Influence of temperature, humidity and ambient ultraviolet radiation on weekend sun exposure in Australian adults

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Abstract. Understanding how people's sun exposure behaviour may change in relation to weather conditions is crucial in the context of managing current behaviour and predicting the possible UV-related health risks under future climate change conditions. We used data from the multi-centre AusD Study and found that changes in weather conditions, including daily maximum temperature, relative humidity and ambient UVR, had only modest influences on weekend sun exposure behaviours in Australian adults.

Introduction

Exposure to solar ultraviolet radiation (UVR) has both beneficial and adverse effects on the health of humans. The balance of the disease burdens of inadequate and excessive exposure to UVR depends on population demographics (i.e. age, sex, skin type) and the personal received dose of UVR, with the latter being a function of ambient UVR and individuals' sun exposure behaviour. Changes in weather conditions, such as temperature and humidity, are likely to alter people's sun exposure behaviour; the level and direction of the effect is likely to vary geographically. Understanding how people's sun exposure behaviour may change in relation to changes in weather conditions is crucial in the context of managing current behaviour and more importantly, predicting the possible UV-related health risks under future climate change scenarios.

Due to the effect of regional acclimatisation, sun exposure behaviour may be modified by the deviation in weather conditions, rather than the absolute weather. Here we examined the effects of deviation in weather conditions (e.g., temperature, humidity, and ambient UVR) on leisure time sun exposure in Australian adults living in regions defined by different thermal and UVR climates.

Methods

This analysis used data from the multi-centre AusD Study, the primary aim of which was to examine determinants of vitamin D status in adults resident in four Australian cities, each separated by an approximate 8º latitude: Townsville (19ºS), Brisbane (27ºS), Canberra (35ºS) and Hobart (43ºS).

1,002 adults aged 18-75 years were recruited using the Australian Electoral Roll between 2009 and 2010. Data were collected by self-administered questionnaire, face-to-face interviews (including physical examination and collection of blood) and daily sun exposure diaries. Dosimeters were used to monitor personal UVR exposure.

Participants recorded the amount of time spent outdoors during each hour from 5 am to 7 pm on 10 consecutive days using the following categories: 0 minutes, <15 minutes, 15-29 minutes, 30-44 minutes, 45-60 minutes. They also recorded their clothing cover and usage of sunscreen. During the ten days, participants wore a polysulphone dosimeter on a wristband to measure daily personal UVR exposure.

Data on weather conditions (including daily maximum temperature and daily average relative humidity) were obtained from the Australian Bureau of Meteorology (BOM) for the entire study period (May 2009 – December 2010) for each study region. Daily surface ambient UVR levels were estimated for each study region with Geographic Information System (GIS), using the National Aeronautics and Space Administration (NASA) Ozone Monitoring Instrument (OMI) data.

The deviation of weather conditions was defined as the difference of absolute weather on a day and average weather of the season for the study region (e.g., deviation of maximum temperature: absolute maximum temperature on the day minus average daily maximum temperature of the season for 2009 and 2010 for the study region).

In order to minimise the effect of occupation on people's sun exposure behaviour, only data from weekend days were used. For all analyses, rainy days (rainfall >0 mm) were excluded.

Results

Overall, men spent more time outdoors per day (127 vs. 105 minutes, P<0.001), received more proportion of ambient UVR (6 % vs. 4 %, P<0.001) and were less likely to use sunscreen (14% vs. 37%, P<0.001), than women. At midday (11 am to 3 pm AEST), women were more likely to wear a long-sleeved top (47% vs. 34%, P<0.001) and long trousers/skirt (62% vs. 49%, P<0.001) compared to men and were less likely to wear a sunhat (15% vs. 31%, P<0.001).

The association between sun exposure behaviour and deviation in weather conditions was explored using multivariable regression analysis (**Table 1**). Analyses were stratified by North (Townsville and Brisbane) and South (Canberra and Hobart) study regions.

There were marked differences in the patterns of association between sun exposure behaviour and deviation in weather conditions between North and South regions. With greater positive deviation of daily maximum temperature from the average, participants living in both

study regions were less likely to wear a long sleeved-top, but only those living in the South region were less likely to wear long trousers.

Positive deviation of daily relative humidity was associated with decreased time spent outdoors for participants living in the South region and positive deviation of ambient UVR was associated with decreased percentage of ambient UVR received for all participants.

The use of a sunhat was not significantly associated with any of the deviation in weather conditions for the two regions.

Table 1 Association between participants' sun exposure behaviour and deviation of weather conditions

	Time outdoors β (95% CI)	% of ambient UVR β (95% CI)
Deviation of maximum temperature (°C)		
North	0.22 (-4.57, 5.02)	-0.05 (-0.44, 0.34)
South	-0.51 (-3.41, 2.39)	0.22 (-0.11, 0.54)
Deviation of relative humidity (%)		
North	0.05 (-0.91, 1.01)	-0.07 (-0.14, 0.11)
South	-0.97* (-1.93, -0.01)	-0.06 (-0.18, 0.05)
Deviation of ambient UVR (kJ/m^2)		
North	-3.11 (-13.92, 7.71)	-0.77* (-1.49, -0.05)
South	8.20 (-2.13, 18.52)	-1.89* (-6.54, -0.47)

Table continues

Table 1 Continued

	Used sunscreen β (95% CI)	Wore long-sleeved top β (95% CI)
Deviation of maximum temperature (°C)		
North	0.88 (0.67, 1.15)	0.79* (0.63, 0.98)
South	0.92 (0.79, 1.05)	0.73* (0.61, 0.87)
Deviation of relative humidity (%)		
North	1.01 (0.96, 1.06)	0.98 (0.94, 1.01)
South	0.97 (0.93, 1.03)	0.96 (0.91, 1.01)
Deviation of ambient UVR (kJ/m^2)		
North	1.68 (0.89, 3.14)	0.87 (0.54, 1.39)
South	2.10* (0.21, 3.66)	0.48* (0.28, 0.84)

Table continues

Table 1 Continued

	Wore long trousers β (95% CI)	Wore sunhat β (95% CI)
Deviation of maximum temperature (°C)		
North	0.95 (0.76, 1.19)	1.03 (0.80, 1.33)
South	0.81* (0.69, 0.95)	0.98 (0.85, 1.13)
Deviation of relative humidity (%)		
North	1.03 (0.99, 1.07)	0.99 (0.94, 1.03)
South	0.99 (0.94, 1.04)	0.99 (0.94, 1.05)
Deviation of ambient UVR (kJ/m^2)		
North	0.90 (0.55, 1.44)	1.29 (0.74, 2.25)
South	0.70 (0.42, 1.17)	1.52 (0.87, 2.67)

* P<0.05

North: Townsville and Brisbane

South: Canberra and Hobart

Model adjusted for sex, age group and season. Analyses for use of sunscreen and clothing styles were restricted to participants who spent more than 15 minutes time outdoors from 11 am to 3 pm AEST

Discussion

In this multicentre study, we found that changes in daily maximum temperature, relative humidity and ambient UVR had significant, although modest, impacts on some sun exposure behaviours among Australian adults.

The current findings enhanced our understanding of the influences of weather conditions on human's sun exposure behaviour. This information could be incorporated into predictive models for skin cancer incidence in the future, which are currently based only on ambient UVR, and to refine the future predictions of skin cancer incidence under climate change conditions.

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