Utilising Shade to Optimize UV Exposure for Vitamin D

D.J. Turnbull and A.V. Parisi
Faculty of Sciences, University of Southern Queensland, Toowoomba, Queensland, Australia. Ph:+61746311450, Fax:+61746311530. Email:turnbull@usq.edu.au

Abstract. Numerous studies have stated that humans need to utilise full sun radiation, at certain times of the day, to assist the body in synthesising the required levels of vitamin D$_3$. Current Australian guidelines suggest exposure to approximately 1/6 to 1/3 of a minimum erythemal dose (MED), depending on age, would be appropriate to provide adequate vitamin D levels. In the light of the considerable body of evidence regarding the harm done by excessive UV exposure and the public awareness of skin cancer, new public health programs are needed in order to optimize human solar UV exposure. Utilizing scattered solar UV radiation to obtain beneficial amounts of UV, while at the same time reducing personal overexposure to harmful UV radiation may prove to be absolutely necessary for an improvement in public health.

Solar UV and Vitamin D

The health effects of solar UV radiation vary significantly, from assisting calcium absorption in humans due to the initiation of the synthesis of vitamin D$_3$ to the severe degradation of body tissue. The good effects are relatively few, but they are essential to a persons well being. It is well known that exposure to small amounts of UVB radiation are beneficial for the human body and important in the production of vitamin D$_3$, whereas excessive exposure to UVB and UVA is known to cause skin cancer, DNA damage, immune suppression, erythema and sun-related eye disorders (Glerup et al, 2000; Terenetskaya, 2000; Sliny, 1994). Epidemiological data and animal studies also indicate that low blood serum vitamin D$_3$ is linked to breast cancer, prostate cancer, colorectal cancer, non-Hodgkin’s lymphoma, multiple sclerosis, diabetes, bacterial infections, inflammatory bowel disease, elevated cholesterol and rheumatoid arthritis (Holick, 2004; Garland et al, 2006). It has been estimated that the number of premature deaths from cancer due to insufficient vitamin D in the USA is 50,000 to 60,000 annually and 19,000 to 25,000 in the UK annually (Grant et al., 2005). The associated cost in the USA for 2004 due to insufficient vitamin D$_3$ has been estimated at $40 to $56 billion (Grant et al., 2005). Vitamin D$_3$ is also important for the prevention of rickets in children, osteoporosis, osteomalacia, and falls and fractures in the elderly (Holick, 2004). Total direct costs related to fall injuries in the USA for people 65 and older in 2000 was more than $19 billion (Stevens et al., 2006) and is expected to rise to approximately $43.8 billion by 2020 (Englander et al., 1996).

It is estimated that approximately 90-95% of our vitamin D$_3$ requirement comes from exposure to the sun (Holick, 2004; 1998). The synthesis of vitamin D$_3$ is initiated through exposure of human skin to UVB radiation. The longer wavelength UVA radiation plays no part in the synthesis of vitamin D$_3$ in humans. In comparison, research by Agar et al. (2004) has shown that UVA plays a significant role in human skin carcinogenesis. Therefore, reducing exposure to UVA while still receiving sufficient amounts of the UVB wavelengths required to produce recommended vitamin D$_3$ levels is essential. Although, over exposure to these UVB wavelengths are known to cause skin damage, vitamin D$_3$ synthesis occurs at doses far below those needed for damage to arise (Webb, 1993). Recently, a position statement was approved by the Working Group of the Australian and New Zealand Bone and Mineral Society, Endocrine Society, Osteoporosis Australia, Australian College of Dermatologists and the Cancer Council Australia recommending five minutes UV exposure either side of the peak UV periods on most days of the week in summer and 2-3 hours solar UV exposure over a week in winter (PS, 2006).

Shade and Vitamin D.

Studies on the levels of UV observed in the shade of different shade environments (e.g. Turnbull & Parisi, 2003; Turnbull et al, 2005; 2003; Parisi et al, 2001) have shown that the ratios of UVB to UVA in the shade are significantly different to that in full sun (Figure 1). The ratio of UVB to UVA is higher in the shade than in the sun. These differences are due to atmospheric scattering, which causes greater scattering at the shorter UVB wavelengths and reduced scattering at the longer wavelength UVA. Therefore, the shade holds the effective wavelengths needed for vitamin D$_3$ production in the body, but not the high levels of UVA experienced in full sun. Spectral measurements showed that, for a solar zenith angle of 40$^\circ$ (latitude of 27.6$^\circ$S), the UVA (315-400 nm) in the scattered component of the solar UV is reduced by approximately 62% compared to the UVA in the global UV, whereas vitamin D$_3$ effective wavelengths are only reduced by approximately 43%.

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Figure 1. Scattered, global and ratio of spectral UV irradiances taken on 17 August 2005 at approximately 11:10 EST.
Current Australian guidelines suggest exposure to approximately 1/6 to 1/3 of a MED (minimum erythemal dose), depending on age, would be appropriate to provide adequate vitamin D₃ levels (Samanek et al, 2006; CDHAA, 2006). Researchers at the University of Southern Queensland measured scattered and global erythemal UV at five minute intervals over a twelve month period for a solar zenith angle (SZA) range of 4° to 80° at a latitude of 27.6°S. The times required for exposure to 1/6 MED from scattered erythemal UV on a horizontal plane for SZA greater than 4° are shown in Figure 2. For scattered UV exposures of 1/6 and 1/3 MED, solar zenith angles smaller than 60° and 50° respectively can be utilised for exposure times of less than 10 minutes.

Figure 2. The times required for an exposure of 1/6 MED due to scattered UV as a function of SZA for all sky conditions during 2003.

The times required for exposure to 1/6 MED from scattered erythemal UV at noon or during a lunch break may be the only option for the necessary UV exposure times during the year for major Australian population cities, as shown in Figure 2. For scattered UV exposures of 1/6 and 1/3 MED, solar zenith angles smaller than 60° and 50° respectively can be utilised for exposure times of less than 10 minutes.

The importance of this research is that it provides a basis for public health campaigns aimed at reducing the incidence of vitamin D₃ deficiency and its attendant disorders, as well as reducing over exposure to harmful solar UV radiation. Utilizing scattered solar UV radiation to obtain beneficial amounts of UV, while at the same time reducing personal overexposure to harmful UV radiation may prove to be absolutely necessary for an improvement in public health.

The findings in this paper may have significant ramifications for future public health policy regarding sun exposure, which is currently being debated in many countries (Diffey, 2006; Gillie, 2006). Also, the findings of this research may prove useful to those that work from 9 am to 5 pm, where solar UV exposure at noon or during a lunch break may be the only option for the necessary UV exposures to initiate the synthesis of vitamin D₃. Therefore, advice to stay out of the sun in the middle of the day, which is best for vitamin D₃ synthesis in the skin, can be adjusted to advocate the possible use of appropriate shade environments.

Acknowledgments This research was supported by a Project Grant awarded by the Queensland Cancer Fund.

References


