WHAT'S DRIVING THE MYOPIA EPIDEMIC?

An update on the myopia epidemic and the efforts to combat it.

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The increase in the prevalence of myopia has become a major public health concern and a top priority in recent years. It is estimated that the myopia epidemic will affect half of the global population by the year 2050.[1] Today, myopia is the second most common cause of global blindness, and the negative effects that myopia can have on the ocular system are comparable to those of hypertension on the cardiovascular system.[2]

Until recently, myopia had been viewed as an eye-focusing disorder, easily corrected with single-vision spectacles. Many now agree, however, that myopia is not simply a refractive disorder, but that it is also a disease with the potential to cause permanent vision loss.

Myopia is associated with an increased risk of retinal complications, cataracts, and glaucoma.[3-8] Depending on its magnitude, myopia can increase the risk of retinal detachment by 2.4 to 24.0 times and increase the risk of primary open-angle glaucoma by 2.0 to 2.5 times.[9,10] Even low amounts of myopia are associated with increased risk of developing posterior subscapular cataract.[6]

The myopia epidemic has also created a large economic burden. Vitale et al estimated the direct cost of refractive error in the United States to be between $3.9 and $7.2 billion per year.[11] Globally, the economic burden is estimated to be $202 billion per year.[12] The cost of myopia care is expected to increase significantly due to the increasing prevalence of myopia, particularly pathologic myopia. Pathologic myopia can lead to increased direct care costs from surgery and doctor visits as well as indirect costs from decreased productivity as a result of vision loss.

THE CAUSE

Although the implications of the myopia epidemic are clear, the exact mechanism behind the epidemic is not. Development of myopia has been linked to genetics. An individual has a 2.08 times greater chance of becoming myopic if he or she had one myopic parent and a 5.07 times greater chance with two myopic parents.[13] The Consortium for Refractive Error and Myopia (CREAM) study, the largest genome-wide association study of refractive error, identified genes linked with axial elongation and myopia.[14] Genetics, however, cannot be the sole explanation for the myopia epidemic, as genetic changes occur much more slowly over time than the epidemic we are observing in our lifetimes.

Data suggest that the cause of myopia is multifactorial, the result of a combination of genetic and environmental factors. The development of myopia is thought to be associated with spending less time outdoors, and not necessarily with performing near work.[13,15] The relationship between time outdoors and myopia may be influenced by light exposure. Studies suggest that outdoor lighting can stimulate retinal dopamine release, which acts as an inhibitor to axial elongation.[15,16]

COMBATTING THE EPIDEMIC

Researchers have investigated ways to reduce the risk of developing myopia, including increasing time spent outdoors and administering low-dose atropine.

A meta-analysis by Xiong et al concluded that time outdoors reduces the onset of myopia but that, in children who are already myopic, time outdoors has no influence on slowing myopia progression.[17] Fang et al observed a reduction in the onset of myopia in premyopic children who were given 0.025% atropine.[18] The Atropine in the Treatment of Myopia (ATOM) Study group is conducting an interventional clinical study to determine the role of 0.01% atropine in preventing the onset and progression of myopia in premyopic and low myopic individuals.

Although the efficacy of atropine to prevent the onset of myopia is still unknown, atropine has been shown in many studies to slow the progression of myopia. Most notably, the ATOM2 study found that 0.01% atropine had the best therapeutic effect on myopia with the least rebound effect.[19] Initial

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data from the Low-Concentration Atropine for Myopia Progression (LAMP) Study, however, suggest that 0.05% atropine may be the most effective concentration for myopia control.[20]

If a child is already myopic, optical and pharmaceutical intervention can help slow the progression of myopia. Treatments that have been shown to clinically reduce myopia progression include orthokeratology, soft center-distance multifocal contact lenses, and low-dose atropine.[19,21-27] Orthokeratology and soft multifocal contact lenses are thought to slow myopia progression by optically decreasing peripheral hyperopic defocus or increasing peripheral myopic blur.[28] A 2015 review by Walline found that soft multifocal contact lenses and orthokeratology slowed myopia progression by 46% and 43%, respectively.[29]

THE FUTURE OF TREATMENT

The increase in the prevalence of myopia has led to the development of many new and innovative treatments aimed at combatting this epidemic.

Of note, the MiSight 1 day soft contact lens (CooperVision) received FDA approval for myopia control. The lenses are expected to be on the market in the United States in 2020. The dual-focus lens has been shown clinically to slow the progression of myopia when initially prescribed for children 8 to 12 years old.[30]

Several other optical innovations are in use for this purpose in other countries, although none of the following is approved in the United States. These innovations include the MyoSmart with Defocus Incorporated Multiple Segments spectacle lens (DIMS; Hoya), Myopilux lenses (Essilor), and MyoKids Pro lenses (Carl Zeiss Meditec).

Ongoing studies investigating methods to slow the progression of myopia include the Control of Myopia Using Novel Spectacle Lens Designs (CYPRESS) trial of a novel spectacle lens design being conducted by SightGlass Vision, the Safety and Efficacy of SYD-101 in Children With Myopia (STAAR) study of an investigational drug being conducted by Sydnexis, and the CHAPERONE study of a microformulation of atropine (MicroPine) being conducted by Eyenovia.

The increase in myopia prevalence has created new standards of care. Young premyopic children should be advised to spend increased time outdoors. This may have benefits beyond myopia, as it can help boost kids' physical activity and mood. Children with myopia should be prescribed either low-dose atropine, a multifocal contact lens, or orthokeratology. Spectacle corrections to slow the progression of myopia, as previously mentioned, can also be prescribed for patients in countries in which they are available. ■

1. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology*. 2016;123(5):1036-1042.
2. Bourne RR, Stevens GA, White RA, et al. Causes of vision loss worldwide, 1990-2010: a systematic analysis. *Lancet Glob Health*. 2013;1(6):e339-349.
3. Vongphanit J, Mitchell P, Wang JJ. Prevalence and progression of myopic retinopathy in an older population. *Ophthalmology*. 2002;109(4):704-711.
4. Lim R, Mitchell P, Cumming RG. Refractive associations with cataract: the Blue Mountains Eye Study. *Invest Ophthalmol Vis Sci*. 1999;40(12):3021-3026.
5. Younan C, Mitchell P, Cumming RG, Rochtchina E, Wang JJ. Myopia and incident cataract and cataract surgery: the Blue Mountains Eye Study. *Invest Ophthalmol Vis Sci*. 2002;43(12):3625-3632.
6. Chang MA, Congdon NG, Bykhovskaya I, Munoz B, West SK. The association between myopia and various subtypes of lens opacity: SEE (Salisbury Eye Evaluation) project. *Ophthalmology*. 2005;112(8):1395-1401.
7. Group TEDC-CS. Risk factors for idiopathic rhegmatogenous retinal detachment. The Eye Disease Case-Control Study Group. *Am J Epidemiol*. 1993;137(7):749-757.
8. Qiu M, Wang SY, Singh K, Lin SC. Association between myopia and glaucoma in the United States population. *Invest Ophthalmol Vis Sci*. 2013;54(1):830-835.
9. Ogawa A, Tanaka M. The relationship between refractive errors and retinal detachment—analysis of 1,166 retinal detachment cases. *Jpn J Ophthalmol*. 1988;32(3):310-315.
10. Marcus MW, de Vries MM, Junoy Montolio FG, Jansonius NM. Myopia as a risk factor for open-angle glaucoma: a systematic review and metaanalysis. *Ophthalmology*. 2011;118(10):1989-1994.e1982.
11. Vitale S, Ellwein L, Cotch MF, Ferris FL, 3rd, Sperduto R. Prevalence of refractive error in the United States, 1999-2004. *Arch Ophthalmol*. 2008;126(8):1111-1119.
12. Smith TS, Frick KD, Holden BA, Fricke TR, Naidoo KS. Potential lost productivity resulting from the global burden of uncorrected refractive error. *Bull World Health Organ*. 2009;87(6):431-437.
13. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K. Parental history of myopia, sports and outdoor activities, and future myopia. *Invest Ophthalmol Vis Sci*. 2007;48(8):3524-3532.
14. Fan Q, Guo X, Tideman JW, et al. Childhood gene-environment interactions and age-dependent effects of genetic variants associated with refractive error and myopia: The CREAM Consortium. *Sci Rep*. 2016;6:25853.
15. Rose KA, Morgan IG, Ip J, et al. Outdoor activity reduces the prevalence of myopia in children. *Ophthalmology*. 2008;115(8):1279-1285.
16. French AN, Ashby RS, Morgan IG, Rose KA. Time outdoors and the prevention of myopia. *Exp Eye Res*. 2013;114:58-68.
17. Xiong S, Sankaridurg P, Naduvilath T, et al. Time spent in outdoor activities in relation to myopia prevention and control: a meta-analysis and systematic review. *Acta Ophthalmol*. 2017;95(6):551-566.
18. Fang PC, Chung MY, Yu HJ, Wu PC. Prevention of myopia onset with 0.025% atropine in premyopic children. *J Ocul Pharmacol Ther*. 2010;26(4):341-345.
19. Chia A, Lu QS, Tan D. Five-year clinical trial on atropine for the treatment of myopia 2: myopia control with atropine 0.01% eyedrops. *Ophthalmology*. 2016;123(2):391-399.
20. Yam JC, Jiang Y, Tang SM, et al. Low-Concentration Atropine for Myopia Progression (LAMP) study: a randomized, double-blinded, placebo-controlled trial of 0.05%, 0.025%, and 0.01% atropine eye drops in myopia control. *Ophthalmology*. 2019;126(1):113-124.
21. Aller T, Wildsoet C. Optical control of myopia has come of age: or has it? *Optom Vis Sci*. 2013;90(5):e135-137.
22. Cho P, Cheung SW, Edwards M. The longitudinal orthokeratology research in children (LORIC) in Hong Kong: a pilot study on refractive changes and myopic control. *Curr Eye Res*. 2005;30(1):71-80.
23. Walline JJ, Jones LA, Sinnott LT. Corneal reshaping and myopia progression. *Br J Ophthalmol*. 2009;93(9):1181-1185.
24. Walline JJ, Greiner KL, McVey ME, Jones-Jordan LA. Multifocal contact lens myopia control. *Optom Vis Sci*. 2013;90(11):1207-1214.
25. Anstice NS, Phillips JR. Effect of dual-focus soft contact lens wear on axial myopia progression in children. *Ophthalmology*. 2011;118(6):1152-1161.
26. Chia A, Chua WH, Cheung YB, et al. Atropine for the treatment of childhood myopia: safety and efficacy of 0.5%, 0.1%, and 0.01% doses (Atropine for the Treatment of Myopia 2). *Ophthalmology*. 2012;119(2):347-354.
27. Chia A, Chua WH, Wen L, Fong A, Goon YY, Tan D. Atropine for the treatment of childhood myopia: changes after stopping atropine 0.01%, 0.1% and 0.5%. *Am J Ophthalmol*. 2014;157(2):451-457.
28. Smith EL, 3rd, Hung LF, Huang J. Relative peripheral hyperopic defocus alters central refractive development in infant monkeys. *Vision Res*. 2009;49(19):2386-2392.
29. Walline JJ. Myopia control: a review. *Eye Contact Lens*. 2016;42(1):3-8.
30. Breakthrough CooperVision MiSight 1 day contact lens for childhood myopia coming to the United States in 2020 [press release]. November 18, 2019. San Ramon, California: CooperVision.

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