**LIGHT, UV RADIATION, MYOPIA PROGRESSION AND CONTACT LENSES**

***Vassilis Fotinakis, M.Sc, BCLA Member***

Contact Lens Department Director – Optical Papadiamantopoulos S.A. 6, Hermou str., 10563 Athens-Greece

Part time lecturer, Athens Technological and Educational Institution (TEI), - Department of Optics and Optometry – Athens, Greece

Communication e-mail: vfotinakis@yahoo.gr

**Abstract** Myopia is a very common refractive condition that has reached epidemic levels the last decades in most modern countries, especially in Asia. This increase has been attributed to hereditary and also environmental factors, the latter mainly being accommodation stress due to increasing near vision tasks in everyday life. However, the vital role of natural light in arresting myopia progression has been also documented. Other theories have been developed, like the one concerning peripheral hyperopic defocus and new refractive devices have been designed to cope with the increase in myopia in infants and adults. Somehow, combining research results gives us a new perspective of what might be the key to the problem and a new old player that everybody seems to be afraid of speaking its name (UV) comes literally to light.

Myopia is a very common refractive condition. In some parts of East Asia, myopia has reached epidemic proportions and its prevalence can even exceed 80% in some highly educated groups. Moreover, there is growing evidence that the prevalence of myopia, including high myopia, is increasing rapidly in the United States and other non-Asian countries ( Fredrick , 2002; Garcia et al, 2005; Mallen et al, 2005; Wu et al, 2001; Mavracanas et al., 2000; Vitale et al., 2008). This rapid rise in myopia prevalence has been frequently suggested that it is significantly affected by changing environmental factors (Morgan and Rose, 2005).

Myopia is associated with ocular complications that can lead to permanent and significant vision loss. Thus, myopic eyes have an increased risk of cataract, glaucoma, chorioretinal degenerations, and retinal detachments (Lim et al, 1999; Wong et al., 2001; 2003; Saw et al., 2005). As a result, myopia is considered to be a leading cause of permanent visual impairment.

Through the last decades there have been many theories and attempts to arrest myopia progression in teens and adults, from hard PMMA flat-fitted contact lenses to atropine use but most of them were rendered rather ineffective and some with only temporary results, except for atropine of course, which has given impressive results but is related with many side-effects for long term use and thus can not be recommended.

In 2008 there was a very interesting hypothesis that was put forward by Prepas (Prepas, 2008) which did not attract a lot of attention. Prepas suggested that “close focusing in the absence of UV light may provoke axial myopia”. During the last decade there have been studies that have also exhibited that greater exposure to natural light and involvement in outdoors activities slows down significantly myopia progression (Rose et al., 2008; Plainis et al., 2009; Mutti , 2010). With regard to contact lenses, orthokeratology has shown some promising results lately (Queiros et al., 2010; Walline et al., 2009; Kakita et al., 2011) as well as fitting youngsters with soft bifocal, center distance design, contact lenses(Aller and Wildsoet, 2008). Lately, following the theory of peripheral defocus and myopia, introduced mainly by Earl Smith III (Smith et al., 2005; 2009;), there have been specially designed ophthalmic lenses and contact lenses that correct peripheral hyperopic defocus and are being tested with mixed results so far (Sankaridurg et al., 2010; Holden et al., 2010; 2011; Anstice and Phillips, 2011).

Myopia increases have been associated in the past mainly with accommodation (Hepsen et al., 2001). Myopia progression and especially axial elongation also seems to be interconnected to a mechanism we call **emmetropization** in which refractive development and eye growth are mainly driven by optical defocus (Schaeffel et al., 1988; Schaeffel and Howland, 1991)

At this point and in the light of all the above, I would like to present the main points of a theory that supports that indeed ***UV radiation*** may play a very vital and important role in myopia progression.

1. Emmetropization is a natural "defensive-protective" mechanism that fights defocus with eye growing from a very young age and remains always active

2. Modern way of living puts far more stress on our accommodation from a very young age continuing for many years in our lives. Stress in accommodation might give fluctuating vision and defocus. The eye responds rather quickly by growing.....it’s the only defensive mechanism it has....

3. UV light interfering with vitamin D formation (Lin et al., 2012) and dopamine plays a vital role in the hardening of the sclera. Thus, quite soon, the eyeball is, normally, hard enough so that it can not respond to any "pseudo-emmetropization" effect. However, if such a hardening does not exist the eye is more capable of growing, thus showing increased axial myopia Ashby and Schaeffel (2010) have also supported that the retardation of myopia development by light is partially mediated by dopamine, as the injection of a dopamine antagonist abolished, in their study, the protective effect of light, at least in the case of deprivation myopia.

4. Through the last five decades in many ways we have filtered UV light in order to protect our eyes from the - actually - aging effects of the UV radiation. We have plastic ophthalmic lenses that filter more UV light , car windscreens that block UV, window panes, we use sunglasses a lot more, we produce UV filtering contact lenses and we live indoors maybe a little more, thus being exposed to UV probably much less. Also, our nutrition has changed and there are possibilities that even this may contribute to eyes more prone to axial elongation and myopia (Knapp, 1936; 1943; Edwards, 1996; Lim et al., 2010; Frassetto et al., 2009).

5. All the above may be valid most prominently for the Caucasian genre, as the Asians particularly in the Far East seem to have extra morphological contributing factors to myopia increase.

6. Through the years it is possible that an inherited predisposition to myopia and axial elongation may be created

7. Orthokeratology (OK) may seem effective in reducing the development of myopia but this may be due to the fact that OK patients do not wear a refractive device before their eyes during the day and maybe they are more exposed to light in general and also UV.

8. Atropine is very effective in the retardation of myopia, first because it neutralizes accommodation and secondly because of the mydriasis it causes and the bigger exposure to light (and UV radiation as well...).

A very recent study by Sherwin et al. (2012) found a very clear protective association between Ultraviolet Autofluorescence (UVAF), a rather dependable biomarker of outdoor light exposure, and myopia (the higher the UVAF, the less myopic the people, even in a multivariable model that adjusted for age, sex, smoking, cataract, height and weight.)

The question that finally emerges is whether, during the last decades, we have managed to protect our eyes from a number of negative effects of UV radiation (pterygia, early cataracts, macular degeneration, pinguecula, etc...), but, on the other hand, we have created many more myopic people, who may suffer cataracts, vitreous or retinal detachment, due to myopia . And can we really support that UV light is far more dangerous today, universally, than it has been 40-50 years ago, due to a certain reduction of the protective ozon layer of our planet ? The answer to this question may change drastically the way we use protective eyewear especially in younger ages and our attitude towards natural light. Furthermore, it may provide stimuli for inventing different ways of providing the eye with the benefits of natural light without being exposed much to it (e.g. cross-linking the sclera with UV, producing vitamin D releasing contact lenses or lenses soaked in solution with Vitamin D, etc.).

**References**

Fredrick, DR (2002): Myopia, BMJ 2002;324: 1195-9

Garcia CA, Orefice F, Nobre GF, Souza DB, Rocha ML, and Vianna RL (2005): Prevalence of refractive errors in students in Northeastern Brazil (In Portugese). Arq.Bras.Oftalmol., 68 (3); 321

Mallen EA, Gammoh Y, Al Bdour M, Sayegh FN (2005): Refractive error and ocular biometry in Jordanian adults. Ophthalm.Physiol.Opt 25(4): 302-309

Wu HM, Seet B, Yap EPH, Saw SM, Lim TH, and Chia KS (2001): Does education explain ethnic differences in myopia prevalence? A population study of young adult males in Singapore

Mavracanas TA, Mandalos A, Peios D, Golias V, Megalou K, Gregoriadou A, Delidou K and Katsougiannopoulos B (2000): Prevalence of myopia in a sample of Greek students. Acta Ophthalmol. (Suppl) 185: 19-23

Vitale S, Ellwein L, Cotch MF, Ferris FL, Sperduto R (2008): Prevalence of refractive error in the United States, 1999-2004. Arch Ophthalmol. 126(8): 1111-1119

Morgan I and Rose K (2005): How genetic is school myopia? Progrees in Retinal and Eye Research, 24(1): 1-38

Lim R, Mitchell P, Cumming RG (1999): Refractive associations with cataract: the Blue Mountais Eye Study. Invest Ophthalmol Vis Sci, 1999:40:3021-6

Wong TY, Klein BE, Klein R, Knudtson M, Lee KE (2001): Refractive errors and incident cataracts: the Beaver Dam Eye Study. Invest Ophthalmol Vis Sci, 2001;42:1449-54

Wong TY, Klein BE, Klein R, Knudtson M, Lee KE (2003): Refractive errors, intraocular pressure and glaucoma in a white population. Ophthalmology, 110: 211-7

Saw SM, Gazzard G, Shih-Yen EC, Chua WH (2005): Myopia ans associated pathological complications. Ophthalmic Physiol Opt 2005;25: 381-391,

Prepas SB (2008): Light, literacy and the absence of Ultraviolet radiation in the development of myopia. Medical Hypotheses, 70(3): 635-637

Plainis S, Moschandreas J, Nicolitsa P, Plevridi E, Giannakopoulou T, Vitanova V, Tzatzala P, Pallikaris IG and Tssilimbaris MK (2009): Myopia and visual acuity impairment: a comparative study of Greek and Bulgarian school children. Ophthalmic Physiol Opt, 29(3): 312-320

Rose K, Morgan IG, Ip J, Kifley A, Huynh S, Smith W, and Mitchell P (2008): Outdoor activity reduces the prevalence of myopia in children. Ophthalmology, 115(8): 1279-1285

Mutti D (2010): Hereditary and environmental contributions to emmetropization and myopia. Optometry and Vision Science, 87(4): 255-259

## Queiros A, Gonzalez-Meijomes MJ, Jorge J, Villa-Collar C and Gutierrez A (2010): Peripheral Refraction in Myopic Patients After Orthokeratology, Optometry and Vision Science, 87(5), pp. 323-329

Walline JJ, Jones LA, Sinnott LT(2009) : Corneal reshaping and myopia progression. Br J Ophthalmol ;93:1181-1185.

Kakita T, Hiraoka T and Oshika T. (2011): Influence of overnight orthokeratology on axial elongation in childhood myopia. Invest.Ophthalmol.Vis.Science, 52 (5), pp 2170-2174

Aller TA and Wildsoet C (2008):Bifocal soft contact lenses as a possible myopia control treatment: a case report involving identical twins. Clinical Experimental Optometry, 91(4), 391-399

Earl L Smith III, Chea su Kee, Rakumar Ramamirtham, Ying Qiao Grider and Li Fang-Hung (2005): [Peripheralvision can influence eye growth and refractive development in infant monkeys](http://www.iovs.org/content/46/11/3965.short). Invest.Ophthalmol.Vis.Sci.,46 (11), 3965-3972.

Earl L Smith III, Li Fang-Hung and Juan Huang (2009): Relative peripheral hyperopic defocus alters central refractive development in infant monkeys. Vision Research 49 (19), 2386-2392.

Sankaridurg P, Donovan L, Varnas S, Ho A, Chen X, Martinez A, Fisher S, Lin Z, Smith Earl L. III, Ge J, Holden, B (2010): Spectacle Lenses Designed to Reduce Progression of Myopia: 12-Month Results. Optometry and Vision Science, 87(9), 631-641.

Holden BA, Sankaridurg P, Lazon de la Jara P, E.L. Smith III, Chen X, Kwan J, Martinez A, Ho A, Ge J (2010): Reduction in the Rate of Progress of Myopia With a Contact Lens Designed to Reduce Relative Peripheral Hyperopia, ARVO 2010 Presentation Abstract (3 May, 2010)

Holden BA, Sankaridurg P, Lazon P, Ho A, Earl L. Smith, III, Xiang Chen, Lin J, Naduvilath T, Ge J (2011): Central And Peripheral Visual Performance Of A Novel Contact Lens Designed To Control Progression Of Myopia – ARVO 2011 Presentation Abstract (5 May, 2011)

# Anstice N and Phillips JR (2011): Effect of Dual-Focus Soft Contact Lens Wear on Axial Myopia Progression in Children. Ophthalmology 118(6), pp 1152-1161

Hepsen IF, Evereklioglou C, and Bayramlar H. (2001): The effect of reading and near-work on the development of myopia in emmetropic boys: a prospective, controlled, three-year follow-up study. Vision Res., 41(19), 2511-2520.

Schaeffel F, Glasser A and Howland HC (1988): Accommodation, refractive error and eye growth in chickens. Vision Research, 28(5), pp 639-657

Schaeffel F and Howland HC (1991): Properties of the feedback loops controlling eye growth and refractive state in the chicken. Vision Research 31(4), pp 717-734

Lin Y, Ubels LJ, Schotanus MP, Yin Z, Pintea V, Hammock BD and

Watsky MA (2012): Enhancement of Vitamin D Metabolites in the Eye

Following Vitamin D3 Supplementation and UV-B Irradiation. Curr.Eye

Res., Vol 37 (10),pp 871-878

Ashby SR and Schaeffel F (2010): The effect of bright light on lens compensation in chicks. Invest.Ophthalmol.Vis. Sci., 51 (10), pp 5247-5253

Knapp AA (1946): The Eye as a Guide to Latent Nutritional Deficiency Diseases. Bull NY Acad.Medicine 22(4), pp 217-222

Knapp AA (1939): VitaminD-complex in progressive myopia; etiology, pathology and treatment. Am J Ophthalmol, 22, 1329

Edwards MH. Do variations in normal nutrition play a role in the development of myopia?: Optom Vis Sci. 1996 Oct;73(10), pp 638-643.

Lim LS, Gazzard G, Low YL, Choo R, Tan DT, Tong L, Yin Wong T and Saw SM (2010): Dietary factors, myopia, and axial dimensions in children. Ophthalmology, May 2010; 117(5): 993-997

Frassetto LA, Schloetter M, Mietus-Synder M, Morris Jr., RC  and Sebastian A,(2009): Metabolic and physiologic improvements from consuming a paleolithic, hunter-gatherer type diet. European Journal of Clinical Nutrition, 63, pp 947-955

Sherwin JC, Hewitt AW, Coroneo MT, Kearns LS, Griffiths LR and Mackey DA (2012): The Association between Time Spent Outdoors and Myopia Using a Novel Biomarker of Outdoor Light Exposure. Invest.Ophthalmol.Visi.Sci., Vol.53 (8), pp 4363-4370