Current Eye & Vision Science Literature

David A. Goss, OD, PhD, FAAO, FCOVD-A

Indiana University School of Optometry

Cordain L, Eaton SB, Miller JB, Lindeberg S, Jensen C. An evolutionary analysis of the aetiology and pathogenesis of juvenile-onset myopia. Acta Ophthalmologica Scandinavica 2002;80:125-135.

This paper is a nicely organized review of selected literature in which the authors suggest that chronic hyperinsulinemia from a diet with high glycemic load may play a role in etiology of juvenile onset myopia. The authors first postulate that myopia was rare among our hunter-gatherer ancestors. They then mentioned that recent introduction of environmental factors may have triggered genetic mechanisms productive of myopia. Along with the introduction of reading, the human diet has shown great increases in carbohydrate intake. The authors cite literature which suggests that "*When novel environmental conditions associated with modern civilizations are introduced into the hunter-gatherer lifestyle, these people rapidly develop (within a single generation) incidence rates for myopia that equal or exceed those in western societies.*" (p.127)

Next the authors discussed studies which found higher prevalences of myopia in urban literate populations than in rural literate populations. Some studies showed higher prevalences of myopia in urban illiterate populations than in rural illiterate populations, with the latter showing a very low prevalence. The authors interpreted these studies as showing that environmental factors in addition to excessive near work play a role in myopia etiology.

The article notes that high levels of protein, moderate levels of fat, and low amounts of carbohydrate are typical of hunter-gatherer diets. The authors also observed that "*Studies of recently acculturated hunter-gatherer populations that have adopted western dietary patterns frequently show high levels of hyperglycemia, insulin resistance, and hyperinsulinemia*" (p. 128). Many rural populations, in both industrialized and non-industrialized countries, have diets consisting of foods with lower glycemic load and less processed foods than urban populations. Foods with high glycemic load can lead to acute and chronic hyperinsulinemia.

Elevations of insulin level lead to increased levels of insulin like growth factor (IGF-1) in circulation and decreased synthesis of both insulin like growth factor binding protein (IGFBP-1) and insulin like growth factor binding protein 3 (IGFBP-3). It is hypothesized that elevated levels of IGF-1 enhance scleral growth. Further it is suggested that decreased levels of IGFBP-3 could reduce the ability of naturally occurring retinoids to activate genes that would reduce proliferation of scleral cells. When these events occur in conjunction with the chemical messengers elicited by reading and leading to scleral growth, the result is the development of myopia.

The authors then reviewed various studies which they offer as corroborating their theory. First, they noted that the increased carbohydrate intake in the human diet shows a correlation with trends over the years of increases in stature and decreases in pubertal age. Second, they discussed studies which have found myopes as a group to be taller than non-myopes. Third, they mentioned a study which found a higher incidence of myopia in adult diabetics than in non-diabetics. Fourth, they discussed studies which found more dental caries in myopes than in non-myopes. The

Correspondence regarding this literature review can be emailed to dgoss@indiana.edu or sent to Dr. David Goss, School of Optometry, Indiana University, Bloomington, IN 47405.

Goss DA. Current eye & vision science literature. Optom Vis Dev 2008;39(4):208-210.

authors concluded by stating that "*these studies suggest that high glycemic load carbohydrate diets may induce permanent changes in the development and progression of refractive errors, particularly during periods of growth.*" (p.132)

Adler PM, Cregg M, Viollier A-J, Woodhouse JM. Influence of target type and RAF rule on the measurement of near point of convergence. Ophthalmic and Physiological Optics 2007;27: 22-30.

The near point of convergence (NPC) is an important diagnostic tool in the evaluation of convergence function. As with any test, its results are dependent upon the target types and procedures with which it is performed. This study compared NPC results with six different targets: (1) pencil tip in free space, (2) fingertip in free space, (3) penlight in free space, (4) N5 letter in free space, (5) N5 letter on RAF rule, and (6) vertical line target on RAF rule. The RAF rule is an instrument commonly used in the United Kingdom. It consists of a 50 cm long rod with a two-pronged cheek rest and with a four sided drum that slides up and down the rod. The sides of the drum contain different visual targets.

The fifty-one subjects in the study ranged from 6 to 30 years. Inclusion criteria were 6/6 unaided visual acuity or better in each eye at distance, N5 visual acuity or better at near, stereoacuity of at least 70 seconds on the Randot test, anisometropia no more than 1.00 D in any meridian, refractive spherical component between -0.25 and +1.00 D, no more than -0.50 D of astigmatism, asymptomatic, normal amplitude of accommodation, dissociated phorias between 6Δ exo and 2Δ eso, no associated phoria, no strabismus, and "*no oculomotor defects such as incomitant eye movements*."

Subjects were divided into three age groups: ages 6-9 years (n=20), ages 11-13 years (n=17), and ages 20-30 years (n=14). There was no significant effect of age group on NPC break and recovery points by analysis of variance ($p>0.05$). There was no significant interaction of age group and target type ($p>0.05$).

The mean NPC breaks and recoveries (with standard deviations in parentheses) for the entire subject group were:

- pencil tip in free space, 5.2 (4.1), 9.3 (5.0)
- fingertip in free space, 5.2 (4.3), 9.6 (5.1)
- penlight in free space, 6.3 (4.8), 10.8 (5.4)
- N5 letter in free space, 5.8 (5.1), 10.3 6.1)
- N5 letter on RAF rule, 9.0 (7.3), 11.3 (7.8)
- vertical line on RAF rule, 9.1 (6.0), 11.4 (8.0).

NPCs with targets on the RAF rule were significantly farther out than NPCs with targets in free space ($p<0.001$). The penlight yielded a more remote NPC than the pencil tip ($p<0.01$) or the fingertip ($p<0.05$). The mean difference between the NPC break and the NPC recovery was less for targets on the RAF rule than for targets in free space.

The authors speculated that the NPC measurements with the RAF rule were farther out because the rule may represent a physical distraction, with attention drawn to the rule itself and away from the target. They thus suggested that the rule and the target on it gave conflicting cues to convergence. They suggested that "*It seems more logical to measure the NPC using an object in free space that correlates with the real world scenario.*" (p. 28)

The authors noted a previous study showing closer NPC findings using targets with stronger accommodative stimuli.[1] That would explain the more remote NPC with the penlight than with the other free space targets. They suggested that the closest measurements may have been obtained with the pencil tip and the fingertip because they are three-dimensional and thus perhaps more effective in stimulating convergence. The authors also noted that when using NPC measurements as an outcome measure for the effectiveness of therapy, it is important to use the same target as was used for the pre-therapy measurements.

Kapoula Z, Bucci MP, Jurion F, Ayoun J, Afkhami F, Brémond-Gignac D. Evidence for frequent divergence impairment in French dyslexic children: deficit of convergence relaxation of divergence per se? Graefe's Archive for Clinical and Experimental Ophthalmology 2007;245:931-936.

This study was conducted to test for differences in vergence performance in children with dyslexia. Vergence measures were compared in 56 children with dyslexia and 47 children in an age-matched control group.

The children in the dyslexia group had poor performance on a standard reading test used in France and a normal IQ. The mean age of the children in the dyslexia group was 11.3 years (SD=2). Their mean IQ was 105 (SD=7), and their mean reading age was

8.9 years (SD=1). The children in the control group exhibited normal school performance. The control group had a mean age of 10.7 years (SD=2).

Tests performed on the children in both groups were stereoacuity by the TNO random dot test, dissociated phorias at 4 m and 30 cm with cover test and with Maddox rod, fusional vergence ranges at 4 m and at 30 cm with prism bar, and NPC with a penlight. Presumably the prism bar vergence range data reported in the paper were break data, but this was not stated.

Stereoacuity and phorias were not significantly different in the two groups. The median 4 m phoria was ortho for both groups. The median 30 cm phoria was 1.5Δ exo in the dyslexia group and 2Δ exo in the control group.

The NPC was significantly more remote in the dyslexia group than in the control group ($p<0.00001$). The NPC was closer than 6 cm in 44% of the dyslexia group and 72% of the control group.

Base-out vergence ranges were not significantly different in the two groups. Median values at 4 m were 14Δ for the dyslexia group and 16Δ for the control group. Median base-out values at 30 cm were 20Δ for both groups.

Base-in vergence ranges were significantly less in the dyslexia group than in the control group at both 4 m and 30 cm ($p<0.005$). Median values at 4 m were 4Δ in the dyslexia group and 6Δ in the control group. Median values for 30 cm were 10Δ in the dyslexia group and 12Δ in the control group.

The authors suggested that because base-in vergence ranges were lower in the dyslexia group at both far and near testing distances, the reduced divergence was a divergence deficit per se rather than a deficit of relaxation of convergence. They also noted an "*empirical observation during testing of these 57 dyslexic children that the fragility of vergence control is also associated with symptoms of visual fatigue and loss of attention and interest.*" (p. 935) The authors observed that poor control of vergence position during saccades in reading could contribute to poor reading performance. They suggested that optometric vision therapy for children with dyslexia should include both convergence and divergence training.

Reference

1. Ciuffreda KJ. Near point of convergence as a function of target accommodative demand. Opt J Rev Optom 1974;111(3):9-10.