Optometry Australia

Position Statement on Myopia Management

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Optometry AUSTRALIA

OA Policy Position

Myopia is a significant global public health concern, and optometrists play a key role in the diagnosis, clinical management, and treatment of myopia across a person's lifespan. Therefore, optometrists have a professional and ethical duty to educate themselves and their patients on the current evidence-based myopia management practice.

Optometry Australia (OA) supports the **World Council of Optometry Standards of Care Guidelines for Myopia Management (2021)** which advises that optometrists should:

- provide comprehensive eye health and vision examinations including the measurement of refractive error and ocular biometry (where possible),
- assess the risks and counsel patients and their parents/guardians/caregivers on ways to delay myopia onset where the risk of myopia is increased, and,
- once a child is diagnosed with myopia, offer appropriate treatment options based on latest evidence to manage myopia progression, with regular follow-up.

Myopia management should also include comprehensive eye health assessment to enable the early diagnosis and management of myopia-related ocular pathology. Therefore, when providing care to patients with myopia, OA endorses a shift in clinical practice from simply correcting vision and refractive error to evidence-based myopia management strategies including patient education regarding approaches to mitigate myopia development and discussion of research-supported management options to slow its progression as the standard of care for all at-risk patients.

Background

Without appropriate intervention, myopia is anticipated to affect **50%** of the world's population and **20 million** Australians by **2050**.[1] Currently, it is estimated that globally almost **two billion** people are myopic and around **227 million** individuals have high myopia.[2] The prevalence of both myopia and high myopia has significantly increased over the past several decades[3] particularly in East Asian countries where the prevalence has reached **>80%** in some urban areas. Furthermore, the onset of myopia appears to be developing at a younger age, increasing the probability of progression to high myopia[2] which carries the risk of significant visual morbidity. It is for these reasons myopia is considered an 'epidemic' and a growing public health concern.[3]

While standard glasses and contact lenses correct the distance visual blur associated with myopic refractive errors, they do not reduce the abnormal axial elongation of the eye associated with myopia development, which is the main driver of myopia-associated ocular pathology[4] including retinal detachment,[5] maculopathy,[6] glaucoma,[7] and cataract formation.[8] While these pathologies are typically associated with high myopia (>-6.00 D), even low to moderate amounts of myopia increase the risk of visual impairment later in life.[9,10] Uncorrectable vision impairment is present in **4%** of **75-year-olds** with myopia and **39%** of patients the same age with high myopia.[11] By **2050**, the number of people predicted to be visually impaired as a result of myopic macular degeneration alone is **55.7 million**, of which **18.5 million** will be legally blind.[12] There is no level of myopia which is considered safe and even low to moderate amounts of myopia increase the risk of eye disease **two to ten-fold**.[9,10] Therefore, efforts to reduce the incidence, progression, and severity of myopia could have a significant impact on public health.

Definitions

Myopia can be classified in several ways including its aetiology, severity or magnitude, age of onset, pattern of progression, and structural complications.[13] The **International Myopia Institute (IMI)** propose the following quantitative definitions for myopia (**Table 1**[13]):

Table 1: International Myopia Institute definitions of myopia based on magnitude of myopia

Clinical test	Notes
Myopia	A condition in which the spherical equivalent refractive error (SER) is (more myopic than) ≤ -0.50 D when accommodation is fully relaxed
Low myopia	A condition in which the SER of an eye is between -0.50 D and -5.75 D when accommodation is relaxed
High myopia	A condition in which the SER of a myopic eye is -6.00 D or greater when ocular accommodation is relaxed
Pre-myopia	A refractive state of between +0.75 D and -0.50 D in children where a combination of baseline refraction, age, and other quantifiable risk factors provide sufficient likelihood of the future myopia development to merit preventative interventions

High myopia in infants and children <10 years of age

High myopia in infants and young children is rare with a prevalence of less than 1% and is often associated with prematurity or genetic causes (i.e. associated with at least one other medical condition which is commonly referred to as syndromic myopia).[14] In this population there are range of diagnostic, systemic health and visual challenges that should be considered and specialist multidisciplinary investigation and management is typically required, usually in a tertiary care setting.[14] Infants born prematurely,[15] those with ametropic inherited retinal dystrophies,[16] children with connective tissue disorders such as Stickler syndrome and Marfan syndrome, or genetic predisposition are all at significant risk of developing high myopia.

In a hospital-based survey of children with high myopia, over half were born prematurely, had neurodevelopmental delay or had an underlying systemic disorder including Marfan syndrome, Stickler syndrome, Noonan syndrome or Trisomy,[21] and 38% has associated ocular pathology.[17] Optometrists, as primary eye care providers, need to recognise the risk factors for syndromic causes of myopia in children and provide timely and appropriate referral.[14] Additional investigation and multidisciplinary team evaluations are warranted when the myopic refractive error (in dioptres) is greater than the age of the child (in years), spectacle-corrected visual acuity is reduced for age, there are complaints of poor night vision, there is suspected ocular pathology on imaging or physical examination, the family history suggests potential syndromic myopia, or medical history points to possible genetic abnormalities, prematurity, hearing loss or developmental delay.[14] In these children, managing myopia progression is only a small part of the therapy plan, and treatment strategies are complex and require a case-by-case approach.

Risk factors associated with myopia development and progression

Myopia is a complex, multi-factorial condition which is the result of a combination of genetic, ethnic and/or environmental risk factors.[18,19] Currently, identified risk factors for the development of myopia[20] include family history, ethnicity, reduced time spent outdoors, refractive error of less than +0.75 D at six years of age, increased time spent on near work, disrupted sleep patterns, and increased time spent on digital devices (**Figure 1**).[18,19] Once myopia has developed, faster myopia progression is generally observed in younger children, females, and those with a higher level of presenting myopia (**Figure 1**).[21,22]

Other risk factors that have been associated with myopia progression[23] include children of Asian ethnicity,[4] those who have two myopic parents, hyperopic peripheral retinal defocus, larger lag of accommodation, a high AC/A ratio, near esophoria, increased time spent on near work, and reduced time spent outdoors. Time spent outdoors has been shown to reduce the incidence (number of new cases) of myopia, however, its ability to significant slow myopia progression in already myopic children is less clear. Evaluating prior change in either SER or axial length of the eye may not accurately predict future myopia progression.[22]

Figure 1: Risk factors, categorised by level of evidence, associated with myopia development and myopia progression.

Level of evidence	Risk Factors for Myopia Development	Risk Factors for Myopia Progression
Strong	• Reflective error more minus than +0.75D at 6 years of age • Reduced time spent outdoors • Parental myopia (one or two myopic parents) • East Asian ethnicity • Increased school length and educational activities • High AC/A ratio and large lag of accommodation	• Younger age • Two myopic parents • Asian ethnicity
Moderate	• Closer reading distance • Continuous reading >30 minutes • Reduced exposure to bright light • Later sleep time	• Female gender • Sleeping late • Increased near work
Weak	• Living in urban environments • First born children • Digital screen time	• Hyperopic retinal defocus • Large lag of accommodation • High AC/A ratio • Near esophoria • Reduced time spent outdoors

Myopia management

While there is no universally agreed upon definition for myopia management, the term is generally used to describe active optical or pharmacological interventions that attempt to slow a patient's myopia progression. More holistically, myopia management may also include evaluation of lifestyle and environmental risk factors for the development or progression of myopia, as well as providing comprehensive eye health and vision care for patients with myopia across the life span.

In 2021, the **World Council of Optometry (WCO)** passed a resolution that supports the myopia management as the standard of care by optometrists in their practice.[24] This resolution identifies three main components of myopia management:

- **Mitigation** – counselling children and their families, during early and regular eye examinations, about lifestyle and other factors to prevent or delay the onset of myopia.
- **Measurement** – regular and comprehensive eye health and vision examinations to evaluate ocular status through measurement of refractive error and ocular biometry, where available.
- **Management** – addressing patients' needs through correcting myopic refractive error while also providing evidence-based interventions to slow myopia progression.

Best practice recommendations for the clinical care of patients at risk of myopia development and progression

The following clinically testing procedures are recommended for the comprehensive evaluation of patients with myopia or those at risk of developing myopia in the future:[25]

- A detailed patient history including the identification of risk factors, parental history, age of myopia onset, history of myopia progression and any previous myopia management interventions. Once a patient has commenced myopia management, other appropriate history questions relevant to the treatment regimen should be asked, for example, compliance and risks associated with treatment complications.
- Distance and near unaided and/or habitual vision.
- Subjective refraction and spectacle-corrected visual acuity.
- Assessment of convergence and accommodation,[26] including children on atropine therapy.
- Cycloplegic subjective refraction[27] (autorefraction) with either 1% cyclopentolate[28] or topical anaesthetic followed by two drops of 1% tropicamide five minutes apart,[29] at initial presentation and then annually. Cycloplegic refraction should occur 30-45 minutes after the initial drop was instilled.[30] Incomplete cycloplegia risks over diagnosis of myopia and iris colour should be factored into the consideration of dose, concentration and timing of the cycloplegic agent.
- Ocular health examination including dilated fundus examination,[31] annually for patients with high myopia or where appropriate.[25]
- Ocular biometry[32] (if available) every six months.
- Corneal topography for children wearing orthokeratology contact lenses, and others as appropriate.
- Pupil size and function for children using atropine, and others as appropriate.
- Intraocular pressure, where appropriate.[25]
- Depending on history and examination findings additional investigations such as retinal imaging, electrophysiology, or referral to a paediatrician or clinical geneticist if high myopia associated with a systemic condition is suspected,[14] may be warranted.

Management of patients with pre-myopia

Pre-myopia is typically considered a non-myopic refractive error in which a combination of the observed pattern of eye growth and risk factor analysis indicate a high-risk of progression to myopia in the future.[13] A cycloplegic SER of less than +0.75 D at six years of age is the single best predictor of the onset of myopia by 13 years of age.[33] Genetics (having one or both parents with myopia), environmental factors (less time outdoors and more time reading), as well as some specific binocular vision disorders increases the risk of developing myopia in pre-myopic children.[25] Currently there are no clear clinical recommendations on managing these children, although lifestyle interventions such as reducing screen time[34,35] and increased time outdoors[36] have been found to reduce myopia development. Both strategies also align with existing public health initiatives to promote healthy lifestyles for children[37] including lowering rates of childhood obesity[38] and improving academic performance.[39] As such there have been government initiatives in China, Singapore and Taiwan to encourage children to spend more time outdoors to reduce the onset of myopia as increased outdoor activity represents a safe, simple, free and practical strategy for myopia prevention.[40,41]

An overview of systematic reviews concluded that increased exposure to outdoor light reduces myopia development.[36] The data analysis suggested that there were significant association between increased outdoor light exposure and reduced prevalence of myopia, with exposure to higher levels of outdoor light associated with a **24-36% reduction in incident myopia**. By contrast, the authors concluded that reductions in myopia progression and axial length elongation of the eye in already myopic children were small and clinically insignificant, and, therefore, outdoor light exposure and increased time outdoors **did not significantly reduce myopia progression**. A cluster randomised controlled trial of nearly 2,000 six-year-old children in China, found an additional 40 minutes of outdoor time at school resulted in a reduced incidence of myopia over the next three years. This was accompanied by a reduced change in SER (0.17 D, 95% confidence intervals 0.01 to 0.33 D), but no statistically significant difference in axial elongation of the eye between the two groups.[42]

Wu et al. recommended children should spend at least 11 hours per week in settings with exposure to at least 1,000 lux for myopia prevention.[43] The authors argued that strong sunlight exposure (typically >10,000 lux compared with <500 lux indoors) is not always necessary, as children with longer duration of moderate light intensity (1,000 – 3,000 lux) also benefitted from the protective role of outdoor time. Other guidelines suggest that a minimum of **3,000 lux for 90-10044 or 12045 minutes per day** is required to reduce the abnormal axial growth associated with myopia.

Even with children wearing both a hat and sunglasses, light levels reaching the eye can still reach approximately 1,000-2,000 lux[46] helping to reduce children's exposure to ultraviolet light significantly, indicating the importance of maintaining sun protection while recommending increased time outdoors for myopia.

One hypothesis for the reduced risk of myopia development with increased time outdoors is that high intensity outdoor light increases the release of retinal dopamine, an ocular growth inhibitor.[47] Additionally, changes in diurnal and/or circadian rhythms, which may be interrupted by abnormal light exposure may also be linked to myopia development.[48] Other possible causal pathways for reduced myopia incidence with increased time spent outdoors include reduced peripheral hyperopic retinal defocus when viewing objects in the distance or differences in the spatial frequency of outdoor scenes compared with indoor work.[49] While Vitamin D, physical activity and time outdoors mediating near work have all been investigated, these are unlikely to be contributing factors to the protective effects of outdoor exposure.[49]

A small number of studies[50–52] have investigated the use of low dose atropine for myopia prevention in children at risk of myopia development and a recent meta-analysis[53] supported the effectiveness of atropine eyes in concentrations ranging from 0.01-0.05% in delaying the incidence of myopia and slowing down axial growth of the eye. However, further research is required due to the limited number of studies and the relatively short duration (6-24 months) of the trials.

Commencing myopia management

Patients and families should be educated on the current understanding of causes of myopia as well as the environmental and other risk factors associated with myopia development and progression; the risks and consequences of myopia progression; and the evidence-based treatment options currently available. Parents'/caregivers' expectations should be managed emphasising that the aim of myopia management is to slow progression, and that no therapies completely halt progression or reverse myopia. Treatment is advised for all children whose myopia is progressing and should commence as early as possible to reduce the risk of myopia-associated ocular pathology later in life.[54] Most children with recent onset myopia progress,[55] therefore, myopia management can be considered at initial diagnosis.[32]

Ensuring patients and their parents/caregivers participate in shared decision-making and can provide truly informed consent is an important part of myopia management, particularly when using off-label therapies such as 0.05% atropine eye drops. Sufficient time should be made available to have a fully informed discussion with children and their parents/guardians/caregivers.[56] Optometrists may also wish to provide parents/caregivers with written material or weblinks to further information to supplement their in-office consultation. Optometry practices should consider providing support staff, for example optical dispensers and assistants, additional training so that they are also able to discussion myopia management with patients and their families after the consultation and answer any further questions or queries, where appropriate.

Options for myopia management

There is now substantial evidence that myopia management therapies reduce the rate of refractive error progression and axial elongation of the eye, while simultaneously providing appropriate optical correction which fully corrects distance (and near) vision. Children with myopia should be encouraged to wear their correction full-time, as treatment efficacy is likely to be correlated with wearing time and under-correction of myopia may increase myopia progression.[25]

Myopia management strategies broadly fall into five categories, all of which are supported by peer-reviewed, published studies from randomised controlled trials:

- Specialised spectacles e.g. defocus incorporated multiple segment,[57] highly aspherical lenslet, common and diffusion optic[58] (not currently available in Australia) designs.[59]
- Specialised contact lenses[23] e.g. multifocal,[60] multi-zone,[61] extended-depth-of-focus,[62] and orthokeratology.[65]
- Pharmaceutical agents: while the response to various concentrations of low dose atropine varies with children's ethnicity, genetics and degree of myopia, recent evidence suggests that 0.01% atropine is likely to be ineffective or only slightly effective in controlling the axial elongation associated with myopia progression and current evidence suggests the use of 0.05% atropine eye drops.[66–68] Eikance (0.01% atropine minims) is available commercially and was approved by the Therapeutics Goods Administration (TGA) in 2021 for the treatment of progressive myopia in 4-14 year old children, where myopia progresses ≥ 1.00 D per year. Other concentrations (0.025-0.05%), and other indications (children outside these age ranges or with less than 1.00 D of myopia progression in a year), are considered an off-label use of atropine.
- Combination therapy[69] for example, a combination of orthokeratology contact lenses and low dose (0.01%) atropine which has the strongest evidence base. There is limited evidence for other combination therapies with some early evidence suggesting reduced progression of SER in European children using 0.01% atropine combined with defocus incorporated multiple segment spectacles lenses, however, there was no significant additive benefit for axial elongation of the eye.[70] Combining 0.01% atropine eye drops with soft multifocal contact lenses (Biofinity D lenses with a +2.50D add power) failed to demonstrate better myopia control than soft multifocal contact lenses alone in the Bifocal & Atropine in Myopia study.[71]
- Repeated low-level red light (RLRL) therapies[72,73] which is an emerging area of myopia management treatment which has been shown to slow the progression of myopia through the emission of visible red light. A recent meta-analysis has found RLRL to be an effective and safe short-term myopia management treatment, however, further longer-term studies for efficacy, standardisation and safety are required, particularly in comparison with other myopia management options.[74] Currently in Australia, a home-based RLRL instrument has been TGA registered as a Class IIa medical device.

Current evidence does not support the use of the following therapies as there is insufficient or contradictory evidence for the efficacy in slowing myopia progression:

- Spectacle under-correction.[75,76]
- Progressive Addition Lenses.[77,78]
- Single vision spectacles,[79] soft contact lenses,[80] and rigid gas permeable contact lenses.[81]

When discussing myopia management treatments, optometrists should participate in shared decision-making and patient-centred care considering multiple factors including the patient and family preferences, the child's age and rate of myopia progression, the ability of the child and their family to adhere to the prescribed therapy, the overall hygiene and personal responsibility level of the child, as well as the clinician's own experience and training. It is important to identify potential motivators and barriers (including financial barriers) to treatment when discussing myopia management options with children and their families.

When commencing myopia management, optometrists should set a goal (or target) for acceptable myopia progression against which treatment efficacy can be evaluated.[82] These target changes in refractive error, and ideally axial length of the eye, should be determined based on the child's age and ethnicity, and may be aided by evaluating published growth charts and models[83,84] (and **Table 2**). The myopia management target, which should aim for below-average progression based on the child's age and ethnicity, can then be communicated to the patient and their parents in dioptres (D) and/or millimetres (mm). Recent evidence also suggests approximately one-third of young adults will also experience myopia progression of at least 0.50 D between 20 and 28 years of age, although at lower rates than during childhood.[85] This study also showed that 14% of participants developed myopia after 20 years of age and this myopia incidence was associated with female sex, East Asian ethnicity and less sun exposure. The authors concluded that more research is needed to assess the efficacy for myopia management therapies in young adults, as with more people pursuing post-graduate qualifications, there may be an increase in myopia development and progression during the third decade of life.

Table 2: Rate of annual eye growth (mm/year) as a function of age based on data from the Orinda Longitudinal Study of Myopia (OLSM) and Singapore Cohort Study of the Risk factors for Myopia (SCORM). Table reproduced from Chamberlain et al., 2021[86]

Age	Children with myopia		Children with emmetropia	
	OLSM	SCORM	OLSM	SCORM
8	0.28	0.39	0.15	0.14
9	0.25	0.31	0.13	0.11
10	0.30	0.25	0.09	0.09
11	0.22	0.20	0.07	0.08
12	0.20	0.17	0.06	0.06
13	0.19	0.14	0.06	0.06
14	0.18	0.12	0.05	0.05

Ongoing care

Review schedules for children with myopia should be determined based on the individual patient, their clinical presentation and the risk of complications associated with any therapies prescribed. The review schedule should be tailored by treatment type, and it is expected that children prescribed atropine eye drops or contact lenses require more frequent initial reviews to evaluate adherence, and to assess for any unanticipated adverse effects.[25] Generally children with myopia should have comprehensive eye health and vision examinations at appropriate intervals to assess the treatment safety and efficacy, usually every 6 months after treatment is established, depending on the treatment(s) prescribed.[25] Optometrists should also consider the need for regular fundus examinations through dilated pupils, recommended annually in patients with high myopia,[25] to ensure that there is a complete assessment of ocular health, given the risk of ocular pathology in myopia.

Changing or stopping therapy

If the prescribed myopia management therapy is not achieving the previously set goal or target, then switching to an alternative treatment(s) could be considered.[25] This may involve changing treatment modalities (for example optical therapy to pharmacology therapy, or vice versa), augmenting the current treatment by considering combination therapy (for example, contact lens therapy with low dose atropine) or changing the optical lens design for contact lens and spectacle treatments. When using an effective treatment supported by an evidence-base, it is first worth considering patient adherence to the prescribed therapy, as current evidence suggests most therapies show a dose-dependent (wearing-time) effect.

Typically, myopia progresses until late adolescence and then stabilises, but it is difficult to determine at what age progression will stop for an individual patient. Therefore, the decision to discontinue myopia management therapy requires careful consideration. The Correction of Myopia Evaluation Trial (COMET) found the average age of myopia stabilisation was 15.6 years.[87] The average age for stabilisation of axial length growth was 16.3 years.[88] However, this means that approximately 50% of children with myopia are still progressing at around 16 years of age, and it wasn't until 24 years of age that 96% of study participants showed complete myopia stabilisation. This data suggests that clinicians should continue prescribing myopia management treatments until at least 16 years of age and monitor patients closely once therapy has been discontinued. Some patients may be happy to continue wearing myopia management spectacles or contact lenses, even after their myopia has stabilised.

There is inconclusive evidence on whether treatment cessation increases myopia progression, known as a 'rebound effect'.[89] In children who had previously used atropine eye drops (0.01% to 1% concentrations), shorter treatment duration, younger age and higher baseline refractive errors were all associated with increased risk of rebound myopia progression.[90] These rebound effects tended to occur even in children who had transitioned to a lower dose of atropine or adopted a stepwise cessation approach, but appeared to be at least partially mitigated when atropine was combined with optical therapies.[90] Current literature suggests that optical treatments produce minimal or no rebound effect compared with pharmacological or light therapies,[91] although a moderate rebound effect has been observed following the discontinuation of orthokeratology lens wear before age 14 years.[92]

Intra-optometry referral

Practitioners report that adopting myopia management enhances patient loyalty, increases practice revenue and improves job satisfaction.[93] However, not all optometry practices may be in the position to offer some myopia management strategies including measurement of axial length of the eye, which is the preferred method for evaluating myopia progression.[32] Therefore, optometrists should consider co-management with another optometrist or ophthalmologist to allow for comprehensive myopia management evaluation and treatment if it is not available within their practice resources. Differences between ocular imaging devices, including ocular biometers, exist and ideally measurements should be undertaken on the same type of instrument over time. Likewise, some children may require referral to a therapeutically endorsed colleague for low dose atropine treatment, or to an orthokeratology practitioner, if these are the patient's preference(s).

Billing / charging for myopia management

When considering Medicare billing, an optometrist should consider whether they:

- Have performed a clinically necessary or relevant service;
- Met the conditions of the **Medicare Benefits Schedule (MBS)** item descriptor;
- Could justify the services provided to a panel of their peers.

Several Medicare item numbers may be appropriate when evaluating patients as part of a myopia management service including 10910 (comprehensive consultation for a patient <65 years of age), 10943 (children's vision assessment), 10914 (where a comprehensive reassessment is clinically indicated), 10918 (subsequent consultation), or 10905 (optometrist to optometrist referral, if the optometrist has been referred a patient for myopia management). For more information regarding appropriate item use, refer to the **Medicare Benefits Scheme Item Use Guide**.

Optometrists may also wish to consider private billing options for myopia management patients and Optometry Australia provides recommendations on **consultation fees** which are indexed annually.

Risks associated with myopia management

The central question is whether the potential benefits of reducing myopia progression outweigh the potential risks of current therapy options for myopia management.[54] This risk needs to be considered both at the population and individual patient level, and is best evaluated via the number needed to treat (NNT) parameter which is widely used in health assessments (for example, the Ocular Hypertension Treatment Study[94]) and represents the number of patients a clinician needs to treat to prevent one additional adverse event or outcome. Modelling predicts that even a modest reduction in myopia progression of 1.00D can prevent 9-15 months of visual impairment in patients with a myopic refractive error between -3 D and -8 D.[54] Based on this data, the NNT to prevent five years of visual impairment in patients with myopia is 1 in 4-7 patients, whereas fewer than 1 in 38 patients are likely to experience vision loss as a result of myopia management interventions.[54] Therefore, current data suggests that myopia control treatments are generally safe,[95] with the risk of microbial keratitis in patients wearing contact lenses for myopia control very low.

Conclusion - myopia management as the standard of care

A recent Cochrane review[89] found that all myopia interventions (except for under-correction with single vision spectacle lenses, standard single vision rigid gas permeable lenses and the adenosine antagonist 7-methylxanthine) were effective at slowing myopia progression in terms of both refractive error and axial length of the eye at 12 and 24 months. Current evidence weighs in favour of prescribing active myopia management therapies to children with myopia[95] and suggests that there is no superior treatment modality with orthokeratology, multifocal and multi-zone soft contact lenses, myopia control spectacles, and low dose atropine all showing similar results.[32]

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References

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: 1036–1042.
2. Baird PN, Saw S-M, Lanca C, et al. Myopia. Nat Rev Dis Primer 2020; 6: 1–20.
3. Modjtahedi BS, Abbott RL, Fong DS, et al. Reducing the Global Burden of Myopia by Delaying the Onset of Myopia and Reducing Myopic Progression in Children: The Academy's Task Force on Myopia. Ophthalmology 2021; 128: 816–826.
4. Bullimore MA, Brennan NA. Efficacy in Myopia Control: Does Race Matter? Optom Vis Sci 2023; 100: 5.
5. van Leeuwen R, Haarman AEG, van de Put MAJ, et al. Association of Rhegmatogenous Retinal Detachment Incidence With Myopia Prevalence in the Netherlands. JAMA Ophthalmol 2021; 139: 85–92.
6. Hashimoto S, Yasuda M, Fujiwara K, et al. Association between Axial Length and Myopic Maculopathy: The Hisayama Study. Ophthalmol Retina 2019; 3: 867–873.
7. Ha A, Kim CY, Shim SR, et al. Degree of Myopia and Glaucoma Risk: A Dose-Response Meta-analysis. Am J Ophthalmol 2022; 236: 107–119.
8. Kanthan GL, Mitchell P, Rochtchina E, et al. Myopia and the long-term incidence of cataract and cataract surgery: the Blue Mountains Eye Study. Clin Experiment Ophthalmol 2014; 42: 347–353.
9. Bullimore MA, Brennan NA. Myopia Control: Why Each Diopter Matters. Optom Vis Sci 2019; 96: 463.
10. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog Retin Eye Res 2012; 31: 622–660.
11. Modjtahedi BS, Ferris FL, Hunter DG, et al. Public Health Burden and Potential Interventions for Myopia. Ophthalmology 2018; 125: 628–630.
12. Fricke TR, Jong M, Naidoo KS, et al. Global prevalence of visual impairment associated with myopic macular degeneration and temporal trends from 2000 through 2050: systematic review, meta-analysis and modelling. Br J Ophthalmol 2018; 102: 855–862.
13. Flitcroft DI, He M, Jonas JB, et al. IMI – Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies. Invest Ophthalmol Vis Sci 2019; 60: M20–M30.
14. Flitcroft I, Ainsworth J, Chia A, et al. IMI—Management and Investigation of High Myopia in Infants and Young Children. Invest Ophthalmol Vis Sci 2023; 64: 3.
15. Repka MX. Refraction and keratometry in premature infants. Br J Ophthalmol 2004; 88: 853–854.
16. Flitcroft DI, Adams GGW, Robson AG, et al. Retinal dysfunction and refractive errors: an electrophysiological study of children. Br J Ophthalmol 2005; 89: 484–488.
17. Marr JE, Halliwell-Ewen J, Fisher B, et al. Associations of high myopia in childhood. Eye 2001; 15: 70–74.
18. Morgan IG, Wu P-C, Ostrin LA, et al. IMI Risk Factors for Myopia. Invest Ophthalmol Vis Sci 2021; 62: 3.
19. Martínez-Albert N, Bueno-Gimeno I, Gené-Sampedro A. Risk Factors for Myopia: A Review. J Clin Med 2023; 12: 6062.
20. Lee SS-Y, Mackey DA. Prevalence and Risk Factors of Myopia in Young Adults: Review of Findings From the Raine Study. Front Public Health 2022; 10: 861044.
21. Moore M, Lingham G, Flitcroft DI, et al. Myopia progression patterns among paediatric patients in a clinical setting. Ophthalmic Physiol Opt 2024; 44: 258–269.
22. Mutti DO, Sinnott LT, Brennan NA, et al. The Limited Value of Prior Change in Predicting Future Progression of Juvenile-onset Myopia. Optom Vis Sci 2022; 99: 424.
23. Sankaridurg P. Chapter 31 - Myopia Control. In: Efron N (ed) Contact Lens Practice (Fourth Edition). New Delhi: Elsevier, pp. 333-343.e4.
24. Hendicott P, Block SS. How the World Council of Optometry produced new guidelines for myopia management. Community Eye Health 2022; 35: 21–22.
25. Gifford KL, Richdale K, Kang P, et al. IMI – Clinical Management Guidelines Report. Invest Ophthalmol Vis Sci 2019; 60: M184–M203.
26. Logan NS, Radhakrishnan H, Cruickshank FE, et al. IMI Accommodation and Binocular Vision in Myopia Development and Progression. Invest Ophthalmol Vis Sci 2021; 62: 4.
27. Sankaridurg P, He X, Naduvilath T, et al. Comparison of noncycloplegic and cycloplegic autorefraction in categorizing refractive error data in children. Acta Ophthalmol (Copenh) 2017; 95: e633–e640.
28. Major E, Dutson T, Moshirfar M. Cycloplegia in Children: An Optometrist's Perspective. Clin Optom 2020; 12: 129–133.
29. Al-Thawabieh W, Al-Omari R, Abu-Hassan DW, et al. Tropicamide Versus Cyclopentolate for Cycloplegic Refraction in Pediatric Patients With Brown Irides: A Randomized Clinical Trial. Am J Ophthalmol 2024; 257: 218–226.
30. Rosenfield M, Logan N, Edwards K (eds). Optometry: science techniques and clinical management. 2nd ed. Edinburgh ; New York: Butterworth Heinemann Elsevier, 2009.
31. Lai TYY, Fan DSP, Lai WWK, et al. Peripheral and posterior pole retinal lesions in association with high myopia: a cross-sectional community-based study in Hong Kong. Eye 2008; 22: 209–213.
32. Brennan NA, Toubouti YM, Cheng X, et al. Efficacy in myopia control. Prog Retin Eye Res 2021; 83: 100923.
33. Zadnik K, Sinnott LT, Cotter SA, et al. Prediction of Juvenile-Onset Myopia. JAMA Ophthalmol 2015; 133: 683–689.
34. Harrington S, O'Dwyer V. The association between time spent on screens and reading with myopia, premyopia and ocular biometric and anthropometric measures in 6- to 7-year-old schoolchildren in Ireland. Ophthalmic Physiol Opt 2023; 43: 505–516.
35. Alvarez-Peregrina C, Sánchez-Tena MÁ, Martinez-Perez C, et al. The Relationship Between Screen and Outdoor Time With Rates of Myopia in Spanish Children. Front Public Health 2020; 8: 560378.
36. Dhakal R, Shah R, Huntjens B, et al. Time spent outdoors as an intervention for myopia prevention and control in children: an overview of systematic reviews. Ophthalmic Physiol Opt 2022; 42: 545–558.
37. Oswald TK, Rumbold AR, Kedzior SGE, et al. Psychological impacts of "screen time" and "green time" for children and adolescents: A systematic scoping review. PLOS ONE 2020; 15: e0237725.
38. Bleich SN, Vercammen KA, Zatz LY, et al. Interventions to prevent global childhood overweight and obesity: a systematic review. Lancet Diabetes Endocrinol 2018; 6: 332–346.
39. Wang J, Sankaridurg P, Naduvilath T, et al. Time outdoors positively associates with academic performance: a school-based study with objective monitoring of outdoor time. BMC Public Health 2023; 23: 645.
40. Wu P-C, Chen C-T, Chang L-C, et al. Increased Time Outdoors Is Followed by Reversal of the Long-Term Trend to Reduced Visual Acuity in Taiwan Primary School Students. Ophthalmology 2020; 127: 1462–1469.
41. Morgan IG, Jan CL. China Turns to School Reform to Control the Myopia Epidemic: A Narrative Review. Asia-Pac J Ophthalmol 2022; 11: 27–35.
42. He M, Xiang F, Zeng Y, et al. Effect of Time Spent Outdoors at School on the Development of Myopia Among Children in China: A Randomized Clinical Trial. JAMA 2015; 314: 1142–1148.
43. Wu P-C, Chen C-T, Lin K-K, et al. Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial. Ophthalmology 2018; 125: 1239–1250.
44. Read SA, Collins MJ, Vincent SJ. Light Exposure and Eye Growth in Childhood. Invest Ophthalmol Vis Sci 2015; 56: 6779–6787.

45. Ho C-L, Wu W-F, Liou YM. Dose–Response Relationship of Outdoor Exposure and Myopia Indicators: A Systematic Review and Meta-Analysis of Various Research Methods. Int J Environ Res Public Health 2019; 16: 2595.
46. Lanca C, Teo A, Vivagandan A, et al. The Effects of Different Outdoor Environments, Sunglasses and Hats on Light Levels: Implications for Myopia Prevention. Transl Vis Sci Technol 2019; 8: 7.
47. Zhang J, Deng G. Protective effects of increased outdoor time against myopia: a review. J Int Med Res 2020; 48: 0300060519893866.
48. Chakraborty R, Ostrin LA, Nickla DL, et al. Circadian rhythms, refractive development, and myopia. Ophthalmic Physiol Opt 2018; 38: 217–245.
49. Lingham G, Mackey DA, Lucas R, et al. How does spending time outdoors protect against myopia? A review. Br J Ophthalmol 2020; 104: 593–599.
50. Fang P-C, Chung M-Y, Yu H-J, et al. Prevention of Myopia Onset with 0.025% Atropine in Premyopic Children. J Ocul Pharmacol Ther 2010; 26: 341–345.
51. Wang W, Zhang F, Yu S, et al. Prevention of myopia shift and myopia onset using 0.01% atropine in premyopic children — a prospective, randomized, double-masked, and crossover trial. Eur J Pediatr 2023; 182: 2597–2606.
52. Jethani J. Efficacy of low-concentration atropine (0.01%) eye drops for prevention of axial myopic progression in premyopes. Indian J Ophthalmol 2022; 70: 238.
53. Lee S-H, Tseng B-Y, Wang J-H, et al. Efficacy and Safety of Low-Dose Atropine on Myopia Prevention in Premyopic Children: Systematic Review and Meta-Analysis. J Clin Med 2024; 13: 1506.
54. Bullimore MA, Ritchey ER, Shah S, et al. The Risks and Benefits of Myopia Control. Ophthalmology 2021; 128: 1561–1579.
55. Bullimore MA, Richdale K. Myopia Control 2020: Where are we and where are we heading? Ophthalmic Physiol Opt 2020; 40: 254–270.
56. Coverdale S, Rountree L, Webber K, et al. Eyecare practitioner perspectives and attitudes towards myopia and myopia management in the UK. BMJ Open Ophthalmol 2024; 9: e001527.
57. Lam CSY, Tang WC, Tse DY, et al. Defocus Incorporated Multiple Segments (DIMS) spectacle lenses slow myopia progression: a 2-year randomised clinical trial. Br J Ophthalmol 2020; 104: 363–368.
58. Rappon J, Chung C, Young G, et al. Control of myopia using diffusion optics spectacle lenses: 12-month results of a randomised controlled, efficacy and safety study (CYPRESS). Br J Ophthalmol 2023; 107: 1709–1715.
59. Bao J, Yang A, Huang Y, et al. One-year myopia control efficacy of spectacle lenses with aspherical lenslets. Br J Ophthalmol 2022; 106: 1171–1176.
60. Fan H, Zhang X, Wei Q, et al. Myopia control efficacy of peripheral defocus soft contact lenses in children and adolescents: A meta-analysis. Eur J Ophthalmol 2024; 11206721241229474.
61. Walline JJ, Walker MK, Mutti DO, et al. Effect of High Add Power, Medium Add Power, or Single-Vision Contact Lenses on Myopia Progression in Children: The BLINK Randomized Clinical Trial. JAMA 2020; 324: 571–580.
62. Cheng X, Xu J, Brennan NA. Randomized Trial of Soft Contact Lenses with Novel Ring Focus for Controlling Myopia Progression. Ophthalmol Sci 2023; 3: 100232.
63. Chamberlain P, Peixoto-de-Matos SC, Logan NS, et al. A 3-year Randomized Clinical Trial of MiSight Lenses for Myopia Control. Optom Vis Sci 2019; 96: 556–567.
64. Sankaridurg P, Bakaraju RC, Naduvilath T, et al. Myopia control with novel central and peripheral plus contact lenses and extended depth of focus contact lenses: 2 year results from a randomised clinical trial. Ophthalmic Physiol Opt J Br Coll Ophthalmic Opt Optom 2019; 39: 294–307.
65. Hiraoka T. Myopia Control With Orthokeratology: A Review. Eye Contact Lens 2022; 48: 100.
66. Repka MX, Weise KK, Chandler DL, et al. Low-Dose 0.01% Atropine Eye Drops vs Placebo for Myopia Control: A Randomized Clinical Trial. JAMA Ophthalmol 2023; 141: 756.
67. 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: 113–124.
68. Yam JC, Zhang XJ, Zhang Y, et al. Three-Year Clinical Trial of Low-Concentration Atropine for Myopia Progression (LAMP) Study: Continued Versus Washout: Phase 3 Report. Ophthalmology 2022; 129: 308–321.
69. Zhang G, Jiang J, Qu C. Myopia prevention and control in children: a systematic review and network meta-analysis. Eye 2023; 37: 3461–3469.
70. Nucci P, Lembo A, Schiavetti I, et al. A comparison of myopia control in European children and adolescents with defocus incorporated multiple segments (DIMS) spectacles, atropine, and combined DIMS/atropine. PLOS ONE 2023; 18: e0281816.
71. Jones JH, Mutti DO, Jones-Jordan LA, et al. Effect of Combining 0.01% Atropine with Soft Multifocal Contact Lenses on Myopia Progression in Children. Optom Vis Sci 2022; 99: 434.
72. Jiang Y, Zhu Z, Tan X, et al. Effect of Repeated Low-Level Red-Light Therapy for Myopia Control in Children: A Multicenter Randomized Controlled Trial. Ophthalmology 2022; 129: 509–519.
73. Zaabaar E, Zhang XJ, Zhang Y, et al. Light exposure therapy for myopia control: a systematic review and Bayesian network meta-analysis. Br J Ophthalmol. Epub ahead of print 13 December 2023. DOI: 10.1136/bjo-2023-323798.
74. Amaral DC, Batista S, Dos Santos-Neto E, et al. Low-level red-light therapy for myopia control in children: A systematic review and meta-analysis. Clinics 2024; 79: 100375.
75. Chung K, Mohidin N, O'Leary DJ. Undercorrection of myopia enhances rather than inhibits myopia progression. Vision Res 2002; 42: 2555–2559.
76. Adler D, Millodot M. The possible effect of undercorrection on myopic progression in children. Clin Exp Optom 2006; 89: 315–321.
77. Gwiazda J, Hyman L, Hussein M, et al. A Randomized Clinical Trial of Progressive Addition Lenses versus Single Vision Lenses on the Progression of Myopia in Children. Invest Ophthalmol Vis Sci 2003; 44: 1492–1500.
78. Berntsen DA, Sinnott LT, Mutti DO, et al. A Randomized Trial Using Progressive Addition Lenses to Evaluate Theories of Myopia Progression in Children with a High Lag of Accommodation. Invest Ophthalmol Vis Sci 2012; 53: 640–649.
79. Ong E, Grice K, Held R, et al. Effects of Spectacle Intervention on the Progression of Myopia in Children. Optom Vis Sci 1999; 76: 363.
80. Walline JJ, Jones LA, Sinnott L, et al. A Randomized Trial of the Effect of Soft Contact Lenses on Myopia Progression in Children. Invest Ophthalmol Vis Sci 2008; 49: 4702–4706.
81. Walline JJ, Jones LA, Mutti DO, et al. A Randomized Trial of the Effects of Rigid Contact Lenses on MyopiaProgression. Arch Ophthalmol 2004; 122: 1760.
82. Bullimore MA, Brennan NA. Juvenile-onset myopia—who to treat and how to evaluate success. Eye 2024; 38: 450–454.
83. CW Klaver C, Polling JR, Group EMR. Myopia management in the Netherlands. Ophthalmic Physiol Opt 2020; 40: 230–240.
84. Sanz Diez P, Yang L-H, Lu M-X, et al. Growth curves of myopia-related parameters to clinically monitor the refractive development in Chinese schoolchildren. Graefes Arch Clin Exp Ophthalmol 2019; 257: 1045–1053.
85. Lee SS-Y, Lingham G, Sanfilippo PG, et al. Incidence and Progression of Myopia in Early Adulthood. JAMA Ophthalmol 2022; 140: 162–169.
86. Chamberlain P, Lazon de la Jara P, Arumugam B, et al. Axial length targets for myopia control. Ophthalmic Physiol Opt 2021; 41: 523–531.
87. The COMET Group. Myopia Stabilization and Associated Factors Among Participants in the Correction of Myopia Evaluation Trial (COMET). Invest Ophthalmol Vis Sci 2013; 54: 7871–7884.
88. Hou W, Norton TT, Hyman L, et al. Axial Elongation in Myopic Children and its Association With Myopia Progression in the Correction of Myopia Evaluation Trial. Eye Contact Lens 2018; 44: 248.

89. Lawrenson JG, Shah R, Huntjens B, et al. Interventions for myopia control in children: a living systematic review and network meta-analysis. Cochrane Database Syst Rev; 2023. Epub ahead of print 16 February 2023. DOI: 10.1002/14651858.CD014758.pub2.
90. Lee S-H, Tsai P-C, Chiu Y-C, et al. Myopia progression after cessation of atropine in children: a systematic review and meta-analysis. Front Pharmacol 2024; 15: 1343698.
91. Sánchez-Tena MÁ, Ballesteros-Sánchez A, Martinez-Perez C, et al. Assessing the rebound phenomenon in different myopia control treatments: A systematic review. Ophthalmic Physiol Opt 2024; 44: 270–279.
92. Chiu Y-C, Tsai P-C, Lee S-H, et al. Systematic Review of Myopia Progression after Cessation of Optical Interventions for Myopia Control. J Clin Med 2024; 13: 53.
93. Wolffsohn JS, Whayeb Y, Logan NS, et al. IMI—Global Trends in Myopia Management Attitudes and Strategies in Clinical Practice—2022 Update. Invest Ophthalmol Vis Sci 2023; 64: 6.
94. Delaying Treatment of Ocular Hypertension: The Ocular Hypertension Treatment Study. Arch Ophthalmol 2010; 128: 276–287.
95. Sankaridurg P, Berntsen DA, Bullimore MA, et al. IMI 2023 Digest. Invest Ophthalmol Vis Sci 2023; 64: 7.

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