Health Policy Institute
AMERICAN OPTOMETRIC ASSOCIATION

Doctors of Optometry in the Management of Myopia and Prevention of Related Eye Disease

Myopia (nearsightedness) is a type of refractive error of the eyes where close objects appear clear, but distant objects appear blurry.[i] Myopia commonly has its onset in childhood.[ii] According to the United States Centers for Disease Control and Prevention (CDC) myopia is the most common refractive error for those younger than 59 years old.[iii] In the United States, the prevalence of myopia has grown to more than 40 percent and has been predicted to be more than 50 percent by the year 2050.[iv] With these soaring rates of myopia comes an increase in vision threatening ocular diseases and increased risk of visual impairment which adversely impacts health care costs, human productivity and quality of life.[v]

A public health urgency exists to address children's vision health in the U.S., including a need to provide coordinated surveillance systems and access to comprehensive child vision and eye health care in every state.[vi] Clinically, while the myopia is not an infectious disease, there is precedent to monitor conditions and behaviors that are risk factors for injuries and other chronic conditions, and to respond with appropriate public health control measures.[vii]

Diagnosis and treatment of myopia is more than just "needing glasses." Myopia is a diagnosed health condition that is associated with comorbidities that increase the risk of severe and irreversible loss of vision including retinal detachment, subretinal neovascularization, myopic macular degeneration, dense cataract, and glaucoma. Importantly, undiagnosed myopia does not need to be present at high levels to result in adverse health outcomes. Any level of undiagnosed myopia can be considered a risk factor for other diseases and/or conditions which may be amenable to treatment.

All newborns are born with vision that is out-of-focus at a distance. If human development proceeds appropriately (providing that light is focusing properly on each retina), babies normally gain clear vision in the first few months of life. As a child grows, like the rest of the body, the eye is expected to appropriately increase in length and size. This is the process of emmetropization. Normal vision - meaning vision which is clear at full distance (20 feet/6 meters and beyond), absent of any refractive error (i.e. myopia, hyperopia, astigmatism) is clinically called emmetropia. Light entering the emmetropic eye focuses perfectly on the retina in all planes, and the child is able to focus and see targets clearly at a distance.

Because of modifiable and non-modifiable environmental factors and genetics, this normal process can be interrupted, becoming dysfunctional and resulting in an ametropic environment (when light enters the eye and does not focuses perfectly on the retina). In primary eye care, there are predominantly three clinically diagnosed forms of ametropia: myopia, hyperopia and astigmatism. If light comes to a focal point in front of the retina, the individual's eye is diagnosed with myopia. If light comes to a focal point behind the retina, the individual's eye is diagnosed with hyperopia. If light comes to two different focal points, the individual's eye is diagnosed with astigmatism. The larger the distance between the focal point of light and the retina, the larger the diagnosed magnitude of myopia or hyperopia.

Physiologically, myopia can occur in two ways: 1) because of the optical system having increased focusing power (i.e. from cornea or lens), or 2) the eye growing too long (axial length of the eye) during normal development, because of ocular disease, or a combination of any of those. Ametropia, detected through a comprehensive eye examination, is a diagnosed clinical sign of an abnormal and potentially unhealthy/diseased eye.

According to the United States Food and Drug Administration (FDA) report from the workshop: *Controlling the Progression of Myopia: Contact Lenses and Future Medical Devices*, the sudden increase in myopia prevalence suggests an environmental (including cultural) influence.[viii] Of note has been the recent trend toward more near vision tasks associated with the significant increase in use of smartphones and tablets, especially in the pediatric population. At a time where the natural physiologic emmetropization process of the eye is occurring, children on average are spending up to six hours per day[ix] on handheld screens. This unnatural and continuous near point stimulus is a highly suspected factor in rising rates of progressive myopia and rising rates of Type 2 diabetes in children.

Increasing screen time is usually accompanied with a lack of outdoor time and more sedentary lifestyle. Guidelines on Physical Activity, Sedentary Behavior and Sleep, recently released by the World Health Organization, call for no more than one-hour screen time for children age 2 through age 4, and no screen time for children less than one year of age.[x]

A lack of outdoor time has been shown to be a myopia-genic factor. As such, there is a known protective effect of increased outdoor time for onset of myopia.[xi] The more time children are inside reading, studying and using their electronic device(s), the less natural light the eye is receiving to develop properly. Importantly, a neurotransmitter called dopamine is stimulated by the sun. Animal models show that dopamine controls the elongation of the eyes and keeps the eye from growing as much. If a child does not have enough dopamine due to sitting inside, then the eye can get longer and longer, and the longer the eye, the more severe the myopia. To help protect their eyesight, children probably should partake in anywhere from one to three more hours of outdoor activity a day.[xii] Increasing time outdoors may be associated with a reduced risk of myopia and myopic progression.[xiii]

Ethnicity is an important factor in myopia prevalence and progression. Children of East Asian ethnicity have a faster myopic progression rate and demonstrate more robust outcomes with interventions aimed at slowing the progression of the condition. While ethnicity is a risk factor, so too is being a biological sibling of an individual with myopia. Genetic effects appear to have the major role in determining the similarity of refractive error between siblings.[xiv]

Fortunately, when myopia is diagnosed through eye examination by an eye doctor, several clinical treatment and management methods have been identified and may be prescribed by the doctor of optometry to control the progression of myopia in individuals in children and adolescents.[xv]

Progressive Myopia Treatment Modalities

Treatment strategies to reduce the rate of myopic progression would be beneficial in avoiding some of myopia's effects on public health.[xvi] A positive note for the treatment of progressive myopia in children is the safety profile of the use of hard (rigid gas permeable) or soft contact lenses. The incidence of corneal infiltrative events in children is no higher than in adults, and in the youngest age range of 8 to 11 years, it may be markedly lower. By this standard, contact lenses are relatively safe to use in children.[xvii]

Orthokeratology (Ortho-K) Style Contact Lenses

These special contact lenses are designed to reshape/mold the cornea overnight to temporarily reduce the corneal power and myopia once they are removed. Ortho-K lenses (think orthodontic retainers for the eye/cornea) are primarily worn during sleep (peripheral defocus modifying design). This in turn enables the wearer to be free of spectacles or contact lenses throughout the day. For those involved with activities where spectacles or contact lenses are contraindicated (such as swimming or contact sports), the corneal molding method is quite beneficial. [xviii]

Soft multi-focal contact lenses worn during waking hours (peripheral defocus modifying design)

These contact lenses have been shown to be quite effective in controlling myopia since the early 1970s. Both concentric ring bifocals and peripheral add multifocals have shown significant efficacy and are proven clinically effective in controlling myopic progression relative to control groups. Today, there are daily disposable soft contact lenses that are available for myopia management (off-label use in the United States, on-label in Europe).

Atropine eye drops are used to dilate (open) the pupils and fully relax the focusing power (accommodation) of the eye (i.e. cycloplegia) and has been used for myopia control for some years. Studies have shown its effectiveness in a concentration-dependent response. While varying strengths (0.05%, 0.025%, and 0.01%) atropine eye drops reduced myopia progression, 0.05% atropine was most effective in controlling myopia progression and eye elongation.[xix] Particular attention must be paid to higher concentrations of atropine due to it being a nonselective muscarinic antagonist. Patients/parents must be made aware of the off-label use of these drugs, as well as all possible side effects.

Spectacles, whether in distance, near, bifocal or progressive design, have not been shown to be clinically effective in the management of progressive myopia.[xx]

In summary, all health care professionals, teachers, school nurses, legislators, public health officials and especially parents need to be keenly aware of the environmental and genetic challenges our youth faces today, including the near epidemic rise of myopia and myopia related ocular disease.

Regular in-person comprehensive dilated and cycloplegic eye examinations by an eye doctor are necessary for all children between the age of 6 months to 12 months and between age 3 and age 5. The specific timeline of eye examination for children and adolescents has been detailed in the American Optometric Association *Evidence Based Clinical Practice Guideline on the Comprehensive Pediatric Eye and Vision Examination*.[xxi]

From a public health perspective, the economic burden of undiagnosed myopia and related vision loss is massive. Intervention at an earlier age can likely prevent the worsening of myopia and myopia related vision loss. Doctors of optometry are extensively trained both didactically and clinically in pediatric (infant, toddler and children's) eye care to be uniquely qualified to manage myopia and related eye and vision health concerns.[xxii] As such, interprofessional referrals from pediatricians, nurses, behavioral/mental health and other health care providers (who assist the identification of vision problems) to doctors of optometry, should be common.

With large gaps in vision and eye health data recorded among individuals age 18 and younger, surveillance systems should be put in place to monitor and record refractive and eye health status of all children and adolescents. Doctors of optometry are accessible in counties where 99 percent of the U.S. population resides.[xxiii] Fortunately, intervention and prevention methods are painless and very accessible to the public. As myopia becomes more prevalent, management and treatment need to become much more common.

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