Minimising Sun-Related Damage to Australian Children's Eyes

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ABSTRACT

Australian children and their families live and enjoy an outdoor lifestyle in an environment with variable and at times, high ultraviolet radiation levels. Generally they have been successfully educated to care for their skin against sun damage. However a similar message regarding the need for eye care has not been as forthcoming. Recent research has shown evidence of sun damage in young Australian children's eyes and indicates the need for eye sun protection. Developing strategies such as wearing hats and sunglasses which aim to minimise eye damage are indicated. In doing this the link between sun avoidance and vitamin D deficiency-related disease needs to be considered.

This paper presents a review of the scientific literature which reports on the prevalence of sun-related eye changes and damage in children's eyes. Possible prevention strategies which offer protection to Australian children's eyes such as sunscreen, sunglasses and hats will be discussed. The need for research in this area will also be highlighted.

Keywords: sun damage, ultraviolet radiation, children

INTRODUCTION

It is well documented that there is a link between sunlight exposure and disease.[1] Australian public health campaigns have existed for many years aimed at encouraging people to protect themselves from the sun. The main focus has been on skin protection, due to the prevalence of skin cancer in Australia. Little public information on the importance of protecting the eyes exists. Challenges occur when formulating recommendations for sun exposure and the eyes when the scientific literature is reviewed. Recently the need to minimise sunlight exposure in children's eyes has been highlighted, as technology has begun to foster an understanding of the presence of sun damage in the eyes of Australian children.[1] Conversely, sun avoidance can pose potential health risks, with a known link to vitamin D deficiency disorders such as rickets.[2] Furthermore, other research suggests that outdoor activity with sun exposure may offer some protection from development of myopia in children.[3] Thus a balance needs to be reached to prevent eye disease linked to lifelong sun exposure without compromising outdoor activities and placing children at risk of disease related to sun avoidance.

Ophthalmohelioses refer to sun-related eye disorders resulting from combined cumulative ultraviolet radiation (UVR) exposure, oxygen and heat causing progressive ocular deterioration and vision impairment.[4] Conditions in this group include photokeratitis, pingueculae, pterygium, cataract, age-related macular degeneration and skin cancers such as basal cell carcinoma.[4,5] The incidence rate of basal cell carcinoma in parts of Australia are amongst the highest rates of cancer in a defined population ever reported.[5] It is also known that prolonged, cumulative UVR exposure, especially related to outdoor occupations, increases the risk of ocular melanomas such as choroidal and ciliary body melanoma.[6]

Thus there is merit in considering UVR prevention strategies in the context of good health which begin in childhood, to minimise the impact of ophthalmohelioses in older age. This paper will present the findings of a literature review funded by the Statewide Ophthalmology Service Agency for Clinical Innovation which examines the available research and discusses the challenges faced in developing these strategies.

THE IMPACT OF ULTRAVIOLET RADIATION

Much has been written on the prediction of safe levels of UVR exposure for skin, which takes into account ambient UVR and seasonal variations, dietary intake of vitamin D and the level of individual skin pigmentation.[2] For example, it is estimated that a person with deeply pigmented skin has the equivalent sun protection as a fair skinned person constantly

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wearing SPF 15 sunscreen.[7] Conversely, synthesis of vitamin D occurs inversely according to skin pigmentation, taking much longer in deeply pigmented than fair skin.[7] However a daily safe level of UVR exposure for the eyes has not yet been established, other than avoiding needless and continuous UVR exposure in extreme environments such as snow, sand and water and in industrial working environments where UVR exposure easily occurs, for example welding.[2]

Ophthalmohelioses can be readily detected in adults by ophthalmic examination. However, measuring the effects of UVR exposure in children is more difficult as early clinical manifestations are not as readily apparent. Recently, ultraviolet fluorescence techniques similar to those which detect signs of UVR exposure-related dermatologic diseases have been used to demonstrate preclinical ocular changes, indicating UVR-related eye damage in children.

Seventy-one Australian children aged 3-15 years underwent ocular examination using ultraviolet fluorescence photography (UVFP), with 23% showing increased fluorescence indicating UVR-related changes; all these children were over the age of 9 years.[1] The UVR changes were detected by UVFP only, and not evident using other ophthalmic techniques. This study also noted that the prevalence of UVR changes increased with age. Ten percent of studied children had established pingueculae on standard photography; these children were all 13 years or older.[1]

The authors acknowledged that the changes detected may have been attributable to other causes and that the eyes with UVR changes may not develop pingueculae or pterygium later in life. However, it was suggested that the ocular changes observed using UVFP may be the earliest indicator of UVR changes in the body. The authors concluded that perhaps UVFP could be used as a universal screening tool for children to detect the preclinical signs of UVR eye damage, leading to parental awareness to prevent further UVR changes and possible eye and systemic disease.

Another study from northern Europe examined 68 children aged 8-15 years, living in an environment of high UVR. The authors found 15% of children had visual field and foveal changes and commented that these children had suffered high unprotected UVR exposure.[8] No other known research reports a link between UVR and eye damage in children.

Individuals may be exposed to up to 80% of their lifetime cumulative ultraviolet radiation before the age of 20 years.[9] Thus the issue of preventative strategies in childhood to reduce ophthalmohelioses later in life needs to be explored. Minimising or avoiding sunlight may be perceived as a possible solution. Sunlight avoidance may occur in individuals who are institutionalised or veiled for cultural reasons. Sun avoidance has been linked to vitamin D deficiency such as rickets in children and osteomalacia and osteoporosis in adults.[2] There is also a suggestion that sunlight avoidance may be linked to other diseases such as bowel cancer.[2]

Findings from the Sydney Myopia Study demonstrated the relationship between sunlight avoidance and the possible negative effect on the eyes. The study examined the refractive status of 2,000 children aged 12-13 years, finding that the time children spent outdoors was negatively associated, with a 23% decrease in the likelihood of having myopia.[3] It was concluded that outdoor activity may provide some protection from children becoming myopic.[3]

STRATEGIES TO MINIMISE ULTRAVIOLET RADIATION

The most common form of sun protection practised by parents and carers for their children is use of sunscreen, with less frequent wear of protective clothing and hats.[10] Studies have found that sole reliance on sunscreen may prevent sunburn but may lead to an increase in the amount of sun exposure a child is allowed thus increasing the UVR exposure to the eyes.[10] Australian schools have generally been proactive in minimising children's sun exposure by increasing the amount of shade available in play grounds and by teachers actively encouraging children to use available shade whilst outside.[11] However, other strategies such as sunglasses and hats should be further investigated for the eye protection they could offer.

SUNGLASSES

The American Academy of Pediatrics described UVR as a hazard to children, including their eyes, and that those children under 10 years of age may be at increased risk for retinal injury because the transmissibility of the lens to damaging visible blue and ultraviolet light is greatest during this period.[12] One of the most obvious strategies available to prevent eye disease from UVR exposure is by wearing sunglasses. Australia was the first country to introduce a national standard for sunglasses known as AS 1067.1-1990 titled "Sunglasses and Fashion Spectacles" in 1971. In 2003 this standard was revised to classify sunglasses and fashion spectacles according to the amount of transmitted UVR. Five categories of lenses were developed and it became mandatory for manufacturers to indicate to consumers through labeling, into which category the sunglasses belonged.

Sunglasses worn by children need to incorporate frames which fit well to the face, close to the surface of the eye to provide maximum protection[12] and which will tolerate bending.[13] The lenses must be secure and impact resistant, manufactured from polycarbonate materials.[13] It is important consumers are warned that a high cost may be a better reflection of the brand or optical quality rather than their ability to reduce or prevent UVR exposure to the eyes.[9]

In 2008, Cancer Council Australia released a position statement titled Eye Protection from Ultraviolet Radiation.[14] The following recommendations were included in the key messages: (i) reduce UVR exposure as much as possible; (ii) wear a broad-rimmed, bucket or legionnaire style hat and (iii) wear close-fitting, wrap-around style sunglasses that meet the Australian Standard AS/NZS 1067:2003 for sunglasses (categories 2, 3 and 4).

The issue of children wearing sunglasses was also addressed with the suggestion that during periods of moderate UVR, that is a UV Index of 3 or greater, children wear sun-protective clothing including a hat which will provide some shade to the eyes; the SunSmart UV Alert which provides the daily UVR being available from the Bureau of Meteorology.[15]

Children spend a substantial period of time in school environments and school programs have been shown to influence children's behaviour towards sun protection through curriculum and policies such as "No hat, no play".[16] Should then, wearing sunglasses be mandatory for children in environments such as school playgrounds and sporting venues? The logistics of enforcing sunglass usage is daunting. An immediate issue would be ensuring that children are wearing sunglasses that reduce the eyes' UVR exposure rather than a pair of fashion spectacles. Parents and carers purchasing sunglasses would need clear instructions regarding how to identify appropriate sunglasses.

The risk of eye trauma from wearing sunglasses in the event of a fall or misuse also needs to be considered. This has recently been studied in the US, with the paediatric population, 0-17 years, having the least number of eye injuries related to wearing glasses when age groups were compared.[17] However this group suffered significantly more injuries related to use of glasses for sport, but it was not reported whether the glasses were prescription or sunglasses.

Introduction of mandatory sunglass usage would also require changes to educational policy and involve support and commitment from governments, schools, parents and carers. The "Kidskin" program conducted in Western Australia aims to reduce sun exposure and improve sun protection behaviours in children. The need to identify a "champion" at an individual school level who could drive participation and acceptance of such a program was highlighted.[16] If sunglass usage is mandated in Australian schools the question of whether this should apply to both primary and secondary school needs to be considered.

Recently, an initiative has begun in a limited number of Victorian and NSW primary schools to introduce sunglass wear for primary school children. The sunglasses are purchased by the school and each child has their own pair which is stored in a labelled, plastic container. The sunglasses are worn each day during recess and lunch. Although not yet considered as part of the school uniform, and it is not compulsory for them to be worn, the sunglass initiative has proven popular with teachers, parents and children.

An additional challenge exists in encouraging teenage children to protect their eyes. Australian teenage populations have been studied previously for their knowledge of the effects of sunlight exposure and their sun protection behaviours. An early study examined trends in sun exposure and protective behaviours in adolescents in all states and territories of Australia, from 1993 to 1999.[18] Students from years 7 to 12 were surveyed, with 78,032 students participating. The outcome of the study showed a significant decrease in use of sunglasses from 1993 to 1999. Further, only 11% of the 1999 cohort reported practising the three protective behaviours of use of a hat, sunscreen and protective clothing.

An Australian study in 2006 surveyed 40 South Australian school students aged 13-18 years to determine their knowledge of the effects of sunlight on the eyes and the need for protection.[19] The results of the survey were then compared to a similar survey conducted in 1995.[20] The 2006 study found a trend of increasing knowledge of the need for sun-protective behaviours with increasing age. The 17-18 years group showed a significantly higher knowledge score than the 13-15 years group. However this knowledge did not ensure a change in behaviour in the group. Seventy-four percent of participants owned a pair of sunglasses, but only 44.5% reported wearing them regularly and 32% wore them occasionally. Also, more than half the participants wrongly believed that sunscreen offered good or fair protection to the eyes, an increase from the 1995 survey.[19] The study found only two-thirds of the 2006 participants acknowledged the risk UVR posed to the eyes. This was significantly lower than the finding in 1995, and the authors commented that the increased efforts by various bodies over the past decade, aimed at increasing awareness of sun-related eye damage in the youth, has not resulted in a significant increase in knowledge.[19]

HATS

It is known that hats effectively reduce sun exposure to the face and head and Australian schools have been proactive in recently implementing policies such as "no hat, play in the shade" policy.[20] In studying outdoor workers in Queensland, it was estimated that consistent outdoor hat-wearing reduced the risk of non-melanoma skin cancers by up to 100 times for basal cell carcinoma and 13 times for squamous cell carcinoma.[21] It is also known that different styles of hats provide varying levels of protection to the face. For example, a hat with a 7.5 cm brim will provide reasonable protection to the cheeks and nose.[22] The shape of the hat has also been found to influence UVR exposure with broad-rimmed and bucket hats providing more protection to the face and head, followed by legionnaire style hats. Baseball

caps provide the least amount of protection to the face and unfortunately these are probably the most popular style to be worn especially by adolescents.[23]

Rather than further complicating the sun protection issue for children by mandating sunglass usage, the role of hats in reducing UVR exposure to the eyes needs to be critically examined. So far, literature is unavailable on how much UVR protection a hat offers to the eyes.

PUBLIC EDUCATION

Whichever strategy is found most suitable, sunglasses, hats or a combination, to reduce UVR exposure to children's eyes, there will need to be a public health awareness raising campaign to support the implementation. Numerous campaigns have been run in the past by the NSW Cancer Council in partnership with NSW Health Department. In evaluating these campaigns for their impact on awareness, knowledge, attitudes and sun-protective behaviours amongst parents and children, it was found that over half of the targeted population was reached. Awareness was highest following a campaign and dropped between campaigns suggesting the need for continued strategies to keep sun protection on the population's agenda, and possibly, development of alternative approaches that have a lasting impact.[24] Programs which educate regarding the deleterious effects of sun exposure and the link to melanoma have been effective in reducing melanoma incidence as mortality rates have stabilised over the past five years.[25] Closer examination of these programs with a focus on reducing the influence of UVR exposure on eyes is highly recommended.

CONCLUSION

The Australian population is increasing and ageing and with this comes a greater incidence of eye disease. Therefore there is merit in ensuring children enter adulthood enjoying good vision and eye health. There is a proven link between lifetime UVR exposure and the likelihood of ophthalmoheliosis. Recent research has shown preclinical signs of UVR damage in relatively young Australian children, although the implication for developing eye disease later is not known.[1]

An urgent need exists to minimise children's exposure to harmful UVR to protect their skin and eyes, within the accepted Australian outdoor lifestyle. Public health campaigns must educate that the eyes as well as the skin require protection, that eye damage will occur from cumulative UVR exposure and that sunscreen will not stop damage to the eyes. Further research is needed to determine the effectiveness of hats in reducing UVR exposure to the eyes. This will contribute to the decision of whether the wearing of hats is sufficient or whether sunglasses should be worn outside to minimise the harmful impact of UVR on Australian children's eyes.

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REFERENCES

1. Ooi JL, Sharma NS, Papalkar D, et al. Ultraviolet fluorescence photography to detect early sun damage in the eyes of school-aged children. Am J Ophthalmol 2006;141(2):294-298.
2. Lucas R, McMichael T, Smith W, Armstrong B. Solar ultraviolet radiation: global burden of disease from solar radiation. World Health Organization Public Health and the Environment Geneva; 2006 [Updated 2006, cited 2010 31st Jul] Available from: http://www.who.int/uv/health/solaruvradfull_180706.pdf.
3. Rose KA, Ip J, Robaei D, et al. Near-work and outdoor activities and the prevalence of myopia in Australian secondary school children aged 12-13 years: The Sydney Myopia Study. Invest Ophthalmol Vis Sci 2006;47:ARVO [E-Abstract:5453].
4. Young RW. The family of sunlight-related eye diseases. Optom Vis Sci 1994;71(2):125-144.
5. Malhotra R, Huilgol SC, Huynh NT, Selva D. The Australian Mohs database part 1: periocular basal cell carcinoma experience over 7 years. Ophthalmology 2004;111(4):624-630.
6. Vajdic CM, Kricker A, Giblin M, et al. Sun exposure predicts risk of ocular melanoma in Australia. Int J Cancer 2002;101(2):175-182.
7. Lucas RM, Ponsonby AL. Ultraviolet radiation and health: friend and foe. Med J Aust 2002;177(11-12):594-598.
8. Vojnikovic B, Micovic V, Coklo M, Vojnikovic D. Sun exposure and visual field damage among children on the Adriatic Island Rab – possible initial risk factor in development of age-related macular degeneration. Coll Antropol 2009:33(3):747-749.
9. Young S, Sands J. Sun and the eye: prevention and protection of light-induced disease. Clin Dermatol 1998;16(4):477-485.
10. Johnson K, Davy L, Boyett T, Weathers L, Roetzheim RG. Sun protection for children: knowledge, attitudes and parent behaviours. Arch Pediatr Adolesc Med 2001;155(8):891-896.
11. Milne E, Corti B, English R, et al. The use of observational methods for monitoring sun-protection activities in schools. Health Ed Res 1999;14(2):167-175.
12. American Academy of Pediatrics Committee on Environmental Health. Ultraviolet light: a hazard to children. Pediatrics 1999;104(2 Pt1):328-333.
13. Prevent Blindness America. Sunglasses: protect your eyes from the sun!; 2005 [Cited 2010 31st Jul] Available from: http://www.preventblindness.org/eye_problems/sunFAQ.html.
14. Cancer Council Australia. Position statement: eye protection; 2006 [Updated Aug 2008, cited 2010 31st Jul] Available from: http://www.cancer.org.au//policy/positionstatements/sunsmart/eyeprotection.htm.
15. Australian Government Bureau of Meteorology. UV Index forecast for Sydney; 2010 [Cited 2010 31st Jul] Available from: http://www.bom.gov.au/products/UV/Sydney_NSW.shtml.
16. Giles-Corti B, English DR, Costa C, et al. Creating SunSmart schools. Health Ed Res 2004;19(1):98-109.
17. Sinclair SA, Smith GA, Xiang H. Eyeglasses-related injuries treated in US emergency departments in 2002-2003. Ophthalmic Epidemiol 2006;13(1):23-30.

18. Livingston PM, White V, Hayman J, Dobbinson S. Sun exposure and sun protection behaviours among Australian adolescents: trends over time. Prev Med 2003;37(6 Pt1):577-584.
19. Pakrou N, Casson R, Fung S, et al. South Australian adolescent ophthalmic sun protective behaviours. Eye (Lond) 2008;22(6):808-814.
20. New South Wales Department of Education and Training. Sun Sense; 2010 [Updated 2010, cited 2010 31st Jul] Available from: https://www.det.nsw.edu.au/languagesupport/documents/sun_sense.htm.
21. Wong JC, Airey DK, Fleming RA. Annual reduction of solar UV exposure to the facial area of outdoor workers in Southeast Queensland by wearing a hat. Photodermatol Photoimmunol Photomed 1996;12(3):131-135.
22. Diffey BL, Cheeseman J. Sun protection with hats. Br J Dermatol 1992:127(1):10-12.
23. Gies P, Javorniczky J, Roy C, Henderson S. Measurements of the UVR protection provided by hats used at school. Photochem Photobiol 2006;82(3):750-754.
24. Smith BJ, Ferguson C, McKenzie J. Impacts from mass media campaigns to promote sun protection in Australia. Health Promot Int 2002;17(1):51-60.
25. McCarthy WH. The Australian experience in sun protection and screening for melanoma. J Surg Oncol 2004;86(4):236-245.