The global burden of disease due to UVR exposure

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Abstract. A global risk assessment of the burden of disease caused by exposure to ultraviolet radiation (UVR) was undertaken. Quantification of risk as loss-of-DALYs (disability-adjusted life-years) allowed comparison of health risks due to this exposure compared to other environmental factors.

Introduction

The first Global Burden of Disease Study (Murray and Lopez 1996) (1990) conducted by the World Health organization sought to quantify and apportion the total global disease burden across 107 health outcomes and 10 disease risk factors. Rather than using mortality as the measure of disease burden, a new metric, the disability adjusted life year (DALY) was developed, incorporating both death and disability into a single measure.

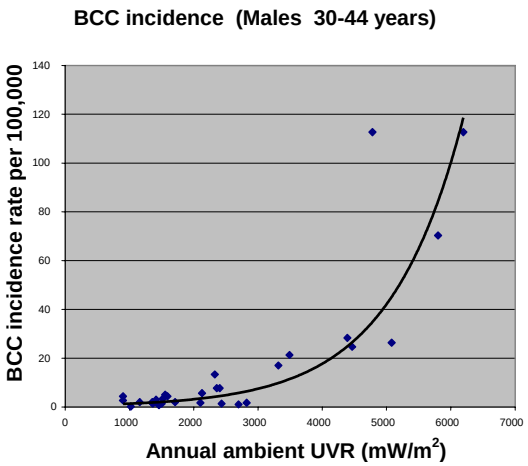
Later Global Burden of Disease Studies have broadened the scope of attribution of disease burden, by including not only diseases and injury, but disease burden attributable to environmental exposures, e.g. unsafe water, sanitation and hygiene, climate change, indoor and outdoor air pollution. This paper presents the methodology and results of the first Global Burden of Disease assessment of ill-health due to excessive and inadequate UVR exposure.

Methods

Systematic literature review identified nine diseases for which there was sufficient evidence of a causal relationship with excessive UVR exposure (see Table 1). A number of other diseases have limited evidence of a causal association with UVR exposure but were not included in this burden of disease assessment. Using available epidemiological data, the population attributable fraction for UVR was calculated for each disorder.

For cutaneous malignant melanoma and cortical cataract the population attributable fraction was directly applied to disease burdens already calculated by WHO (WHO 2002). For seven other diseases, we developed population level exposure-disease relationships and used these to calculate disease incidence and mortality for data-poor regions (an example is presented in Figure 1). Incidence and mortality rates were calculated for lightly pigmented populations and then adjusted for deeply pigmented populations. However no adjustment was made for differences between populations in sun exposure behaviour.

Figure 1. Incidence of basal cell carcinomas in males aged 30-44 (derived from epidemiological studies) in relation to ambient UVR of study location.



We also estimated the burden of disease avoided by adequate UVR exposure (due to the avoidance of vitamin D deficiency and consequent rickets, osteomalacia and osteoporosis). In contrast to the diseases of UVR over-exposure which typically occur in later adulthood, disorders of under-exposure, e.g. rickets, may occur in infancy. For any individual case, years of life lost or lived with disability will be much greater for disorders of under- compared to over-exposure.

Results and Discussion

There is a modest burden of disease caused by the adverse effects of excessive UVR exposure (~0.1% of the total global burden of disease in 2000), see Table 1. The greatest disease burden is attributable to cutaneous malignant melanoma. Lightly pigmented populations living in areas of high ambient UVR particularly bear the burden of disease due to skin cancers.

Disorders such as pterygia and solar keratoses cause disability only if they progress: for pterygia, to vision loss and for solar keratoses, to squamous cell cancers, or if they are removed. Thus, although they are extremely common, their occurrence results in the loss of few disability adjusted life years.

The disease burden associated with cataracts is caused by the associated loss of vision. Cortical cataracts are the cataract type least likely to be associated with loss of vision and thus accrue a relatively low disease burden.

Table 1. Diseases for which there is sufficient evidence of a causal association with UVR exposure and which were assessed in the Global Burden of Disease Study

Diseases causally associated with UVR exposure	Population attributable fraction* Upper (lower)	Global burden of disease ('000 DALYs) Upper (lower)
Skin		
Cutaneous malignant melanoma	0.9 (0.5)	621.22 (345.13)
Squamous cell carcinoma of the skin	0.7 (0.5)	82.75 (59.11)
Basal cell carcinoma of the skin	0.9 (0.5)	52.18 (28.99)
Sunburn	1.0	293.56
Solar keratoses /photoaging	1.0	8.31
Eyes		
Pterygium	0.74 (0.42)	34.62 (19.65)
SCC of the cornea and conjunctiva	0.7 (0.5)	1.74 (1.24)
Cortical cataract	0.20	529.24
Immune effects		
Reactivation of latent virus infection – herpes labialis	0.5 (0.25)	68.30 (34.15)
Effects on bone		
Rickets and osteomalacia	1.0	3,304,816.42

* Population attributable fraction refers to the fraction of disease incidence within the population that is attributable to UVR exposure.

The estimates for sunburn and reactivation of herpes labialis are based on scanty epidemiological data and are highly uncertain. Further data will be required to refine these estimates.

In addition to the disease burden caused by excessive UVR exposure, there is a very large burden of disease avoided by having adequate UVR exposure, by avoiding the health consequences of vitamin D deficiency – rickets, osteomalacia and osteoporosis.

This finding occurs at least in part as a result of the construction of the disability adjusted life year measurement. Many years of life are lost when a child dies and many years lost to disability are accrued when an illness suffered early in life, e.g. rickets, leads to long-lasting disability. However, for low mortality diseases of older age, such as most skin cancers, few years of potential life are lost. Furthermore, excision of lesions is generally associated with only a small "disability" of short duration and thus few DALYs.

Compared to other environmental risk factors, ultraviolet radiation causes a relatively small disease burden globally (see Table 2). However, diseases of excessive UVR exposure are extremely common, with skin cancers the most commonly diagnosed cancer in many countries. Disorders of UVR over-exposure should be entirely avoidable by adherence to simple public health measures. This remains a very important public health message. That public health message must be carefully crafted to retain the protective effects of adequate UVR exposure.

Table 2. Global burden of disease due to UVR exposure, compared to other environmental risk factors

Environmental risk factor	DALYs '000
Ultraviolet radiation – upper estimate	1,692
Ultraviolet radiation – lower estimate	1,319
Occupational noise	4,153
Urban air pollution	7,869
Indoor air pollution	38,537
Unsafe water, sanitation and hygiene	53,155

Conclusions

While there is a modest disease burden due to overexposure to UVR (0.1% of total DALYs), a much greater disease burden is avoided by adequate UVR exposure. This finding supports the recent position statement by the Cancer Council Australia and others recommending modest sun exposure rather than none (The Cancer Council Australia 2005).

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