract	0.000	0.000	0.000	0.165	0.612	0.735	0.415	0.064	0.000	0.000	0.000	0.290	1.121	0.988	0.535	0.102	5.027
Pterygium	0.000	0.000	0.000	0.021	0.044	0.025	0.020	0.004	0.000	0.000	0.000	0.014	0.032	0.019	0.018	0.005	0.202
SCCC	0.000	0.000	0.001	0.003	0.004	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.001	0.020
RHL	0.000	0.136	0.416	0.384	0.254	0.105	0.052	0.009	0.000	0.129	0.396	0.377	0.260	0.121	0.075	0.019	2.733
TOTAL	0.000	0.246	2.377	5.737	8.676	6.134	3.681	1.098	0.229	0.256	1.264	4.885	7.288	4.613	3.956	1.862	52.301

Table A7.117 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

EUR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.061	1.078	2.790	3.937	2.289	1.199	0.316	0.127	0.071	0.480	2.290	3.014	1.641	1.502	0.678	21.473
SCC	0.000	0.000	0.000	0.013	0.265	0.448	0.362	0.234	0.000	0.000	0.000	0.011	0.124	0.191	0.279	0.245	2.172
BCC	0.000	0.000	0.008	0.050	0.128	0.250	0.260	0.053	0.000	0.000	0.002	0.027	0.123	0.109	0.105	0.078	1.193
Solar keratoses	0.000	0.000	0.003	0.033	0.074	0.069	0.060	0.030	0.000	0.000	0.000	0.017	0.050	0.065	0.045	0.032	0.478
Cataract	0.000	0.000	0.000	0.165	0.612	0.735	0.415	0.064	0.000	0.000	0.000	0.290	1.121	0.988	0.535	0.102	5.027
Pterygium	0.000	0.000	0.000	0.012	0.025	0.014	0.011	0.002	0.000	0.000	0.000	0.008	0.018	0.011	0.010	0.003	0.114
SCCC	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.001	0.001	0.014
RHL	0.000	0.068	0.208	0.192	0.127	0.052	0.026	0.005	0.000	0.065	0.198	0.189	0.130	0.061	0.037	0.009	1.367
TOTAL	0.000	0.129	1.298	3.257	5.171	3.859	2.334	0.704	0.127	0.136	0.681	2.834	4.582	3.068	2.514	1.148	31.838

Table 7.118 EUR C Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.141	1.293	9.362	17.962	10.007	5.372	0.874	0.055	0.000	2.496	10.586	15.228	9.469	6.977	2.212	92.034
SCC	0.000	0.000	0.000	0.009	0.345	0.686	0.543	0.453	0.000	0.000	0.000	0.010	0.136	0.275	0.600	0.627	3.684
BCC	0.000	0.000	0.007	0.050	0.200	0.485	0.495	0.089	0.000	0.000	0.002	0.029	0.222	0.236	0.269	0.241	2.325
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Cataract	0.000	0.000	0.000	1.863	7.625	15.882	6.625	0.671	0.000	0.000	0.000	1.786	8.550	15.198	9.894	1.652	69.746
Pterygium	0.000	0.000	0.000	0.017	0.039	0.029	0.022	0.004	0.000	0.000	0.000	0.009	0.022	0.021	0.024	0.006	0.193
SCCC	0.000	0.000	0.000	0.002	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.002	0.003	0.003	0.002	0.001	0.019
RHL	0.000	0.191	0.656	0.817	0.620	0.271	0.124	0.020	0.000	0.182	0.635	0.825	0.704	0.387	0.264	0.072	5.768
TOTAL	0.000	0.332	1.956	12.143	26.852	27.427	13.243	2.136	0.055	0.182	3.133	13.256	24.912	25.651	18.081	4.848	174.207

Table A7.119 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

EUR C	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.127	1.164	8.426	16.166	9.006	4.835	0.786	0.049	0.000	2.247	9.527	13.705	8.522	6.280	1.991	82.831
SCC	0.000	0.000	0.000	0.007	0.241	0.480	0.380	0.317	0.000	0.000	0.000	0.007	0.095	0.193	0.420	0.439	2.579
BCC	0.000	0.000	0.007	0.045	0.180	0.436	0.445	0.080	0.000	0.000	0.002	0.026	0.200	0.212	0.242	0.217	2.092
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Cataract	0.000	0.000	0.000	0.373	1.525	3.176	1.325	0.134	0.000	0.000	0.000	0.357	1.710	3.040	1.979	0.330	13.949
Pterygium	0.000	0.000	0.000	0.012	0.029	0.022	0.017	0.003	0.000	0.000	0.000	0.006	0.017	0.015	0.018	0.005	0.144
SCCC	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.001	0.001	0.013
RHL	0.000	0.096	0.328	0.408	0.310	0.136	0.062	0.010	0.000	0.091	0.318	0.412	0.352	0.193	0.132	0.036	2.884
TOTAL	0.000	0.223	1.499	9.295	18.511	13.322	7.126	1.355	0.049	0.091	2.567	10.345	16.128	12.239	9.123	3.056	104.930

Table A7.120 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

EUR C	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.000	0.070	0.646	4.681	8.981	5.003	2.686	0.437	0.027	0.000	1.248	5.293	7.614	4.735	3.489	1.106	46.016
SCC	0.000	0.000	0.000	0.005	0.172	0.343	0.272	0.227	0.000	0.000	0.000	0.005	0.068	0.138	0.300	0.314	1.844
BCC	0.000	0.000	0.004	0.025	0.100	0.242	0.247	0.045	0.000	0.000	0.001	0.014	0.111	0.118	0.135	0.121	1.163
Solar keratoses	0.000	0.000	0.000	0.023	0.058	0.065	0.061	0.025	0.000	0.000	0.000	0.009	0.047	0.062	0.051	0.037	0.438
Cataract	0.000	0.000	0.000	0.373	1.525	3.176	1.325	0.134	0.000	0.000	0.000	0.357	1.710	3.040	1.979	0.330	13.949
Pterygium	0.000	0.000	0.000	0.007	0.016	0.012	0.009	0.001	0.000	0.000	0.000	0.004	0.009	0.009	0.010	0.003	0.080
SCCC	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.001	0.001	0.010
RHL	0.000	0.048	0.164	0.204	0.155	0.068	0.031	0.005	0.000	0.045	0.159	0.206	0.176	0.097	0.066	0.018	1.442
TOTAL	0.000	0.118	0.814	5.319	11.008	8.910	4.631	0.874	0.027	0.045	1.408	5.889	9.736	8.200	6.031	1.929	64.941

Table 7.124 SEAR B Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.021	0.014	0.105	0.215	1.205	1.665	0.534	0.117	0.000	0.001	0.587	1.586	2.086	1.267	1.294	0.253	10.950
SCC	0.000	0.000	0.000	0.087	1.722	2.374	1.680	0.600	0.000	0.000	0.000	0.012	0.944	0.975	0.895	0.766	10.055
BCC	0.000	0.000	0.012	0.334	0.446	0.240	0.221	0.125	0.000	0.000	0.009	0.182	0.440	0.206	0.107	0.072	2.394
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Cataract	0.000	0.000	0.000	21.465	38.685	20.695	8.194	1.330	0.000	0.000	0.000	21.642	42.318	24.050	9.756	1.787	189.922
Pterygium	0.000	0.000	0.014	0.065	0.167	0.090	0.052	0.012	0.000	0.000	0.000	0.033	0.089	0.051	0.031	0.008	0.612
SCCC	0.000	0.001	0.009	0.027	0.029	0.010	0.004	0.001	0.000	0.001	0.007	0.025	0.027	0.011	0.005	0.001	0.158
RHL	0.000	0.301	0.909	0.635	0.313	0.115	0.046	0.010	0.000	0.288	0.877	0.633	0.329	0.130	0.055	0.015	4.656
TOTAL	0.021	0.316	1.050	22.834	42.572	25.192	10.732	2.195	0.000	0.290	1.480	24.116	46.238	26.693	12.145	2.903	218.777

Table A7.125 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

SEAR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.019	0.012	0.095	0.194	1.085	1.498	0.480	0.106	0.000	0.001	0.529	1.427	1.878	1.141	1.165	0.228	9.858
SCC	0.000	0.000	0.000	0.023	0.456	0.628	0.445	0.159	0.000	0.000	0.000	0.003	0.255	0.263	0.241	0.207	2.680
BCC	0.000	0.000	0.011	0.300	0.401	0.216	0.199	0.113	0.000	0.000	0.008	0.164	0.396	0.185	0.096	0.065	2.154
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Cataract	0.000	0.000	0.000	4.293	7.737	4.139	1.639	0.266	0.000	0.000	0.000	4.328	8.464	4.810	1.951	0.357	37.984
Pterygium	0.000	0.000	0.010	0.048	0.124	0.066	0.038	0.009	0.000	0.000	0.000	0.024	0.066	0.038	0.023	0.006	0.452
SCCC	0.000	0.001	0.006	0.019	0.020	0.007	0.003	0.001	0.000	0.001	0.005	0.018	0.019	0.008	0.004	0.001	0.111
RHL	0.000	0.151	0.455	0.318	0.157	0.058	0.023	0.005	0.000	0.144	0.439	0.317	0.164	0.065	0.027	0.007	2.330
TOTAL	0.019	0.164	0.578	5.201	9.985	6.615	2.828	0.659	0.000	0.146	0.981	6.284	11.247	6.513	3.509	0.872	55.599

Table A7.126 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

SEAR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.010	0.007	0.053	0.108	0.603	0.832	0.267	0.059	0.000	0.000	0.294	0.793	1.043	0.634	0.647	0.126	5.476
SCC	0.000	0.000	0.000	0.017	0.326	0.449	0.318	0.113	0.000	0.000	0.000	0.002	0.182	0.188	0.172	0.148	1.915
BCC	0.000	0.000	0.006	0.167	0.223	0.120	0.111	0.063	0.000	0.000	0.005	0.091	0.220	0.103	0.053	0.036	1.198
Solar keratoses	0.000	0.000	0.001	0.006	0.005	0.003	0.001	0.000	0.000	0.000	0.000	0.003	0.005	0.003	0.002	0.001	0.030
Cataract	0.000	0.000	0.000	4.293	7.737	4.139	1.639	0.266	0.000	0.000	0.000	4.328	8.464	4.810	1.951	0.357	37.984
Pterygium	0.000	0.000	0.006	0.027	0.070	0.038	0.022	0.005	0.000	0.000	0.000	0.014	0.037	0.021	0.013	0.003	0.256
SCCC	0.000	0.001	0.005	0.014	0.015	0.005	0.002	0.001	0.000	0.001	0.004	0.013	0.014	0.006	0.003	0.001	0.079
RHL	0.000	0.075	0.227	0.159	0.078	0.029	0.011	0.003	0.000	0.072	0.219	0.158	0.082	0.032	0.014	0.004	1.163
TOTAL	0.010	0.083	0.298	4.791	9.057	5.615	2.371	0.510	0.000	0.073	0.522	5.402	10.047	5.797	2.855	0.676	48.101

Table 7.127 SEAR D Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

Burden of disease in DALYs(000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.625	1.306	2.975	3.290	6.184	1.675	1.331	0.412	0.146	0.442	1.682	1.991	4.158	2.146	0.701	0.172	29.236
SCC	0.000	0.002	0.009	0.454	6.085	8.008	5.852	2.247	0.000	0.001	0.006	0.214	2.933	3.029	2.831	2.286	33.957
BCC	0.000	0.001	0.036	0.608	0.946	0.705	0.639	0.276	0.000	0.000	0.020	0.329	0.948	0.472	0.261	0.195	5.436
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	30.057	213.938	133.818	42.188	6.755	0.000	0.000	0.000	92.722	235.484	120.470	60.565	11.023	947.020
Pterygium	0.000	0.000	0.035	2.691	7.222	3.519	2.140	0.492	0.000	0.000	0.000	1.253	3.493	1.852	1.206	0.307	24.210
SCCC	0.000	0.003	0.044	0.121	0.143	0.054	0.020	0.004	0.000	0.003	0.025	0.058	0.100	0.044	0.019	0.004	0.642
RHL	0.000	1.182	3.050	2.154	1.186	0.422	0.177	0.037	0.000	1.093	2.784	1.968	1.121	0.436	0.197	0.046	15.853
TOTAL	0.625	2.494	6.149	39.375	235.704	148.201	52.347	10.223	0.146	1.539	4.517	98.535	248.237	128.449	65.780	14.033	1056.354

Table A7.128 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

SEAR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.563	1.176	2.677	2.961	5.566	1.508	1.198	0.371	0.131	0.398	1.514	1.792	3.742	1.932	0.631	0.155	26.315
SCC	0.000	0.000	0.001	0.066	0.890	1.172	0.856	0.329	0.000	0.000	0.001	0.031	0.431	0.445	0.416	0.336	4.974
BCC	0.000	0.001	0.032	0.547	0.852	0.635	0.575	0.249	0.000	0.000	0.018	0.296	0.853	0.425	0.235	0.176	4.894
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	6.011	42.788	26.764	8.438	1.351	0.000	0.000	0.000	18.544	47.097	24.094	12.113	2.205	189.405
Pterygium	0.000	0.000	0.026	1.991	5.344	2.604	1.583	0.364	0.000	0.000	0.000	0.927	2.585	1.370	0.892	0.227	17.913
SCCC	0.000	0.002	0.031	0.085	0.100	0.038	0.014	0.003	0.000	0.002	0.018	0.041	0.070	0.031	0.013	0.003	0.449
RHL	0.000	0.591	1.525	1.077	0.593	0.211	0.089	0.019	0.000	0.547	1.392	0.984	0.560	0.218	0.098	0.023	7.927
TOTAL	0.563	1.770	4.292	12.738	56.133	32.932	12.753	2.686	0.131	0.947	2.943	22.615	55.338	28.515	14.398	3.125	251.877

Table A7.129 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

SEAR D	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.313	0.653	1.487	1.645	3.092	0.838	0.666	0.206	0.073	0.221	0.841	0.995	2.079	1.073	0.350	0.086	14.618
SCC	0.000	0.000	0.001	0.047	0.636	0.837	0.612	0.235	0.000	0.000	0.001	0.022	0.308	0.318	0.297	0.240	3.554
BCC	0.000	0.000	0.018	0.304	0.473	0.353	0.319	0.138	0.000	0.000	0.010	0.165	0.474	0.236	0.131	0.098	2.719
Solar keratoses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cataract	0.000	0.000	0.000	6.011	42.788	26.764	8.438	1.351	0.000	0.000	0.000	18.544	47.097	24.094	12.113	2.205	189.405
Pterygium	0.000	0.000	0.015	1.130	3.033	1.478	0.899	0.207	0.000	0.000	0.000	0.526	1.467	0.778	0.507	0.129	10.169
SCCC	0.000	0.002	0.022	0.061	0.072	0.027	0.010	0.002	0.000	0.002	0.013	0.029	0.050	0.022	0.010	0.002	0.321
RHL	0.000	0.296	0.762	0.538	0.296	0.105	0.044	0.009	0.000	0.273	0.696	0.492	0.280	0.109	0.049	0.012	3.961
TOTAL	0.313	0.951	2.305	9.736	50.390	30.402	10.988	2.148	0.073	0.496	1.561	20.773	51.755	26.630	13.457	2.772	224.747

Table 7.130 WPR A Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.083	0.000	0.622	2.830	5.487	3.565	2.658	0.986	0.000	0.092	0.839	2.318	3.032	1.598	1.495	1.110	26.715
SCC	0.000	0.000	0.001	0.019	0.686	1.230	1.178	1.174	0.000	0.000	0.000	0.015	0.278	0.410	0.746	1.201	6.938
BCC	0.000	0.000	0.010	0.074	0.322	0.689	0.832	0.267	0.000	0.000	0.002	0.037	0.283	0.220	0.227	0.383	3.346
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Cataract	0.000	0.000	0.000	0.549	1.175	0.510	0.226	0.041	0.000	0.000	0.000	0.668	1.212	0.555	0.267	0.090	5.293
Pterygium	0.000	0.000	0.000	0.025	0.105	0.059	0.054	0.017	0.000	0.000	0.000	0.022	0.102	0.061	0.067	0.033	0.545
SCCC	0.000	0.000	0.002	0.005	0.014	0.007	0.004	0.001	0.000	0.000	0.001	0.004	0.011	0.007	0.005	0.002	0.063
RHL	0.000	0.144	0.553	0.590	0.606	0.275	0.156	0.044	0.000	0.135	0.524	0.575	0.603	0.295	0.205	0.090	4.795
TOTAL	0.083	0.144	1.193	4.148	8.520	6.431	5.173	2.556	0.000	0.227	1.366	3.671	5.644	3.225	3.082	2.953	48.416

Table A7.131 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

WPR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.075	0.000	0.560	2.547	4.938	3.208	2.392	0.887	0.000	0.083	0.755	2.086	2.729	1.438	1.346	0.999	24.043
SCC	0.000	0.000	0.000	0.013	0.479	0.859	0.823	0.821	0.000	0.000	0.000	0.011	0.195	0.286	0.522	0.839	4.848
BCC	0.000	0.000	0.009	0.066	0.289	0.620	0.749	0.240	0.000	0.000	0.002	0.033	0.254	0.198	0.204	0.345	3.009
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Cataract	0.000	0.000	0.000	0.110	0.235	0.102	0.045	0.008	0.000	0.000	0.000	0.134	0.242	0.111	0.053	0.018	1.058
Pterygium	0.000	0.000	0.000	0.018	0.077	0.044	0.040	0.013	0.000	0.000	0.000	0.017	0.075	0.045	0.050	0.025	0.404
SCCC	0.000	0.000	0.001	0.004	0.010	0.005	0.003	0.001	0.000	0.000	0.001	0.003	0.008	0.005	0.004	0.001	0.044
RHL	0.000	0.072	0.277	0.295	0.303	0.138	0.078	0.022	0.000	0.068	0.262	0.287	0.301	0.147	0.102	0.045	2.397
TOTAL	0.075	0.072	0.852	3.109	6.456	5.072	4.195	2.018	0.000	0.151	1.020	2.603	3.927	2.309	2.351	2.316	36.524

Table A7.132 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

WPR A	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.042	0.000	0.311	1.415	2.743	1.782	1.329	0.493	0.000	0.046	0.419	1.159	1.516	0.799	0.748	0.555	13.357
SCC	0.000	0.000	0.000	0.010	0.342	0.614	0.588	0.586	0.000	0.000	0.000	0.008	0.139	0.205	0.373	0.599	3.464
BCC	0.000	0.000	0.005	0.037	0.161	0.344	0.416	0.134	0.000	0.000	0.001	0.018	0.141	0.110	0.114	0.192	1.673
Solar keratoses	0.000	0.000	0.005	0.056	0.125	0.096	0.065	0.026	0.000	0.000	0.000	0.032	0.123	0.079	0.070	0.044	0.721
Cataract	0.000	0.000	0.000	0.110	0.235	0.102	0.045	0.008	0.000	0.000	0.000	0.134	0.242	0.111	0.053	0.018	1.058
Pterygium	0.000	0.000	0.000	0.010	0.044	0.025	0.023	0.007	0.000	0.000	0.000	0.009	0.043	0.025	0.028	0.014	0.228
SCCC	0.000	0.000	0.001	0.003	0.007	0.004	0.002	0.001	0.000	0.000	0.001	0.002	0.006	0.004	0.003	0.001	0.032
RHL	0.000	0.036	0.138	0.148	0.151	0.069	0.039	0.011	0.000	0.034	0.131	0.144	0.151	0.074	0.051	0.022	1.199
TOTAL	0.042	0.036	0.460	1.789	3.808	3.036	2.507	1.266	0.000	0.080	0.552	1.506	2.361	1.407	1.440	1.445	21.732

Table 7.133 WPR B Summary estimates (sunburn excluded), Burden of disease due to UVR-related diseases in DALYs (000)

	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.003	0.015	0.901	2.434	5.881	3.709	1.433	0.306	0.057	0.308	1.151	3.295	3.788	1.985	1.127	0.405	26.798
SCC	0.000	0.002	0.006	0.298	6.293	8.863	6.507	3.569	0.000	0.000	0.004	0.184	2.583	2.863	3.738	3.796	38.706
BCC	0.000	0.003	0.124	1.079	2.600	3.932	3.705	0.825	0.000	0.001	0.032	0.519	2.121	1.213	0.930	0.993	18.077
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Cataract	0.000	0.000	0.315	31.131	73.103	62.105	20.238	2.552	0.000	0.000	0.000	29.938	83.066	74.852	32.951	6.096	416.347
Pterygium	0.000	0.000	0.006	0.310	0.794	0.366	0.249	0.049	0.000	0.000	0.000	0.238	0.617	0.289	0.244	0.073	3.235
SCCC	0.000	0.001	0.022	0.074	0.109	0.043	0.019	0.003	0.000	0.001	0.016	0.055	0.084	0.040	0.021	0.005	0.493
RHL	0.000	2.256	6.403	6.513	3.877	1.397	0.624	0.109	0.000	2.022	5.950	6.121	3.604	1.356	0.738	0.199	41.169
TOTAL	0.003	2.277	7.832	42.442	93.415	80.865	33.013	7.473	0.057	2.332	7.153	40.675	96.557	82.936	39.982	11.657	548.669

Table A7.134 Burden of disease attributable to UVR exposure (sunburn excluded) – upper estimates, in DALYs (000)

WPR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.003	0.013	0.811	2.190	5.293	3.338	1.289	0.275	0.051	0.278	1.036	2.966	3.410	1.786	1.015	0.364	24.118
SCC	0.000	0.001	0.004	0.201	4.251	5.988	4.396	2.411	0.000	0.000	0.003	0.124	1.735	1.923	2.511	2.549	26.097
BCC	0.000	0.003	0.112	0.971	2.340	3.539	3.335	0.743	0.000	0.001	0.029	0.467	1.909	1.091	0.837	0.893	16.270
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Cataract	0.000	0.000	0.063	6.226	14.621	12.421	4.048	0.510	0.000	0.000	0.000	5.988	16.613	14.970	6.590	1.219	83.269
Pterygium	0.000	0.000	0.004	0.229	0.588	0.271	0.184	0.036	0.000	0.000	0.000	0.176	0.457	0.214	0.181	0.054	2.394
SCCC	0.000	0.001	0.015	0.052	0.076	0.030	0.013	0.002	0.000	0.001	0.011	0.039	0.059	0.028	0.015	0.004	0.345
RHL	0.000	1.128	3.202	3.257	1.939	0.699	0.312	0.054	0.000	1.011	2.975	3.061	1.802	0.678	0.369	0.100	20.587
TOTAL	0.003	1.146	4.266	13.729	29.866	26.736	13.815	4.091	0.051	1.291	4.054	13.146	26.679	21.028	11.751	5.273	176.924

Table A7.135 Burden of disease attributable to UVR exposure (sunburn excluded) – lower estimates, in DALYs (000)

WPR B	Male								Female								Total
Disease	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	0-4	5-14	15-29	30-44	45-59	60-69	70-79	80+	
Melanoma	0.002	0.007	0.450	1.217	2.940	1.855	0.716	0.153	0.028	0.154	0.575	1.648	1.894	0.992	0.564	0.202	13.397
SCC	0.000	0.001	0.003	0.144	3.037	4.277	3.140	1.722	0.000	0.000	0.002	0.088	1.239	1.374	1.793	1.821	18.641
BCC	0.000	0.001	0.062	0.539	1.300	1.966	1.853	0.413	0.000	0.000	0.016	0.260	1.060	0.606	0.465	0.496	9.037
Solar keratoses	0.000	0.000	0.055	0.603	0.758	0.450	0.238	0.060	0.000	0.000	0.000	0.325	0.694	0.338	0.233	0.090	3.844
Cataract	0.000	0.000	0.063	6.226	14.621	12.421	4.048	0.510	0.000	0.000	0.000	5.988	16.613	14.970	6.590	1.219	83.269
Pterygium	0.000	0.000	0.002	0.130	0.334	0.154	0.104	0.021	0.000	0.000	0.000	0.100	0.259	0.121	0.102	0.031	1.358
SCCC	0.000	0.001	0.011	0.037	0.055	0.022	0.010	0.002	0.000	0.001	0.008	0.028	0.042	0.020	0.011	0.003	0.247
RHL	0.000	0.564	1.601	1.628	0.969	0.349	0.156	0.027	0.000	0.505	1.488	1.530	0.901	0.339	0.185	0.050	10.292
TOTAL	0.002	0.574	2.247	10.524	24.014	21.494	10.265	2.908	0.028	0.660	2.089	9.967	22.702	18.760	9.943	3.912	140.085