

Ultraviolet radiation exposure of children and adolescents in Durban, South Africa

C.Y. Guy

School of Life and Environmental Sciences, University of Natal, Durban, South Africa

Abstract. This paper presents the findings of an initial investigation into the daily ultraviolet radiation (UV) exposure patterns and erythematous UV doses of thirty children and adolescents in Durban for one week during school term in summer. Polysulphone film badges were used to quantify individual erythematous UV dose and each subject recorded their daily activities in a journal. The mean daily erythematous UV dose was 1.03 MEDs with a median of 0.57 MEDs. An explanation for the relatively low mean erythematous UV dose was sought in the prevailing climatic conditions. Of the factors considered, behaviour was found to have more influence on individual erythematous UV dose compared with gender and age.

Introduction

Stratospheric ozone plays an important role in absorbing ultraviolet radiation (UV). The well-known depletion of the ozone layer has raised several concerns with regard to an expected increase in surface UV levels. South Africa, situated in the southern mid-latitude region, has experienced a general downward trend in total column ozone since 1979 [Kalicharran *et al.*, 1993]. As a result of this negative trend in total column ozone, the ultraviolet flux at the earth's surface is expected to increase. Overexposure to UV is known to have acute and chronic impacts on human health, including erythema and skin cancer.

A number of studies have acknowledged a relationship between childhood and adolescence UV exposure and the risk of contracting skin cancer, particularly malignant melanoma skin cancer, during adulthood [Lew and Rosenthal, 1988; Diffey *et al.*, 1996; Gies *et al.*, 1998; Weinstock *et al.*, 1998; Moise *et al.*, 1999a; Moise *et al.*, 1999b; and O'Riordan *et al.*, 2000]. In order to assess this risk and suggest safe-sun practices, the quantification of individual UV doses and exposure patterns of young individuals in South Africa is required. As the first study of its kind to be undertaken in South Africa, this paper will be concerned with investigating the daily erythematous UV doses and exposure patterns of children and adolescents residing in Durban.

Data and Methodology

Three groups of subjects were identified based upon similar studies by Diffey *et al.* [1996] and Moise *et al.* [1999b]: 4 – 6 years; 7 – 9 years and 13 – 14 years. Thirty volunteers were recruited from four local schools situated within an 8-km radius of the University of Natal (Durban).

Polysulphone film badges (PSFB) with a film thickness of 50 μm were used to quantify the daily erythematous

(UV) doses of 30 children and adolescents over a one-week period (26 February 2001 – 4 March 2001) during school term in Durban. A total of 210 PSFBs were issued with a 96% return with only 5% damaged and unusable.

Each subject wore one PSFB per day attached to the lapel anatomic site. Calibration of the polysulphone film was done against erythematous UV measurements (280 – 315 nm) made by a YES UVB-1 pyranometer located on the roof of the Desmond Clarence Building at the University of Natal (Durban).

A dose – response curve (Figure 1) relating the change in absorbance of the polysulphone film at 330 nm (ΔA_{330}) to the erythematous UV dose as recorded by the pyranometer was used to calculate the daily erythematous UV dose of each subject, where $y = 5069x^2 + 505.45x$. Pre- and post absorbance measurements of the PSFBs were undertaken using a Varian DMS 300 UV-Visible spectrophotometer located in the School of Pure and Applied Chemistry at the University of Natal (Durban).

Each subject completed a daily activity journal that included information on: time and nature of activity, indoors or outdoors, sun or shade; type of clothing (garment and fabric) and use of sunscreen.

Results and Discussion

The mean daily erythematous UV dose of all subjects was 1.03 MEDs (1 MED = 200 J m⁻²) with a median of 0.57 MEDs and a 95% range of 0.22 – 7.22 MEDs. An explanation for the unexpectedly low erythematous UV doses was sought in the prevailing climatic conditions. Total daily ambient erythematous UV levels were relatively high, i.e. 20.57 – 30.60 MEDs, however high maximum air temperatures (>27.3°C) and humidity values (>81%) may have encouraged the children and adolescents to avoid direct sunlight and find shade while outdoors.

Although the results showed great variability, subjects between the ages of 4 – 7 years tended to receive higher daily erythematous UV doses compared to subjects aged 13 – 14 years. On average, male subjects tended to spend more time outdoors compared to female subjects and although there was no statistically significant difference (T-test) between the two, males appeared to receive higher daily erythematous UV doses than females.

Behaviour was found to have the most explanatory power in terms of the subjects' daily erythematous UV doses. Time spent outdoors was generally greater on the weekend than weekdays. The mean duration of time spent outdoors for all subjects on all days was 2.3 hours which is relatively low, however, the timing of exposure was critical in determining the intensity and severity of the erythematous UV dose. Frequent outdoor UV exposures on weekdays were school break times between 10:00 –

11:00 and 12:00 – 13:00 when ambient erythematous UV levels are highest (Figure 2). Individual erythematous UV doses were potentially high, however, on account of shading, behaviour, orientation of the body towards the direct solar beam and random movement, they remained lower than ambient erythematous UV levels.

The mean daily erythematous UV dose of all subjects for all days as a percentage of the total daily ambient erythematous UV was 4.58%. Using this percentage, together with total daily ambient erythematous UV levels for Durban during 2000 and the number of MED units required to induce minimal erythema for skin types I – III, it becomes apparent that children and adolescents in Durban face the risk of minimal erythema on at least 32 days during the year.

Based on these findings there is a need for the integration of a safe-sun programme into the South African outcomes-based education curriculum in order to implement effective communication strategies during a child's formative years regarding the health risks associated with exposure to UV.

Conclusion

This study is the first of its kind to be undertaken in South Africa and has provided objective data on the magnitude and range of daily erythematous UV doses received by children and adolescents in Durban.

Acknowledgements

The New Zealand Cancer Association is acknowledged for their sponsorship allowing the author to attend the UV Workshop 26 – 28 March 2002 at the Antarctic Centre, Christchurch. Partial funding for the project was received from the National Research Foundation (NRF) and the University of Natal (Durban). The South African Weather Service is acknowledged for provision of the meteorological data for Durban.

References

- Diffey, B.L., Gibson, C.J., Haylock, R. and McKinlay, A.F. 1996. Outdoor ultraviolet exposure of children and adolescents, *British Journal of Dermatology*, 134, 1030 – 1034.
- Gies, H.P., Roy, C., Toomey, S., MacLennan, R. and Watson, M. 1998. Solar ultraviolet radiation exposures of school children at three locations in Queensland, *Photochemistry and Photobiology*, 68 (1), 78 – 83.
- Kalicharran, S., Diab, R.D. and Sokolic, F. 1993. Trends in total ozone over southern African stations between 1979 and 1991, *Geophysical Research Letters*, 20 (2), 2877 – 2880.
- Lew, R. and Rosenthal, F. 1988. Daily exposure of adolescents to ultraviolet light, *Journal of Investigative Dermatology*, 90.
- Moise, A.F., Buttner, P.G. and Harrison, S.L. 1999a. Exposure at school, *Photochemistry and Photobiology*, 70, 269 – 279.
- Moise, A.F., Gies, H.P. and Harrison, S.L. 1999b. Estimation of the annual solar ultraviolet radiation exposure dose of infants and small children in Tropical Queensland,

Australia, *Photochemistry and Photobiology*, 69 (4), 457 – 463.

O'Riordan, D.L., Stanton, W.R., Eyeson-Annan, M., Gies, P. and Rey, C. 1999. Correlations between reported and measured ultraviolet radiation exposure of others and young children, *Photochemistry and Photobiology*, 71 (1), 60 – 64.

Weinstock, M.A., Colditz, G.A., Willet, W.C., Stampfer, M.J., Bronstein, B.R., Mihm jnr, M.C. and Speizer, F.E. 1989. Non-familial cutaneous melanoma incidence in women associated with sun exposure before 20 years of age, *Pediatrics*, 84 (2), 199 – 204.

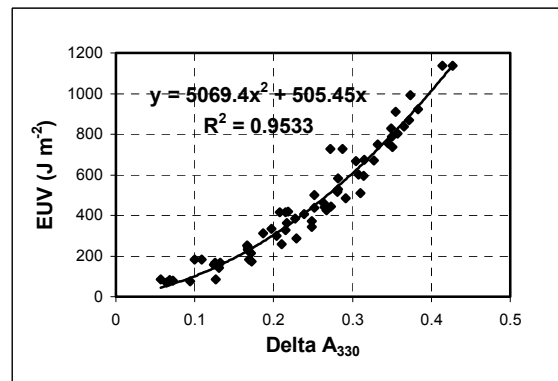


Figure 1. Dose-response of polysulphone film showing ΔA_{330} versus YES UVB-1 pyranometer erythematous UV dose.

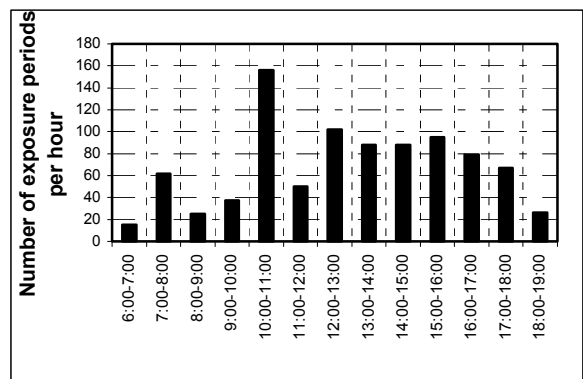


Figure 2. Frequency of subjects' daily UV exposure periods for all subjects during the study period.