Special Issue

IMI 2021 Reports and Digest – Reflections on the Implications for Clinical Practice

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The International Myopia Institute's (IMI) mission is to advance research, education, and management of myopia to decrease future vision impairment and blindness associated with increasing myopia. Its approach is to bring together scientists, clinicians, policymakers, government members, and educators into the field of myopia to stimulate collaboration and sharing of knowledge. The latest reports are on pathologic myopia, the impact of myopia, risk factors for myopia, accommodation and binocular vision in myopia development and progression, and the prevention of myopia and its progression. Together with the digest updating the 2019 International Myopia Institute white papers using the research published in the last 18 months, these evidence-based consensus white papers help to clarify the imperative for myopia control and the role of environmental modification initiatives, informing an evidence-based clinical approach. This guidance includes who to treat and when to start or stop treatment, and the advantages and limitations of different management approaches.

Keywords: myopia, refractive error, pathologic myopia, myopia control, accommodation

Public health is defined as "the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society."[1] Myopia has a major impact on eye health and hence quality of life and disability, particularly later in life, owing to its association with both direct and indirect damage to the chorioretina, optic nerve, and the crystalline lens.[2] The global burden of myopia is growing, with nearly 30% of the world population currently myopic and an expectation that this number may increase to nearly one-half of the world's population in 2050.[3] Over this time period, approximately 10% of the world's inhabitants will have high myopia, translating to nearly 1 billion people.[3] Uncorrected myopia is the most common cause of avoidable distance visual impairment, and myopic macular degeneration has already become the leading cause of uncorrectable vision loss in some parts of the world.[4]

Although pathologic myopia is associated with higher degrees of myopic refractive error (see the International Myopia Institute [IMI] Pathological Myopia Report),[5] its complications, especially posterior staphyloma, can also occur in eyes with lower degrees of myopia. There are no distinct cut-off values for refractive error or axial length when pathology occurs; rather, any increase in axial length in a myopic eye (with associated change in refractive error) increases the risk of pathology.[2] The assumption that interventions in childhood myopia progression will decrease the prevalence of pathologies later in life is unsubstantiated (but likely),[6] owing to the lack of data charting the long-term course between childhood myopia progression and the onset of pathologic changes such as myopic maculopathy. Myopia-associated pathologies also vary with patient characteristics such as sex, ethnicity, and the level of myopia,[7,8] confounding direct associations without longitudinal data. It has been hypothesized that the stimulus for the current myopia epidemic, particularly the increase in the prevalence and degree of common childhood myopia, is due to ongoing changes in our behavior and environment, rather than being driven genetically. Genetic and prevalence data suggest that extreme myopia has a different origin than the more commonly seen childhood myopia, which is most likely largely driven environmentally.[9–11] In this respect, studies already demonstrate a strong association between the level of refractive error and myopic maculopathy across a wide range of myopic refractive errors,[7,8] and recent 6- and 12-year prospective longitudinal studies from Japan reported

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significant increases in the prevalence of different levels of myopia and associated pathology.[12,13] Hence, the incidence of myopia-related ocular complications and permanent vision impairment is very likely to significantly increase alongside the growing prevalence of myopia globally.[3]

The IMI Impact of Myopia Report[14] summarizes recent research on the increasing prevalence of myopia, including the disproportionally greater increase in high myopia and the lifetime manifestations of myopia. In addition, it highlights the considerable direct health expenditures and indirect costs such as lost productivity and reduced quality of life associated with myopia.

Environmental Modification

The IMI Risk Factors for Myopia Report[15] identifies the difficulties in "untangling" the risk factors for the development and progression of myopia from current research; however, education and time spent outdoors were identified as the key factors. They conclude that there is a large body of consistent evidence of a causal association between the higher prevalence and degree of myopia with an increasing intensity and duration of education, but the mechanism involved is still unclear. The current evidence implicating digital devices is sparse and far from consistent. No interventions in decreasing nearwork have been validated in controlled trials. Strong evidence has been accumulated for time spent outdoors (principally lighting levels) decreasing the prevalence and progression of myopia,[16–19] possibly owing to dopamine release, decreasing the impact of other risk factors such as parental myopia[20] and higher levels of nearwork.[21] School-based intervention trials have shown that an increase in time outdoors of 40 to 80 minutes per day produces a significant decrease in the incidence of myopia.[22–24] Interestingly, one study suggested modest increases in class-room lighting strongly inhibited the development of myopia,[25] but replication of this finding is needed.

It should be noted that, unlike other epidemics, such as the increase in obesity and diabetes, myopic environmental risk factors are driven largely by a desire to improve the prospects of children and the quality of life of nations, by increasing the level of education. In addition, the success of less divisive public health programs to decrease obesity and diabetes has been limited[26,27]; hence, national public health programs focused on decreasing the impact of myopia by environmental modifications alone cannot be relied on to decrease significantly the impact of myopic epidemic, and eye care practitioners have a key role in improving the future eye health of their patients including providing holistic advice about increasing time spent outdoors.

An Evidence-Based Clinical Approach

Who to Treat and When to Start

The IMI have defined premyopia as "A refractive state of an eye of ≤ +0.75 D and > –0.50 D in children where a combination of baseline refraction, age, and other quantifiable risk factors provide a sufficient likelihood of the future development of myopia to merit preventative interventions."[28] A cycloplegic refraction should be performed to avoid misclassification,[29] unless the practitioner can be assured the eye is unaccommodated.[30,31] Premyopia can be predicted as early as 6 years of age by a refractive error of <+0.75 diopters [D] (<+0.50 D in a 7- to 8-year-old child; <+0.25 D in a 9- to 10-year-old child; and emmetropia in an 11-year-old child) with a high degree of confidence.[32] Although the number of myopic parents is a risk factor for myopic progression (odds ratio in 6- to 8-year-olds: 1.4× for 1 parent and approximately 2.3× for 2 parents), along with harder to measure ocular biometry factors such as the AC/A ratio (approximately 1.25×), axial length (2.0–2.5×) and peripheral refraction (1.4×), a study found refractive error alone best predicts the risk of future myopia.[32] A recent study in the UK also found axial length (>23.07 mm) at baseline (odds ratio, 2.5×) at the age of 6 years and at least one myopic parent (odds ratio 6.3×) as predictive of progression to myopia by age 16 years along with a refraction of <+0.63 D.[33] Although binocular vision status is important in children to optimize visual clarity and minimize eye strain, and therefore should be assessed and managed if necessary, evidence for any role in myopia development and progression is limited (see the IMI Accommodation and Binocular Vision in Myopic Development and Progression report).[34]

Management Approach

Advising on maximizing time spent outdoors is good for all children's general mental health[35] as well as decreasing the incidence and progression of myopia,[16–19] especially in winter when myopic progression is greater.[36] However, as identified elsewhere in this article, this factor will have a limited effect on decreasing the incidence of myopia or its progression in those who are already myopic owing to societal factors. For those who have premyopia, or who have low myopia (<–0.5 D), a refractive correction would not be suitable so advice should be given as to the need for regular eye examinations and to prepare the patient and their parents/carers. If there is ≥–0.50 D of myopia, in consultation with the child´s caregiver, consideration for a refractive and/or pharmaceutical correction should be considered (see the IMI Prevention of Myopia and Its Progression report)[37]

- Orthokeratology – effective from –0.50 to –4.00 D[38,39] and up to –3.50 D of astigmatism,[40] and can be used in conjunction with an optical correction worn during the day for higher myopia (>6.0 D).[41] However, it requires overnight contact lens wear with its associate risks of microbial keratitis.[42] A desire for children to be free of a refractive correction during the day is key in the success of orthokeratology.[43]
- Soft myopia control multifocal contact lenses – effective commercially available lenses are now on the market in a wide range of powers. Up to 6 years of clinical trials demonstrate good safety and efficacy.[44–48] Daily disposable modality has a risk of microbial keratitis of about 10× less than that of orthokeratology treatment.[49]
- Myopia control spectacle lenses – have become commercially available with variable efficacy reported with data for up to 2 years in clinical trials, but there has been limited research conducted to date.[50,51]
- Atropine – the most appropriate dose has yet to be determined, but based on current research is within the range 0.01% to 0.05%[52,53]; however, the use of a pharmaceutical depends on the availability and risks, which include untested long-terms effects.

- Combination therapy seems to be more effective than a single treatment approach, and so should be considered if myopic progression continues.[54,55]
- Sequential treatment modalities – the effectiveness of current treatments appears to decrease with time, providing approximately a cumulative maximum approximately 1.0 D decrease in refractive error or approximately +0.44 mm decrease in axial length.[6,56] However, treatment modalities seem to have differing mechanisms of action, so it is possible that using different modalities sequentially may have a greater cumulative effect, although this has yet to be researched.

It has been argued that, to monitor myopic progression, axial length is a more reliable measure than even cycloplegic refractive error and it is the principal risk factor for myopia-associated pathology.[6] However, instrumentation using partial coherence interferometry/optical coherence tomography or optical low coherence reflectometry (essentially the same technique, but using a laser or a superluminescent diode respectively) which have a suitable resolution of approximately 0.01 mm or <0.05 D,[57] are still relatively expensive and not yet commonplace in clinical practice.

When to Stop

There are few data on when myopia stops progressing. Progression has been noted in young adults[58] and approximately one-third of myopia adults only develop myopia after 15 years of age.[59] The mean age of refractive error stabilization for early childhood onset myopic seems to be around 16 years of age (perhaps about 1 year younger in females than males),[60,61] but there is considerable variability. Axial length seems to take much longer to stabilize, with 90% stabilizing by 21 years of age in one longitudinal study.[60,62] Hence, careful monitoring of patients after ceasing treatment is prudent. Fortunately, in controlled trials, a clinically significant rebound effect has only been observed after ceasing higher dose atropine treatment[63,64] and perhaps in young children with orthokeratology.[65]

Conclusions

There is more than sufficient evidence to warrant the adoption of myopia prevention and control measures in clinical practice. Although there remain gaps in academic knowledge about mechanism of action and long-term outcomes, the benefits outweigh the risks if they are appropriately managed.[66] More research on the effectiveness and safety of combination and sequential treatment modalities would further enhance patient management options. Eye care practitioners have a key role to play in preventing visual impairment in future generations and must become more proactive[67] in the identification and treatment of myopia.

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