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POINT-COUNTERPOINT

The case for treating all children with myopia control interventions

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INTRODUCTION

James S. Wolffsohn

With the growing rates of myopia across the world and the potentially devastating effect of myopia-associated pathology in later life, should we be treating all children with myopia control interventions? Conversely, interventions are not without side effects such as impact on visual function, increased risk of ocular infection and possible ocular surface effects from long-term applications. The focus of this Point–Counterpoint article is to weigh up whether the risks outweigh the benefits of treating all children with myopia control interventions until there is a way to predict accurately those that will benefit substantially from them.

Untreatable retinal pathology is life changing, impacting an individual's ability to work, their independence and their mental health. Therefore, this issue cannot be taken lightly. The focus on healthcare in most countries across the world is shifting towards prevention rather than a 'cure' as this is generally more economically viable for already stretched healthcare systems. As retinal pathology associated with myopia typically takes decades to become evident in an individual, the eye care community and regulatory agencies will need to take a stance on this question before there is definitive evidence as to the potential tsunami of myopia-associated visual impairment in their population. Here, Xiangui He and Nicola Logan debate whether the case for treating all children with myopia control interventions is warranted or not.

POINT

Xiangui He

Although the prevalence of myopia continues to rise globally, only a small proportion of individuals will progress to pathologic myopia resulting in vision impairment. Additionally, the lifetime cost of managing myopia progression is substantial. Therefore, there is a need to identify myopes at high risk of rapid progression using appropriate tools and to prioritise treatment for these individuals.

Visual impairment caused by myopia

Among all myopic children, only a small proportion will progress rapidly and go on to develop high myopia (defined as a spherical equivalent (SE) ≤ −6.00 D) in adulthood. Among participants who developed myopia before 12 years of age, around 24% would be at risk of becoming high myopes, while for those with myopia onset after 12 years of age, the risk of developing high myopia in adulthood was only about 1%.[1] In a retrospective study conducted in Denmark examining participants who developed myopia after 10 years of age, none had high myopia.[2] Interestingly, Polling et al.[3] observed that while all subjects with an SE ≤ −3.00 D (measured with cycloplegia) under 10 years of age developed high myopia in later life, those with a SE between −0.50 and −1.50 D (without cycloplegia) and older than 12 years of age had virtually no risk of developing high myopia. Similarly, Pärssinen

and Kauppinen[4] demonstrated that the baseline age and myopic progression during the first year post-onset in childhood were closely associated with high myopia in adulthood. The consequences indicate that, even with high prevalences of myopia and early-onset myopia, only a limited proportion of myopic children will experience fast progression and develop high myopia.

The risk of pathologic myopia is closely associated with the severity of the refractive error.[5] Most pathology occurs in eyes with high myopia. The increased prevalence of pathologic myopia with greater refractive error first conforms to a linear trend until −7.00 D, followed by an exponential increase.[6] The cumulative risk of uncorrectable visual impairment increases significantly with age when myopia <−6.00 D. For participants under 60 years of age, there was no significant difference in the risk of visual impairment between non-myopes and low myopes; however, by 75 years of age, the cumulative risk of visual impairment was 2.9%, 3.0%, 5.5%, 20% and 80.3% for a non-cycloplegic SE > −0.50 D, −0.50 to −3.00 D, −3.00 to −6.00 D, −6.00 to −15.00 D and ≤−15.00 D, respectively.[7] These findings suggest that only a small subgroup of myopic children who experience rapid progression towards high myopia require interventions to mitigate the risk of myopia-related complications. Notably, axial length (AL) presented as a stronger predictor of visual impairment or blindness than refractive error. The cumulative risk of visual impairment by 75 years of age was <7%, ≈26% and >90% for ALs < 26 mm, between 26 and 30 mm and ≥30 mm, respectively. When both parameters were included in the logistic regression model, AL was significantly associated with visual impairment whereas SE was not.[7] Since pathologic myopia is primarily attributed to excessive axial elongation, the inconsistent relationship between AL and refractive error due to the variations in corneal and lens power may account for the similar disease risk between low myopes and non-myopes.

Cost-effectiveness of managing myopia

The cost-effectiveness of myopia management is a crucial consideration. Following the recommendations of the World Health Organization, most studies use a willingness-to-pay (WTP) per quality-adjusted life-year (QALY), some one to three times the gross domestic product (GDP) per capita as a benchmark for determining cost-effectiveness.[8] A study in Hong Kong found that implementing myopia control with Defocus Incorporated Multiple Segment (DIMS) spectacle lenses resulted in an incremental cost-effectiveness ratio (ICER) of US$26,407 per QALY gained.[9] Although this cost per QALY was lower than Hong Kong's per capita GDP of US$48,359, it was still relatively high. The WTP threshold is also closely associated with family income, which, of course, varies widely in different regions. When the WTP for a QALY was set at US$18,000, which already exceeds the average annual family income in most countries, the probability of myopia control using DIMS being cost-effective, when compared with no intervention, was only 50%.

Tools for identifying high-risk populations

Nowadays, an increasing number of models have been developed to predict the onset of myopia and help identify those at high risk of rapid progression.[10–20] Baseline refractive error has been shown to be one of the strongest single predictors for myopia onset.[12,13,21–25] The SE combined with other parameters such as ocular biometrics, age, parental myopia and time spent outdoors can assess the risk of developing myopia satisfactorily.[9–12] In recent years, with the advancement of artificial intelligence (AI), fundus imaging has also been proposed for predicting myopia, addressing the inconvenience of cycloplegia during large-scale screening. For example, Foo et al.[18] developed a deep learning system utilising objective fundus imaging and/or clinical data to identify children at risk of developing high myopia in their teenage years (within 5 years). AI-enabled decision support systems have been developed for retinal fundus image analysis, which can not only predict myopia onset using non-cycloplegic ophthalmic parameters but also stratify children accurately into low- and high-risk groups.[20] Despite the emergence of more AI models to predict myopia and its complications,[16,26] these systems are trained on specific population data sets and might not be generalisable across different ethnicities, ages and environments. More large-scale real-world studies are required to refine model construction and validation. The lack of long-term follow-up data also limits the accuracy and precision of predictions over extended periods. Therefore, while AI-driven tools hold significant promise for identifying myopes with high risk of rapid progression who merit early intervention effectively, the crucial next step is to incorporate models into clinical practice to validate their effectiveness across diverse populations and real-world settings.

We know that every dioptre matters,[27] but we are still at the beginning of this myopia journey. We need to figure out what causes myopia and how to manage myopia progression effectively. Given the limited resources, knowledge and skills, at this point, we should focus our energy on addressing those in urgent need, that is, to treat young myopic children with a high risk of myopia progression.

COUNTERPOINT

Nicola S. Logan

Promoting the treatment and active management of myopia in all children is essential, as the condition has profound and lifelong implications for the individual and for society. The argument for treating all children with myopia,

rather than focusing only on those at high risk of progression, rests on several critical points: (1) early intervention reduces risk of progression, (2) risk stratification for identification of children at high risk is imperfect, (3) the economic benefits of preventing progression, (4) high myopia is not the only concern and (5) equity in access to myopia control.

Early intervention reduces risk of progression

Myopia typically progresses over time, and the earlier the age of onset of myopia, the higher the risk of developing high myopia,[1,28] which is associated with severe complications such as retinal detachment, myopic maculopathy, glaucoma and cataracts.[5] Proactively treating all children with myopia, regardless of their initial progression risk, allows for early intervention strategies and myopia control therapies that can slow progression and potentially reduce the likelihood of these sight-threatening conditions.[29]

Risk stratification is imperfect

Identifying children at 'high risk' of progression is not always straightforward.[30] Factors such as genetics, environment and lifestyle all have a role in myopia progression and are complex and variable in their influence, making it difficult to predict the rate of progression accurately. Although several AL growth charts have been produced for different populations,[31–34] these are useful to monitor if a child's AL is greater or less than average but do not allow for accurate prediction of eye growth for an individual child. A study in Singapore has used deep learning to predict the 5-year risk of high myopia in children, using fundus images.[18] While the study demonstrated the feasibility of using retinal fundus images and refraction for myopia prediction, with relatively good (>0.90 Area Under the Receiver Operating Characteristic curve (AUROC)), this comes with certain limitations. The results indicated that 5-year predictive models may be less useful clinically compared with those having shorter time frames. Furthermore, the emphasis on high myopia could restrict the applicability of these models to a more general population. Notably, the focus was on detecting myopia and predicting the risk of high myopia, without accounting for potential myopia control interventions. By treating all children with myopia, this uncertainty is addressed, thereby ensuring that no child is overlooked who might otherwise progress to high myopia.

Economic benefits of prevention

While it may appear cost-effective to focus on high-risk cases only, the long-term economic burden of untreated or minimally managed myopia far outweighs the initial costs of proactive treatment.[35] These burdens include healthcare costs for managing complications of high myopia and productivity losses due to visual impairment. The global potential productivity loss associated with the burden of Vision Impairment in 2015 was estimated at US$244 billion from uncorrected myopia and US$6 billion from myopic macular degeneration.[36] With the trends towards a rising prevalence of myopia, a future increase in these costs is expected. At an individual level, data from Singapore estimate the lifetime per capita cost of myopia to be approximately US$17,000 for those with 80 years of myopia.[37] Preventative and active treatment for all myopic children mitigates these inevitable, ensuing costs.

High myopia is not the only concern

Even children whose myopia does not progress to high levels can experience significant challenges if the myopia is left untreated. Even mild or moderate uncorrected myopia can negatively affect a child's education, development and daily functioning.[35] There is also the broader societal impact of reduced quality of life for the individual with myopia.[35] Providing all children with appropriate treatment ensures minimal progression of their myopia, thus facilitating their participation in educational and social activities and maximising their developmental potential and opportunities. In addition, research shows that no level of myopia is without risk, with even low levels of myopia at increased risk of conditions such as glaucoma and retinal detachment compared to non-myopic eyes.[38,39] Treating all children with myopia helps reduce these risks, regardless of progression rate.

Equity in access to care

Focusing only on high-risk children may inadvertently exclude those who could benefit from treatment but fall outside narrow risk criteria. Treating all children with myopia ensures equitable access to care, supporting both those with evident progression risk and those whose progression might be harder to predict but have equal impact. There may be an argument for a cautious approach in young children with high levels of myopia, as this is often associated with a syndrome.[40] However, high myopia in young children is rare and although little evidence exists on the benefits of myopia control in this cohort, given the low risk of adverse events with myopia control interventions versus the benefit from treatment, it would seem prudent to intervene.[41] There is also a concern that defining high myopia based on an arbitrary threshold may lack inclusivity. Dismissing a child predicted to have −5.75D with a long AL simply because they do not meet the established criteria for high myopia raises questions about fairness. Focusing only on children who meet specific criteria may result in others, who could benefit from treatment, being overlooked. However, it is acknowledged that while there will be costs to families or healthcare systems when treating all

children with myopia,[42] this may be mitigated with lower costs later in life through the use of early myopia control interventions.[9,37]

Advocating for the active treatment of myopia in all children with myopia is crucial for preventing progression, enhancing quality of life, reducing the risk of future ocular complications and addressing both psychosocial and economic implications. In addition, this approach means that healthcare systems can adopt a preventative approach that addresses the risks, burdens and long-term consequences of the condition comprehensively. This strategy, along with integrating comprehensive eye care and regular monitoring into paediatric health practices, is essential for promoting long-term visual health in children with myopia. Treating myopia early and comprehensively is therefore not just a medical necessity, but also a societal imperative to mitigate its far-reaching consequences on individuals and the broader community.

SUMMARY

James S. Wolffsohn

Points of agreement

- The risk of pathologic myopia is closely associated with the severity of myopia.
- Most pathologic myopia occurs in eyes with high myopia.
- Advocating for the active reduction of myopia in children is crucial for enhancing their quality of life and reducing the risk of future ocular complications, hence addressing both psychosocial and economic implications.
- Comprehensive eye care and regular monitoring of children in paediatric health practices is essential for promoting long-term visual health in children with myopia.
- Treating myopia early and comprehensively is more than a medical necessity.

Issues to be resolved

- Can myopia development in a child ever be fully predicted due to the complexity between genetic and environmental elements (see Guggenheim et al.[43])?
- What would be the economics of myopia control treatment as the price is driven down by increasing competition and a much larger market size?
- Do myopia control treatments have any long-term adverse risks on visual performance (due to peripheral blur or contrast reduction) or ocular health (from long-term contact lens wear from an early age, light therapy or use of a pharmaceutical such as atropine)?
- Is health equality affordable or should healthcare systems focus only on those with the greatest risk?
- Will politians provide a financial budget for an increase myopia control costs now for future savings beyond their term of office?

AUTHOR CONTRIBUTIONS

Xiangui He: Conceptualization; writing – original draft; writing – review and editing. **Nicola S. Logan:** Conceptualization; writing – original draft; writing – review and editing. **James S. Wolffsohn:** Conceptualization; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors are all members of the International Myopia Institute but have no commercial conflicts of interest.

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