POSTER

SPECTRAL TRANSMITTANCE OF SOME OPHTHALMIC LENSES IN MALAYSIA

Sharanjeet-Kaur, M. Normazila* & A.E. Ariffin**

ABSTRACT

This study was conducted to determine the spectral transmittance of some commonly dispensed ophthalmic lenses in Malaysia. The efficiency of these lenses in providing ocular protection against ultraviolet radiation was also examined. Eight lenses that are currently marketed in Malaysia as lenses with "UV-coating" were randomly selected for the testing. These lenses (Hoya, Essilor Orma, Optron, Sola, Igel, Zeiss, Vista Optics and American Optical) were obtained from a few optometric practices in Kuala Lumpur. They were marketed as lenses with "UV blocking" properties by virtue of the UV coat on them. A Spectrophotometer (Shimadzu UV-160A) was used to determine the spectral transmittance of these lenses. It was found that Hoya, Essilor, Optron, Sola and Igel lenses provided good protection against ultraviolet B radiation. However, there was transmission (10 to 15%) of ultraviolet C radiation. It was also found that these lenses transmitted some ultraviolet A radiation, averaging at about 28% for all 5 lenses. Zeiss, Vista Optics and American Optical lenses were all found to be capable of blocking ultraviolet C radiation. However, Zeiss lens transmitted some ultraviolet A and Vista Optics lens transmitted some ultraviolet A and B radiations as well. The American Optical lens was the only lens that blocked the transmission of all of ultraviolet radiations A, B and C. This study shows that UV-coated American Optical lenses as marketed in Malaysia provide sufficient protection against ultraviolet radiation.

Key words: *Spectral transmittance, ultraviolet radiation*

ABSTRAK

Kajian ini bertujuan untuk menentukan transmisi spektra beberapa kanta oftalmik yang biasa didispenskan di Malaysia. Keberkesanan kanta tersebut melindungi mata daripada sinaran ultraungu juga turut dikaji. Lapan kanta yang dipasarkan di Malaysia sebagai kanta berlapisan-UV telah dipilih secara rawak untuk kajian ini. Kanta-kanta ini (Hoya, Essilor Orma, Optron, Sola, Igel, Zeiss, Vista Optics and American Optical) telah didapati daripada beberapa praktis optometri di sekitar Kuala Lumpur. Kanta ini dipasarkan sebagai kanta yang mempunyai sifat "penghalang sinar UV" iaitu mempunyai lapisan UV di atas permukaannya. Satu spektrofotometer (Shimadzu UV-160A) telah digunakan untuk menentukan transmisi spektra kanta-kanta tersebut. Didapati kanta Hoya, Essilor, Optron, Sola and Igel memberikan perlindungan yang baik kepada sinar ultraungu B. Namun terdapat transmisi (10 hingga 15%) kepada sinar ultraungu C bagi kanta-kanta ini. Didapati juga yang kanta-kanta ini mentransmitkan sinar ultraungu A, berpurata sekitar 28% untuk kelima-lima kanta. Kanta Zeiss, Vista Optics and American Optical didapati mampu untuk menghalang transmisi sinar ultraungu C. Walaubagaimanapun, kanta Zeiss mengtransmisikan sedikit ultraungu A and kanta Vista Optics pula mentransmisikan sedikit ultraungu A dan B. Hanya kanta American Optical sahaja yang mampu menghalang transmisi kesemua sinar ultraungu A, B dan C. Kajian ini menunjukkan kanta American Optical berlapiskan penghalang UV yang dipasarkan di Malaysia memberikan perlindungan yang cukup terhadap sinaran ultraungu.

Kata kunci: *Transmisi spektra, sinaran ultraungu*

INTRODUCTION

Light is made up of electromagnetic radiation, which ranges from wavelengths of 10^{-5} nm to 10^{15} nm. It comprises cosmic radiation, X-rays, ultraviolet radiation, visible light, infrared radiation, microwave radiation and radio frequency radiation. Radiations with shorter wavelengths have higher frequencies and in turn have higher energies (Halliday & Resnick 1988).

The main source of electromagnetic radiation is sunlight. Cosmic radiation includes wavelengths that range from 10^{-14} to 10^{-12} nm. The human retina is very sensitive to radiation from sunlight because such rays are known to cause damage to the sensitive retinal layer. Many ocular pathological conditions such as age-related cataract, age-related macular degeneration, pterygium, photokeratitis and

* *Department of Optometry, Faculty of Health Sciences, Universiti Kebangsaan Malaysia*

cancer of the eyelids have been associated with exposure to sunlight (Young 1993).

Ultraviolet radiation (UV) ranges between 100 and 380 nm. UV between wavelengths of 320 and 400 nm is known as UVA while UV that lies between 290 and 320 nm is called UVB. UV of wavelengths below than 290 nm is known as UVC (Sliney 1995). The amount of UVA and UVB in the environment varies greatly by time of day, altitude and season. The ozone layer absorbs almost all of UVC. UVA and UVB on the other hand are partially absorbed by the ozone layer; but it is a rather an uncomforting fact that the levels of UV in general are on the increase due to the thinning of the ozone layer.

As for the ocular effects, UVA is transmitted by the cornea and absorbed primarily by the crystalline lens, with small amounts being transmitted onto the retina. UVB is absorbed by the cornea and crystalline lens; however, a small significant amount also impinges on the retina. UVA can have adverse effects on the cornea (Zigman 1995) and crystalline lens (Pitts 1990). What is more compelling is that results from a number of research projects have shown that UVB is associated with corneal damage (Zuclich 1980), cataract and age-related macular degeneration (Cruickshanks et al. 1992; McCarty & Taylor 1999; McCarty et al. 1999; McCarty et al. 2000). These studies point to an important public health awareness that is to be instilled into people, that is to protect their eyes from the harmful radiations of the sun.

One way by which the eyes can be protected is by wearing spectacles with UV-absorbing ophthalmic lenses. The reduction in UV radiation from wearing of such spectacles varies with the properties of the material (of the ophthalmic lenses) used. In general, an ophthalmic lens should afford UV protection by ideally absorbing wavelengths between 290 nm and 400 nm (Dain 1993; Young 1993).

In developed countries like Britain, Australia, USA and Germany, there are standards set by the government with regards to the issue here. Manufacturers of ophthalmic lenses are required to produce ophthalmic lenses with UV absorbing properties. There are guidelines that manufacturers have to adhere to ensure adequate absorption of specified UV radiations before the lenses are allowed to be marketed.

In Malaysia, however, no such law is in existence. The scenario currently is that some lenses are obtained from overseas countries. These lenses undergo the UV block coating process in the home country before they are exported to Malaysia. Examples of such lenses are the Hoya, Essilor, American Optical, Vista Optics and Zeiss lenses. Some lenses are also imported into Malaysia without any UV blocking coat and distributors of ophthalmic lenses here apply the UV coat locally. There are no standards imposed by the government to ensure the coated lenses meet certain standard safety requirements.

Malaysia is a tropical country with high exposure to UV radiation. As such, protection from these harmful radiations is, needless to, say crucial. The present study was undertaken to determine the spectral transmittance/absorbing properties of some ophthalmic lenses marketed in Malaysia within the optical/optometric circles and thus the efficiency of these lenses in providing eye protection against ultraviolet radiation.

METHODOLOGY

The Shimadzu UV-160A Visible Spectrophotometer was used to measure the spectral transmission of 8 different lenses commonly marketed in Malaysia. These lenses were randomly obtained from a few optometric practices within Kuala Lumpur. The lenses tested were: Hoya, Essilor Orma, Optron, Sola, Igel, Vista Optics, American Optical, and Zeiss. All lenses were 2.2 mm thick and they were did not have any tint in them. All lenses had UV blocking coat and were made of CR 39 material. They were all plano powered lenses except for two i.e. Sola and Igel which had a power of –0.50D.

Measurements were made at room temperature. The spectrophotometer was initially calibrated by measuring spectral transmission without any lenses in the receptacle. See Fig I for a diagram of the apparatus. Spectral transmission without any lens during calibration was noted to be 100% for all wavelengths between 200 nm and 600 nm. The ophthalmic lens under investigation was subsequently placed inside the spectrophotometer and transmission was measured again over a wavelength range of between 200 nm and 600 nm. The concave side of the ophthalmic lens faced the UV light. The UV light was incident perpendicular to the lens and passed through the center of the lens. The incident UV light had a height of 3.5 mm and a width of approximately 1.5 mm. Measurement was made for all 8 lenses in the following order: Essilor Orma, Optron, Hoya, Sola, Igel, American Optical, Zeiss and Vista Optics lenses. A spectral transmission curve was derived for each lens that underwent testing.

RESULTS

Figure 2 shows the spectral transmission curves for the Hoya and Essilor lenses being compared on the same graph, since both lenses show similar transmission pattern.

There is transmission of wavelengths between 370 nm and 400 nm (UVA range) for the Hoya lens and wavelengths of between 390 nm and 400 nm for the Essilor lens. Transmission at 400 nm is around 20% for the Hoya lens but only about 3% for the Essilor lens. However, wavelengths in the UVB range (290 nm and 320 nm) are completed absorbed by both lenses. There is also transmission of wavelengths less than 290 nm (UVC range) with about 10% transmission of wavelengths less than 270 nm by both lenses.

Spectral transmission curves for Optron, Sola and Igel lenses are shown in Figure 3. Here again, there is transmission of parts of the UVA range i.e. wavelengths between 360 nm and 400 nm. Transmission at 400 nm is around 40% for Sola lens, and for the Optron and Igel lenses, transmission at 400 nm is about 50%. Like the lenses described previously, Sola, Igel and Optron lenses completely absorb UVB radiation. It can also be seen that all three lenses transmit wavelengths less than 280 nm, with about 15 % transmission of wavelengths less than 260 nm.

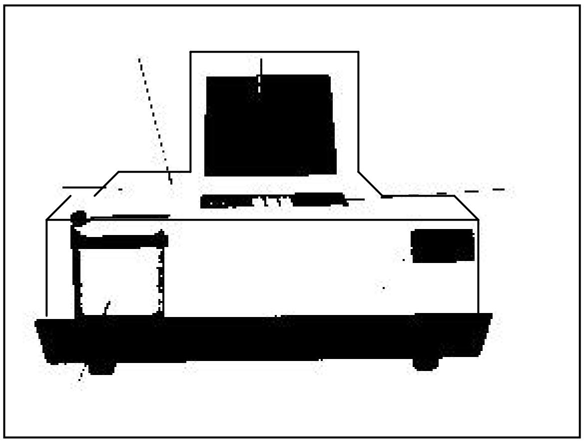

Figure 1. Outside view of the Shimadzu UV-160A Visible Spectrophotometer

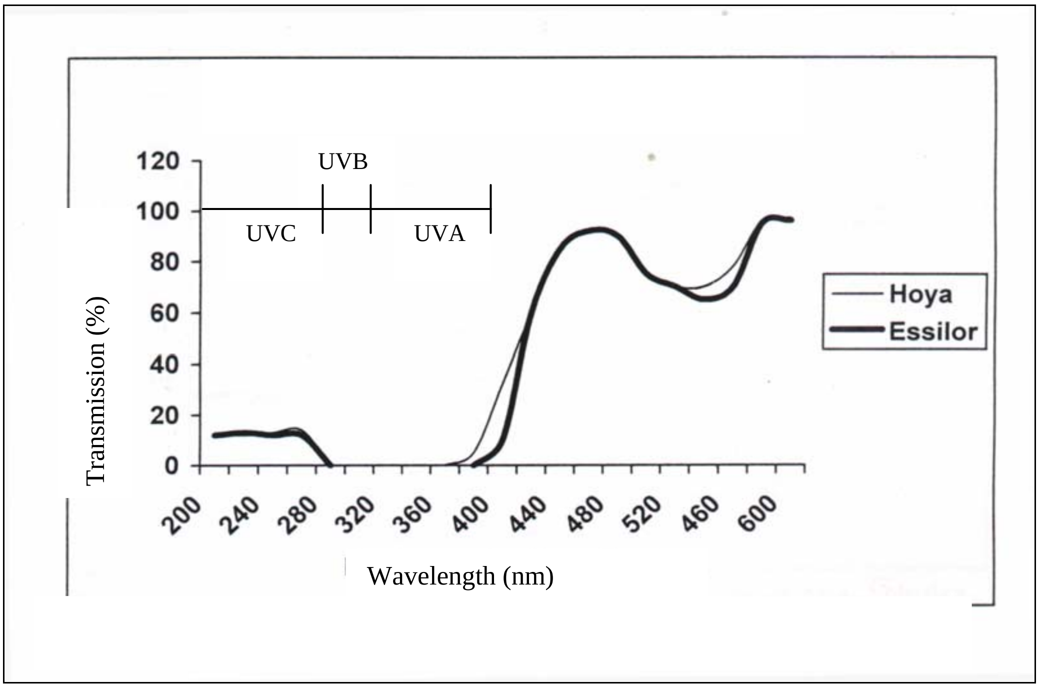

Figure 2 : Spectral transmission curves for the Hoya and Essilor lenses

Figure 4 shows the spectral transmission curves for the American Optical, Vista Optics and Zeiss lenses. A striking property here is that there is no transmission of wavelengths less than 290 nm (UVC range) for all three lenses. In the UVA range there is transmission of wavelengths between 360 nm and 400 nm for the American Optical lens, between 340 nm and 400 nm for the Zeiss lens and between 320 nm and 400 nm for the Vista Optics lens. Transmission at 400 nm is around 80% by the American Optical and Zeiss lenses, and around 70% by the Vista Optics lens. But whilst the American Optical and Zeiss lenses do not transmit any wavelengths in the UVB range, Vista Optics lens transmits about 5% at 320 nm.

Table 1 shows the percentage transmission of UV radiation for specific wavelengths located in the middle of the UVA, UVB and UVC ranges. It can be seen that 4 of the lenses tested: Hoya, Essilor Orma, Sola and AO American Optical absorb 360 nm, which is the wavelength at the center of the UV-A range. All the lenses tested absorb 300 nm, which is the wavelength in the center of the UV-B range. However, only 3 of the lenses tested: American Optical, Vista Optics and Zeiss fully absorb 240 nm, which is the wavelength in the middle of the UV-C range.

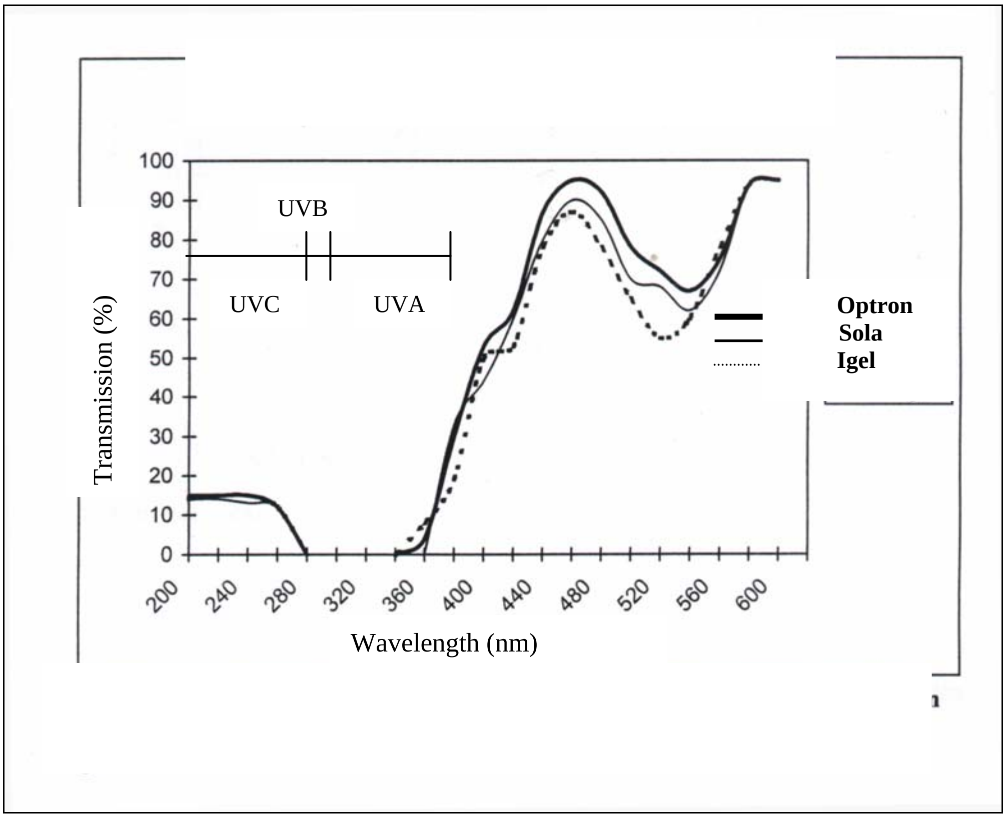

Figure 3: Spectral transmission curves for the Optron, Sola and Igel lenses

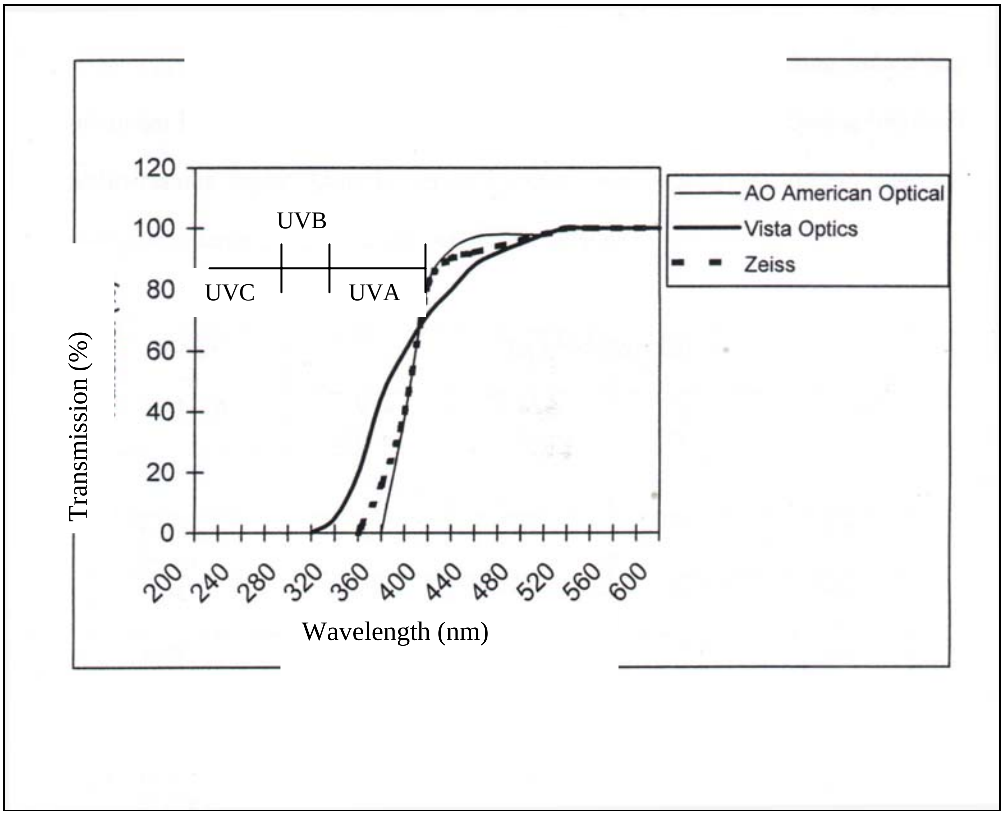

Figure 4: Spectral transmission curves for the American Optical, Zeiss and Vista Optics lenses

Table I: Percentage transmission of UV radiation for wavelengths in the middle of the UVA, UVB and UVC ranges.

Type of lens	Transmission (%)		
	UV-A (360 nm)	**UV-B (300 nm)**	**UV-C (240 nm)**
1. Hoya	0	0	12
2. Essilor Orma	0	0	12
3. Optron	2	0	16
4. Sola	0	0	14
5. Igel	8	0	14
6. American Optical	0	0	0
7. Vista Optics	46	0	0
8. Zeiss	18	0	0

Table 2 shows the presence (indicated by √) and absence (indicated by X) of transmission of UV radiation for the different lenses tested. The wavelengths in brackets refer to those transmitted. It can be seen that all lenses tested transmit UV-A radiation to some extent. But only one lens, Vista Optics, was found to transmit UV-B radiation. It can also be seen that only 3 lenses: the American Optical, Vista Optics and Zeiss, were found to block off UV-C radiation.

Table 2: Presence (indicated by √) and absence (indicated by X) of transmission of UV radiation for the different lenses tested. The wavelengths in brackets are those transmitted.

Type of lens	Transmission (%)		
	UV-A (320-400 nm)	**UV-B (290-320 nm)**	**UV-C (<290 nm)**
1. Hoya	√ (>370 nm)	X	√ (<290 nm)
2. Essilor Orma	√ (>390 nm)	X	√ (<290 nm)
3. Optron	√ (>360 nm)	X	√ (<280 nm)
4. Sola	√ (>360 nm)	X	√ (<280 nm)
5. Igel	√ (>360 nm)	X	√ (<280 nm)
6. AO American Optical	√ (>360 nm)	X	X
7. Vista Optics	√ (5% at 320 nm)	√ (>300 nm)	X
8. Zeiss	√ (>340 nm)	X	X

DISCUSSION

The transmission characteristics of lenses tested are similar for some while different for others. Figures 2, 3 and 4 depict the transmission properties of the 8 lenses, as they are being grouped together on a particular graph based of "similar" transmission patterns. These lenses were made of the same material (CR 39) and are of similar thicknesses and powers (plano or slightly minus). They are purportedly absorbing harmful UV radiation from the sun and thus protecting the eyes. However, they vary in their respective abilities to provide such protection as can be seen from the results obtained.

A comparison can be made in the transmission characteristics of the lenses tested in this study with that provided by the manufacturer. For the Hoya lens, the manufacturer stated that the lens provide full protection against UV-B and UV-C and 90% protection against UV-A. The present study found that this lens provides protection of around 85% against UV-C. The lens does provide 100% block to UV-B radiation and 90% protection against UV-A as claimed by the manufacturer. This lens is coated in Japan.

The manufacturer of Essilor Orma lenses also claim that their lenses can provide protection against all UV-B and UV-C radiations and 90% protection against UV-A. Results of the measurements made in the present study confirm this. The Essilor lab in Penang coats these lenses locally.

Vista Optics lens has been stated by its manufacturer to be able to provide protection of 98% against all UV radiations. Results of the present study show that while the lens blocks off UVC completely, it can only provide protection of 95% against UV-B and around 50% against UV-A. This lens is coated in the United Kingdom. However, Vista Optics ophthalmic lenses are no longer in the Malaysian market as they are now only concentrating on contact lenses and intraocular lenses.

The manufacturer of American Optical lenses claim that their lens can protect against 98% of UV-A and all of UV-B and UV-C radiations. This claim is substantiated by the results of the measurements made in the present study. This lens is coated in Singapore by American Optical laboratory.

The Zeiss lens was found to transmit about 20% of UV-A radiation. However, there is a disparity from what is claimed by the manufacturer who stated that the lens could provide protection against 98% of UV-A radiation. The lens, however, was found to provide full protection against UV-B and UV-C radiations, in total agreement with the manufacturer's claim. This lens is coated in Germany.

Transmission characteristics of Optron, Sola and Igel lenses could not be obtained from the local distributors of these lenses. As such, no similar comparisons can be made for these lenses. The local distributors coat these lenses in their own respective laboratories.

In conclusion, the American Optical lens is found to be the lens that provides the best protection, among the 8 lenses tested, against UV radiation as a whole i.e. 98% protection against UV-A, 100% protection against UV-B and 100% protection against UV-C radiations. The good UV blocking property could be a function of the following properties: material of the lens itself (inherent UV blocking property as a result of chemical additions made to the original CR39), the so-called "UV coat", the "hard coat" and the "antireflection coat" that is applied to the lens surface. The final UV blocking ability can very well be a product of combinations of the said properties.

REFERENCES

Cruickshanks, K.J., Klein, B.E. & Klein, R. 1992. Ultraviolet light exposure and lens opacities: The Beaver Dam Eye Study. *Am J Public Health*. **82**: 1658-1662.

Dain, S.J. 1993. Comparison of the Transmittance and Coloration Requirements of the Four National Sunglass Standards. *Optom & Vis Sci*. **70** (1): 66-74.

Halliday, D. & Resnick, R. 1988. *Fundamentals of Physics*. 3rd ed. New York: John Wiley.

McCarty, C. & Taylor, H.R. 1999. Light and Risk for Age-related Eye Diseases. In: Taylor A. (ed). *Nutritional and Environmental Influences on the Eye*. Chapter 8. Washington DC: CRC Press.

McCarty, C.A., Mukesh, B.N., Fu, C.L. & Taylor, H.R. 1999. The epidemiology of cataract in Australia. *Am J Ophthalmol*. **128**: 446-465.

McCarty, C.A., Nanjan, M.B. & Taylor, H.R. 2000. Attributable risk estimates for cataract to prioritize medical and public health action. Invest Ophthalmol Vis Sci. **41**(12):3720-5.

Pitts, D.G. 1990. Ultraviolet-Absorbing Spectacles Lenses, Contact Lenses and Intraocular Lenses. *Optom & Vis Sci*. **67**(6): 435-440.

Sliney, D.H. 1995. UV radiation ocular exposure dosimetry. *Photochem Photobiol* **31**: 69-77.

Young, R.W. 1993. The Charles F. Prentice Medal Award Lecture 1992: Optometry and the Preservation of Visual Health. *Optom & Vis Sci*. **70** (4): 255-262.

Zigman, S. 1995. Environmental Near-UV Radiation and Cataracts. *Optom & Vis Sci.* **72**(12): 899-901.

Zuclich, J.A. 1980. Cumulative effects of near-UV induced corneal damage. *Health Phys*. **38**: 833-8.