Implications of climate change for skin cancer prevention in Australia

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Discussions of the impact of climate change on human health typically focus on the potential for increased morbidity and mortality from heat waves, floods and droughts; an increased burden from malnutrition, diarrhoea, and cardio-respiratory and infectious diseases; and the changed distribution of some disease vectors, for example for mosquito-borne diseases.[1] Less commonly discussed is the potential for an increased burden from skin cancer.

Skin cancer accounts for more than 80% of all cancers diagnosed in Australia[2] and results in the highest cost to the health system of all cancers.[3] It is estimated that nearly 450,000 Australians get skin cancer every year.[4] Ultraviolet (UV) radiation from sunlight has been identified as the cause of more than 95% of skin cancers in Australia.[5] Accordingly, the focus of skin cancer prevention programs is reducing exposure to UV radiation through education, legislation and public policy to improve sun protection behaviours.[6]

In Victoria, improvements in sun protection behaviours and reductions in sunburn and in melanoma incidence rates among younger people have been observed since the SunSmart program was established in 1988.[7-9] Based on these successes, a recent report identified an intensive SunSmart campaign as one of a handful of cost-effective interventions for the future that would have a large impact on Australia's health.[10] However, climate change has the potential to undermine past progress, through increases in the intensity of UV radiation and through temperature-dependent changes in sun protection behaviours.

Climate change and increases in UV radiation intensity

The United Nations Framework Convention on Climate Change defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."[11] Such changes are associated with global warming, an average increase in global temperatures due to increased concentrations of greenhouse gases in the atmosphere, which can trigger changes in rainfall and other weather patterns. Mean temperatures in Australia have increased over the past 30 years and are projected to rise further by 0.6 to 1.5°C by 2030;[12] the decade to 2010 was the warmest on record.[13]

The United Nations Environment Program (UNEP) recently published an updated assessment of the environmental effects of ozone depletion and its interactions with climate change.[14] The amount

Abstract

It is estimated that nearly 450,000 Australians get skin cancer every year. Ultraviolet (UV) radiation from sunlight has been identified as the cause of more than 95% of skin cancers in Australia. Accordingly, the focus of skin cancer prevention programs is reducing exposure to UV radiation. In Victoria, improvements in sun protection behaviours and reductions in sunburn and melanoma incidence rates among younger people have been observed since the SunSmart program was established in 1988. However, climate change has the potential to undermine these successes.

First, surface UVB radiation is dependent on stratospheric total ozone amounts. While signs of impact of international restrictions on the production of ozone-depleting substances have been observed, improvements have not yet returned ozone to pre-1970s levels. Interactions between ozone depletion and climate change may slow the recovery of the ozone layer and compound increases in UV radiation at some latitudes. Before recovery, it is expected that higher levels of UV radiation will continue in most Australian regions, with an associated higher risk of skin cancer. Indeed, recent data show increases in surface UV radiation throughout Australia since the 1970s.

Second, mean temperatures in Australia have increased over the past 30 years and are projected to rise further by 2030. Australian data shows that with higher temperatures, adults spend more time outdoors, are less likely to wear covering clothing and more likely to be sunburnt. Hence, rising temperatures can be expected to result in increases in sun exposure, sunburn and correspondingly, skin cancer risk.

Key words: skin cancer prevention, sun protection, ultraviolet radiation, climate change

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So what?

Changes to sun protection behaviours due to increasing temperatures, combined with continued elevated levels of UV radiation may result in increased exposure to the sun. As a result, skin cancer risk may be particularly acute at this time. Adequate funding of skin cancer prevention programs should therefore be a priority.

of UVB radiation at the surface of the earth is strongly dependent on the amount of ozone in the stratosphere. Ozone absorbs UV radiation over the wavelengths that are most important for human health, thus having a protective effect. In the 1970s, depletion of the ozone layer was observed on a global scale. This prompted the global community to commit to international restrictions on the production of ozone-depleting substances via the Vienna Convention in 1985, and subsequently the stricter Montreal Protocol and Copenhagen Amendments.[14,15] While there are signs that international restrictions on the production of ozone-depleting substances have had an impact, improvements have not yet returned ozone to pre-1970s levels. It had previously been estimated that full recovery of the ozone layer would not occur until mid-century, however interactions with climate change may further delay this recovery at some latitudes, while facilitating recovery elsewhere.[14] The UNEP assessment concluded that "projected changes in ozone and clouds may lead to large decreases in UV at high latitudes, where UV is already low, and to small increases at low latitudes, where it is already high".[14]

Recent data show that surface UV radiation has increased in southern (37-45˚S, 110-160˚W), central (29-37˚S, 110-160˚W) and northern (10-29˚S, 110-160˚W) Australia since the 1970s, both in summer and winter.[16] It is expected that these higher levels will continue in most Australian regions until ozone recovery reduces surface UV radiation to 1980s levels or below by the end of the century or somewhat earlier, and into the next century in the north of Australia.[14] As a result, for the next few decades, simply maintaining existing levels of sun protective behaviours will result in increased exposure to UV radiation, which can be expected to result in a higher incidence of skin cancer in years to come.

Climate change and changes in sun protection behaviours

Data has recently been published suggesting a link between temperature and rates of skin cancer, estimating that for each 1°C increase in temperature, the incidence of basal cell carcinoma and squamous cell carcinoma increases by 3% and 6%, respectively.[17] This analysis was prompted by laboratory experiments showing that increasing room temperatures resulted in increased UV radiation-induced carcinogenesis in mice irradiated with constant UV radiation doses.[18] There is as yet no firm evidence to suggest that increases in ambient temperature may increase skin carcinogenesis in humans; however, the higher skin cancer rates observed in people living in areas with higher ambient temperatures may be at least partially attributable to established temperature-dependent variations in sun protection behaviours and resultant sun exposure.

Australian research has shown a strong link between temperature and sunburn rates. Sunburn is a good proxy for skin cancer risk, as it is a biologic marker of excess intermittent exposure, a result of intermittent intense sun exposure combined with skin characteristics that control susceptibility.[19] Analyses of data from a national survey of sun protection attitudes and behaviours and sunburn conducted in summer 2003-04 showed that sunburn was strongly related to the amount of time spent outdoors, and for adults, to wearing longer styles of clothing.[20] On days with higher temperatures, adults spent more time outdoors and were less likely to wear covering clothing. Correspondingly, at temperatures above 22°C, adults and adolescents spending time outdoors during peak UV times were 2-3 times more likely to be sunburnt than on cooler weekend days. Moreover, as temperatures increased further to above 28°C, adults and adolescents were three times more likely to be sunburnt when outdoors.[20] Hence, rising temperatures may result in increases in sun exposure, sunburn, and correspondingly, skin cancer risk.

In practice, regional differences in climate mean there are likely to be differences in behavioural responses to increases in temperature. In the study described above, the relationship between temperature and sunburn was slightly attenuated when the analysis included those who chose to remain indoors.[20] This may be an indication of changes in behaviour to avoid sun exposure at very high temperatures, which it was not possible to quantify with the sample size and degree of temperature variation included in the study. Previous research has indeed found higher personal UV radiation exposure in central Queensland in winter compared with summer, due to people spending less time in direct sun when temperatures are more extreme.[21] In the far north of Australia, temperature-dependent changes in behaviour could mitigate the effects of ongoing increased levels of UV radiation in summer, although there is the potential for winter exposure to be amplified. Similarly, in more southern regions where summer temperatures are milder, temperature-dependent changes in behaviour could compound increases in personal exposure during the next few decades due to the elevated levels of UV radiation.

Conclusion

Taking into account interactions between climate change and ozone recovery, elevated levels of UV radiation in Australia are projected to continue throughout Australia for the next few decades, and for longer in the far north. At the same time, increasing temperatures may result in increased exposure to the sun at some times of year in some regions through associated changes to sun protection behaviours. As a result, the risk of skin cancer may be particularly acute at this time, before ozone recovery reduces surface UV radiation to 1980s levels or below in the regions where the majority of the Australian population live. Adequate funding of skin cancer prevention programs should therefore be a priority.

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