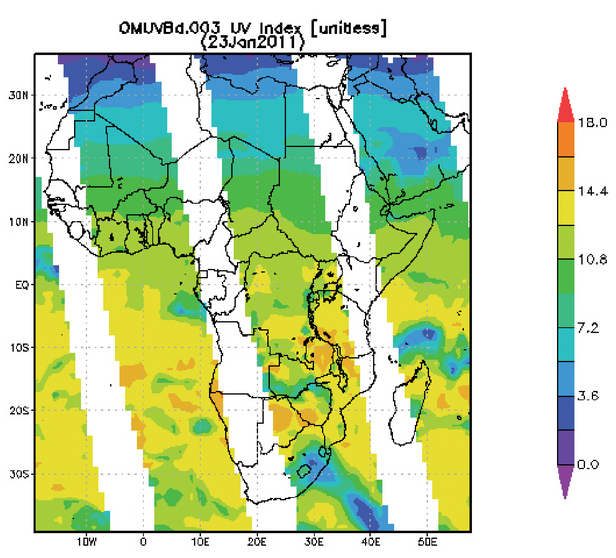
Ambient Solar UV Radiation and Seasonal Trends in Potential Sunburn Risk among Schoolchildren

CARADEE Y. WRIGHT[1], GERRIE COETZEE[2] AND KATLEGO NCONGWANE[2]
[1]CSIR Natural Resources and the Environment, PO Box 395, Pretoria 0001, South Africa
[2]South African Weather Service, Pretoria, South Africa
Email: cwright@csir.co.za – www.csir.co.za

INTRODUCTION

The detrimental effects of excess personal solar ultraviolet (UV) radiation exposure include sunburn, skin cancer and immune suppression. In South Africa, individuals with minimum natural protection from melanin, including fair-skinned individuals, African albinos and people spending extended periods outdoors and unprotected, especially during high solar UV radiation hours, are at risk of sunburn, a risk factor for skin cancer. Previous studies have shown that children are exposed to potentially high, sunburn-causing solar UV radiation levels during school hours.[1-2] In order to intervene effectively, baseline information on patterns of potential schoolchild sunburn risk in South Africa is required.



OMUVBd.003 UV Index (unitless) for Africa on 23 June 2011. Analyses and visualizations were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC.

AIM

To estimate national potential child sunburn risk patterns using monitored ambient solar UV radiation levels for six sites in South Africa.

Schoolchildren with sensitive skin may experience sunburn during spring, summer and autumn months across South Africa and targeted intervention is needed.

METHODS

The South African Weather Service monitors ambient solar erythemal UV-B radiation at six sites (Fig. 1) using UV Biometers (model 501) comprising a Robertson-Berger pattern UV radiation detector, digital recorder and control unit. The erythemal UV-B spectral range closely mimics the McKinley/Diffey Erythemal Action Spectrum. Logged readings were converted into hourly MED (minimal erythemal dose) values (1 MED = 210 Jm^{-2}). Using this definition, hourly MED values for each of the six stations were converted into hourly SED values, the international standard unit for expressing personal solar UV radiation exposure (defined as 1 SED = 100 Jm^{-2}). Ambient solar erythemal UV-B radiation data for 2006 were applied in this study, since this annual data set is the most recent and complete set for all six geographical sites. Ambient seasonal trends were calculated and then applied to estimate potential schoolchild solar UV radiation exposure by skin type using the reported 5% of the total daily ambient solar UV radiation.[3-6]

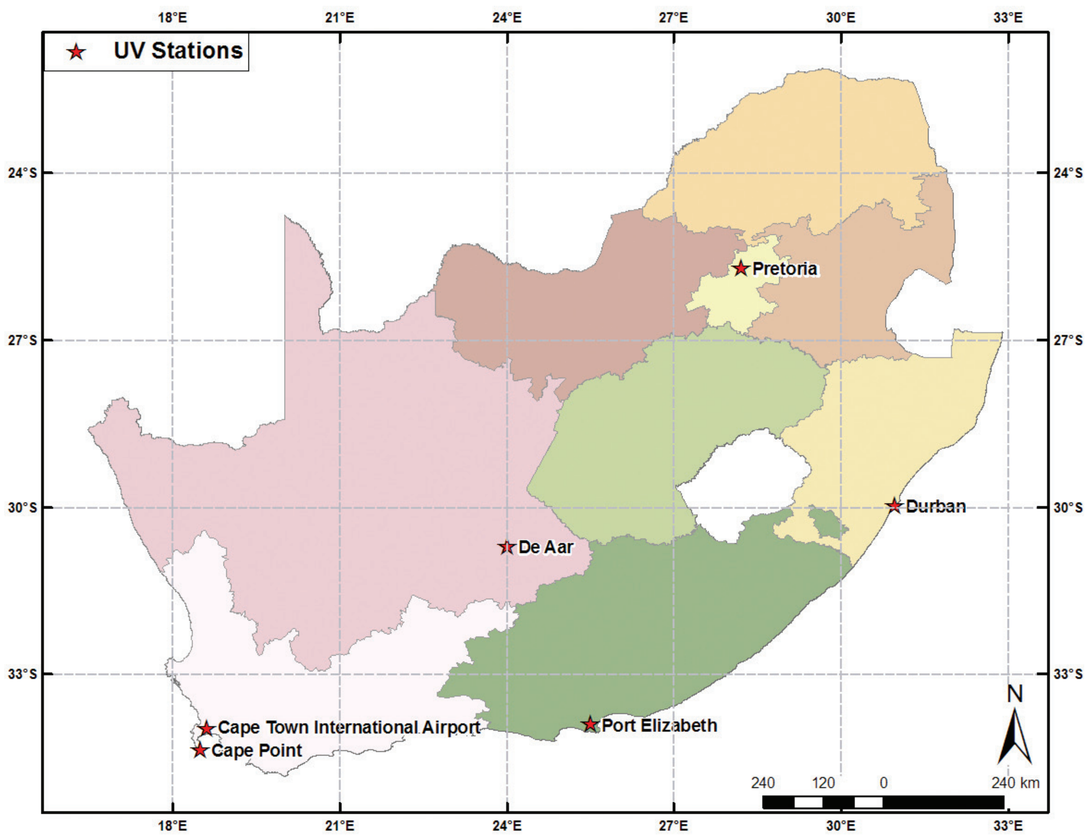


Figure 1: Location of solar UV radiation monitoring stations in South Africa.

RESULTS AND DISCUSSION

School-going children with skin types I, II and III were identified as being at greatest risk of sunburn (Fig. 2). There were 44 and 99 days in a year when schoolchildren with skin type III (only moderately sensitive) living in Durban and De Aar, respectively, would be likely to experience sunburn (Fig. 3). Schoolchildren with skin types I (extremely sensitive) and II (moderately sensitive) living in all six locations were at risk of experiencing sunburn on at least one day per year, the total number of days per year ranging from 14 in Pretoria (skin type II) to 166 days in De Aar (skin type I). Seasonal patterns show schoolchildren may experience sunburn in spring, summer and autumn months depending on geographic location.

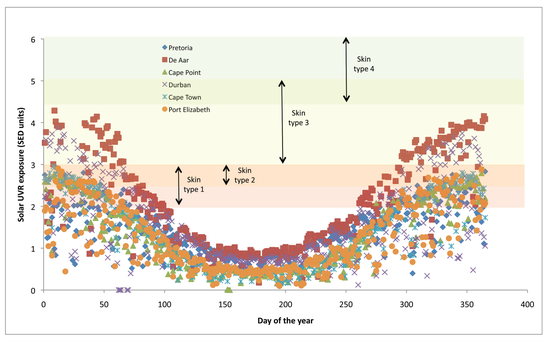


Figure 2: Potential total daily child solar UV radiation exposure (SED = standard erythemal dose; 1 SED = 100 Jm^{-2}) at Pretoria, Durban, Cape Town, Cape Point, De Aar, and Port Elizabeth.

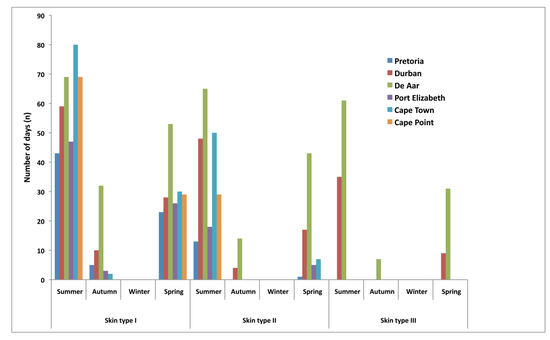


Figure 3: Total number of days per season that schoolchildren of varying skin types may be at risk of experiencing sunburn from excess solar UV radiation exposure depending on activity and sun protection, using an estimated personal exposure of 5% of the total daily ambient solar UV radiation levels.

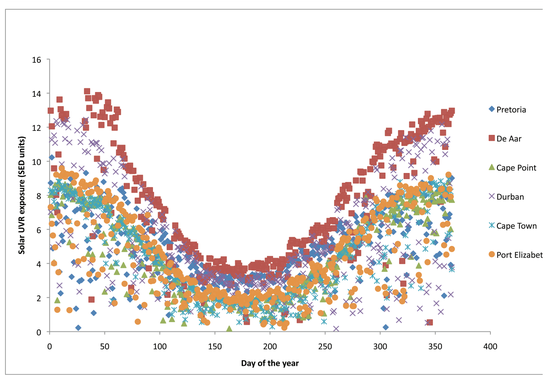


Figure 4: Ambient 1-hour solar UV radiation exposure for midday maximum between 12h00 and 13h000 at six monitoring stations across South Africa.

Table 1. Fitzpatrick skin phototype classification with personal solar UV radiation exposure estimates likely to cause sunburn on un-tanned, unprotected skin.

Skin type – unexposed skin colour, UVR sensitivity to sunburn	Constitutive characteristics	History of sunburn	Continuous UVR exposure estimated to elicit sunburn on un-tanned skin (SED units)
I – white, extremely sensitive	Fair skin, blue or light eyes and freckles	Always burns on minimal exposure	2 - 3
II – white, very sensitive	Red or blonde hair, blue, hazel or brown eyes and freckles	Burns very readily, freckles common	2.5 - 3
III – white or light brown, moderately sensitive	Brown hair and blue, hazel or brown eyes	May burn on regular exposure with no protection, tans slowly	3 - 5
IV – light brown, relatively tolerant	Brown hair and dark eyes	Burns rarely, tans rapidly with minimal exposure	4.5 - 6
V – brown, variable	Brown eyes and dark brown or black hair	Despite pigment, may burn easily on exposure	6 - 20
VI – black, relatively insensitive	Brown eyes and dark brown or black hair	Rarely burns, though sunburn is difficult to detect on heavily pigmented skin	6 - 20

SED = standard erythemal dose; 1 SED = 100 Jm^{-2}.

Since these calculations are based on a percentage estimate of schoolchild exposure in relation to total daily ambient solar UV radiation levels, it is not possible to detect diurnal patterns of schoolchild solar UV radiation exposure. To do so, real-time and time-stamped personal solar UV radiation monitoring in conjunction with personal activity record keeping would be required. However, many schools schedule lunch breaks in the two-hour period either side of midday. Fig. 4 shows the ambient one-hour solar UV radiation exposure levels for the midday maximum between 12h00 and 13h00 at the six monitoring stations. Levels ranged between two and 12 SED units, with the highest midday ambient solar UV radiation levels recorded during the summer months and in Durban. Schoolchildren who do not use sun protection or seek shade may be at risk of sunburn; however, use of cumulative total daily personal solar UV radiation exposures excludes interpretation of hourly patterns of schoolchildren during school hours alone.

CONCLUSION

While sunburn risk depends on schoolchildren's skin type and the season, as well as sun protection, timing and duration of exposure, and nature of activity, these results will help inform messages aimed at schoolchildren, schoolteachers and parents/caregivers in skin cancer prevention and sun protection awareness campaigns.

ACKNOWLEDGEMENTS

This research was funded by a CSIR Parliamentary Grant. Data were kindly provided by the South African Weather Service. This research was published in Wright *et al*. (2011) Ambient solar UV radiation and seasonal trends in potential sunburn risk among schoolchildren in South Africa. *SA Journal of Child Health* **5**(2): 33-38.

REFERENCES

[1] Kimlin M, Parisi A. Usage of real-time ultraviolet radiation data to modify the daily erythemal exposure of primary schoolchildren. *Photodermatol Photoimmunol Photomed* 2001;**17**(3):130-135.
[2] Hunter S, Wells KJ, Jacobsen PB, *et al*. Assessment of elementary school students' sun protection behaviours. *Pediatr Dermatol* 2010;**27**(2):182-188.
[3] Guy CY, Diab RD, Martincigh BM. Ultraviolet radiation exposure of children and adolescents in Durban, South Africa. *Photochem Photobiol* 2003;**77**:265-270.
[4] Wright C, Reeder A, Bodeker G, Gray A, Cox B. Solar UVR exposure concurrent activities and sun-protective practices among primary schoolchildren. *Photochem Photobiol* 2007;**83**:749-758.
[5] Thieden E, Philipsen PA, Heydenreich J, Wulf HC. UV radiation exposure related to age, sex, occupation, and sun behaviour based on time-stamped personal dosimeter readings. *Arch Dermatol* 2004;**140**:197-203.
[6] Diffey BL, Gibson CJ, Haylock R, McKinlay AF. Outdoor ultraviolet exposure of children and adolescents. *Br J Dermatol* 1996;**134**:1030-1034.