Position Statement for Assessing and Managing Myopic Children in the United Arab Emirates

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Date of publication: February, 2026

Date for review: February, 2027

Financial support – No financial support was received for creating this position statement

Funding sources – Nil relevant

Aim: To outline an evidence-based approach to best practice for assessing and managing myopic children

Remit: For healthcare practitioners seeing myopic children in the United Arab Emirates, (UAE)

Uncertainties: Data gaps exist, and these will be highlighted as areas for further research. If possible, discretionary recommendations will be made.

Patient groups: Myopic children in the UAE

Inclusion/Exclusion criteria: Inclusion: All children presenting with myopic refractive error. Exclusion: Healthcare systems based outside of the UAE, where different pathways may exist.

Target audience: Paediatric ophthalmologists, General Ophthalmologists, Optometrists and Orthoptists

Settings: All healthcare facilities in the UAE where children are seen for refraction

Key Question to be addressed:

How should we be assessing, measuring and managing myopic children in the UAE?

Definitions

We have adopted the International Myopia Institute definitions (IMI)(1–3), and key definitions are summarised below:

Myopia: Spherical Equivalent Refraction is $\leq$ -0.50D when ocular accommodation is relaxed

High Myopia: Spherical Equivalent Refraction is $\leq$ -6.00D when ocular accommodation is relaxed

Pre-Myopia: A refractive state $\leq$+0.75D and >-0.50D in children where a combination of risk factors predicts future development of myopia and would merit preventative intervention.

Myopia Management: A comprehensive approach to myopia and pre-myopia that includes prevention, myopia risk assessment, early detection through screening, appropriate correction, lifestyle recommendations, interventions to reduce myopia progression and axial elongation, monitoring of refraction and axial length, and management of emerging myopia-related complications.

Myopia Control: The clinical application of evidence-based interventions specifically intended to slow the progression of myopia and axial elongation. Such interventions may also compensate for refractive errors (i.e., provide “myopia correction”). Myopia control constitutes one essential component within the broader scope of myopia management and should include monitoring of treatment efficacy. When describing a specific product in clinical communications, the term “myopia control” should only be applied to evidence-based interventions supported by clinical trials indicating efficacy in slowing myopia progression and/or axial elongation. Ideally, evidence for efficacy should include cycloplegic refraction and axial length data. For some interventions, such as orthokeratology, axial length alone is

appropriate. When used in product marketing, this should also be supported by regulatory approval.

Introduction

Myopia prevalence is increasing while age of onset is decreasing across the world(4). There is potential for significant burden of visual impairment from myopia-related complications in the future, particularly for those with high myopia (≤-6.00DS)(5–7). Myopia increases the risk of cataract, retinal detachment, glaucoma and myopic maculopathy. These complications are related to abnormal axial elongation, and greater elongation increases these risks(6,8).

Over the last decade we have seen a significant advance in interventions available for myopia management. These can be broadly categorised as optical and pharmaceutical interventions. Summaries of the interventions and their efficacy have been published(9–15).

Given the wide range of options available and the increasing levels of myopia, there is a need to increase awareness of myopia and myopia management amongst clinicians, parents and caregivers(16–19). However, equally, there is no standardised pathway to help practitioners manage these children when they present to clinic. Several helpful pathways have been put forward explaining the interventions available but none of these comprehensively explain the practicalities of assessing, beginning myopia management and follow-up for children using myopia management(20–22). There are no guidelines utilising well-established international criteria currently available. The aim of this position statement is to provide eye health professionals with an evidence-based pathway to help assess and manage children beginning and continuing myopia management interventions, whilst highlighting areas where further research is needed.

Who to Treat?

An argument has been made for only those children showing evidence of significant progression to be offered intervention(23). This is difficult to quantify and there is no agreed cut-off. However, almost all children progress and there is no link between age of onset and stabilisation(24). As such, younger patients would progress the most and have the most to gain. Moreover, recent studies have used myopia interventions in pre-myopia. Studies using low concentration atropine(25–28) and highly aspherical lenslets(29,30) have shown that intervening in pre-myopes, delays the onset of myopia. Given that evidence shows we can delay the onset of myopia it may be counterintuitive to await myopia progression before considering utilising the same interventions.

All children who have no secondary cause for myopia should be offered myopia management. Younger age of onset (<10 years), East Asian ethnicity and parental myopia are associated with faster progression(31–34). These children have the most to gain from a myopia management intervention. The possibility of secondary cause should be considered in young children who

present with high myopia (e.g., retinal dysfunction, spherophakia). Myopia management has not been studied in children with significant anisometropia and resultant amblyopia.

Recommendations:

All typical myopic children and their caregivers should be informed of myopia control options

All myopic children should have an individualised discussion explaining the advantages and disadvantage of myopia control interventions

What should we advise Children and Parents?

Environmental influences of Myopia

Increased time outdoors delays myopia onset. A minimum of one hour per day has been shown to reduce incidence(35,36), however, up-to 2 hours per day should be encouraged(37,38).

Near work distance and duration is linked to myopia progression. It is advisable to limit continuous near work (>30 minutes) and distance of near work (<30cm) to reduce the risks of myopia progression(39–43). At present, individual outcomes for environmental measures are not predictable.

Recommendations

Aim for time outdoors for *at least* 1-2 hours each day

Ensure there is good lighting when doing near work

Take a break from near work after 30 minutes

Ensure there is a minimum working distance of 30cm for near work

Initial Assessment

All children should undergo a detailed ophthalmic exam to exclude secondary causes of myopia prior to considering any myopia control intervention. This is especially important if myopia develops in pre-school children or if a child under 10 years develops high myopia ($\leq$6.00DS)(44) .

A baseline measure of refraction, (using cycloplegia at baseline is preferred), should be recorded alongside best corrected visual acuity (BCVA). A baseline assessment of amplitude of accommodation should be conducted. Ideally, all children should have a baseline measurement of their axial length and this should be used to monitor progression at 6 monthly intervals. The following, (box 1 and 2), shows a recommended assessment for myopic children and when to consider secondary causes. Those children considered to have a secondary cause for myopia should be investigated by a paediatric ophthalmologist. A

discussion on myopia control can form part of this discussion, although the evidence base for efficacy is still evolving and no recommendations can be reached at the present time.

Box 1: Recommended assessment for a myopic child

Assessment for Myopia Management
Risk factors: Age, Ethnicity, Parental myopia, Near work / Visual environment, Time outdoors
Refraction and BCVA
Accommodation assessment
Ocular health assessment (Box 2)
Pupil size (scotopic and photopic)
Additional investigations:
Axial length (*preferred*)
Corneal topography (if considering ortho-keratology or concerns regarding corneal ectasia)

Box 2: When to suspect secondary causes for myopia in children. (*Adapted from Flitcroft et al. with additions*(44))

High myopia (≤-6.00DS) in child under 10

or

Myopia greater than child's age in years **plus** any of the following:

- BCVA ≤0.2logMAR
- Nystagmus
- Nyctalopia
- Abnormal macula OCT
- Clinical features of retinal dystrophy
- Family history of visual impairment
- Hearing loss
- High astigmatism/inconsistent refraction
- Abnormal colour vision

Recommendations

All children should have a baseline assessment of risk factors for myopia

Preferably, all children should have an axial length measurement at baseline and follow-up

High myopia (≤-6.00DS) in a child under 10 should be investigated to exclude secondary causes

Interventions for Myopia Management

There are several options available to manage myopia. Broadly, these would either be an optical intervention (specialist spectacle lens or contact lens)(9) or a pharmaceutical intervention (low concentration atropine)(10). It is important to stress to families that such interventions are not a substitute for behavioural modifications, which should continue. Some of the interventions available are highlighted below:

Spectacle options for Myopia Control

Spectacles are classically worn to compensate for refractive error. Conveniently, we can adapt the lenses to offer myopia management and visual correction in a single device. Although they are generally very well tolerated, there may be a small risk of non-compliance and cosmetic concerns around visible lines and dots on the lens surface.

Table 1: A summary of frequently cited spectacle lens myopia control options.

Technology	Design
Defocus Incorporated Multiple Segments (DIMS) (45,46)	Clear central zone 9mm correcting distance refraction surrounded by multiple (approximately 400) segments (33 mm in diameter) having a relative positive power (+3.50 D)
Highly Aspherical Lenslets (HAL) (47,48)	Clear central zone for distance vision surrounded by contiguous lenslets (each 1.12mm diameter). 11 rings of lenslets with successive rings having different asphericities.
Cylindrical Annular Refractive Element (CARE)(49)	7-9mm clear central zone correcting refractive error, surrounded by cylindrical elements arranged in concentric rings 0.5mm apart. The cylindrical power is either +9.6D or +7.8D
Diffusion Optics Technology (DOT)(50,51)	Translucent microscopic diffusers measuring 0.14mm x 0.2mm spaced 0.365mm apart
Asymmetric Myopic Peripheral Defocus Lenses (MPDL)(52)	Clear 7mm oval central zone correcting refractive error surrounded by asymmetric peripheral defocus, with +1.8D and +1.5D (temporal and nasal areas) and +2.0D at the bottom of the lens.

At present, studies comparing these options are inconclusive(53–55). As such, we cannot recommend one design over another. Wearing time impacts response and it is important to fit a spectacle lens that has proven clinical evidence of myopia control. Importantly, the patient must be able to tolerate the design and wear spectacles comfortably.

It is unclear whether these options would be effective if a child has manifest strabismus and/or central suppression. The optical centration and visual axis would not be aligned, potentially reducing efficacy. We are not aware of any published studies that have examined this. In those children with intermittent exotropia, which is more common, there is evidence that spectacles for myopia control do not impact control of the deviation(56).

Recommendations:

All myopic children and their families should be informed of optical interventions available for myopia control

Soft Contact lenses for Myopia Control

Contact lenses offer spectacle independence and can be preferred for sport and recreational activities. However, this has to be mitigated against the low (2.7 per 10,000 patient-years) risks of microbial keratitis(57).

Table 2: Examples of soft contact lenses, cited for myopia control

Technology	Design
Dual focus contact lens(58)	Soft, daily disposable contact lens made with Omafilcon A. It has a central distance lens design with 2 'treatment zones' of +2.00DS defocus alternating with 2 distance zones.
Extended depth of focus(59)	Soft, daily disposable contact lens made with Etafilcon A. Centre-distance, extended depth of focus lens design with rapid increase in positive power, reaching +11D in the periphery.
Centre distance multifocal(60)	Soft, daily disposable contact lens made with Comfilcon A. A centre-distance design with continuous aspheric design and range of near add powers with +2.50D being used for myopia control

Recommendation

Children and their families should be offered myopia control contact lens options when considering spectacle independence for myopia control

Children and their families should be informed of the potential (although low) risk of microbial keratitis and informed of the need for urgent assessment if they have a painful red eye and how to access care

Orthokeratology for Myopia Control

Orthokeratology utilises overnight wear of reverse geometry (flat central and steep peripheral) rigid gas-permeable lenses to correct myopia by flattening the central cornea. This

is thought to cause peripheral myopic defocus(61,62), with some evidence for induced higher order aberrations and accommodative response(63). Children wear these lenses overnight and are *spectacle independent* in the daytime. There may be rebound progression(64,65) on cessation and there are low (13.9 per 10,000 patient years of wear) risks of microbial keratitis(66).

Recommendation

Children should be seen by an experienced practitioner who is trained in the assessment, fitting and follow-up of complex contact lens designs

Children and their families should be educated on the risks of rebound progression

Children and their families should be informed of the potential, (although low), risk of microbial keratitis and informed of the need for urgent assessment if they have a painful red eye

Low Concentration Atropine for Myopia Control

Atropine has been used to slow myopia for over 100 years(67). Higher concentrations of atropine have greater myopia control effect(10). However, higher concentrations have greater risks of intolerance due to pupillary dilation, (leading to photophobia and blur), and difficulty with near vision due to loss of accommodation. Additionally, withdrawing atropine can lead to rebound, (defined as progression beyond the mean for the child's age and ethnicity(65)), and this appears to be greater for younger children and higher concentrations of atropine(10).

As such, trials focussed on using lower concentrations of atropine to sustain a myopia control effect but mitigate against deleterious side effects(26,68). Following the Atropine for the Treatment of childhood Myopia (ATOM)(68) and Low concentration Atropine for Myopia Prevention (LAMP)(69) studies, several trials were launched to determine whether these findings could be repeated in non- East-Asian populations(70–74). These trials showed variable results, but were impacted significantly by the coronoavirus-19 pandemic and some children taking additional therapies(71,73,75). Overall, there was evidence of efficacy for low concentration atropine and this appeared greater for Caucasian sub-populations in the studies(71,73).

Presently, atropine is used in a range of low concentrations from 0.01% to 0.05%. Compounding atropine had been the only way to obtain low-concentration atropine. This is inconsistent and can lead to less than target concentrations of atropine administered(76). There is a need for a licensed and stable atropine preparation.

Following submissions from the STAR(77) study, atropine 0.01% (*Ryjunea*®) has received market authorisation for Europe(78). This becomes the first atropine licensed for myopia control in children in Europe and has the following indications:

Myopia -0.5D to -6.00D AND progressing by at least 0.50D per year prior to treatment AND age 3-14 years(78)***.***

Separately, atropine 0.025% (*Ryjusea*®) has received market approval in Japan(78). In India, atropine is licensed at 0.01% and 0.05% concentrations (*Myatro*®)(79).

It is unclear how to taper and stop atropine most effectively. However, measurements of axial length have been proposed as a target assessment and either reducing concentrations or frequency of administration to maintain control of axial elongation(80). Children should be monitored closely to mitigate the risk of rebound progression.

Box 3: A suggested algorithm for starting and monitoring atropine treatment

- Discuss risks/benefits of atropine therapy including rebound and need for long-term therapy
- Commence at lowest concentration that will balance efficacy and side effects
- Review with axial length measurements at 6 monthly intervals
- If axial elongation greater than mean for age and ethnicity, consider increasing concentration or combining with optical intervention

Box 4: A suggested algorithm for tapering and stopping atropine treatment

- Once axial elongation is $\leq$0.1mm/year discuss tapering treatment
- Discuss the risks of rebound versus continued treatment
- Taper treatment slowly, over a period of several months
- Either reduce concentration **or** reduce frequency of administration
- Monitor closely e.g. 2-3 months after initiating taper with repeat axial length measurements
- If evidence of rebound progression (greater axial elongation than mean for age and ethnicity) escalate treatment again
- If no evidence of rebound, continue taper

Recommendations

Practitioners should discuss licensed low-concentration atropine as an option for myopia control with children and their families

Children and their families should be informed of the risks of rebound and the need for long-term treatment

Potential side effects of photophobia and blurred near vision should be explained and mitigated against

Children should be monitored closely during withdrawal of atropine to detect rebound progression

Repeated Low-level Red Light (RLRL) Therapy

Several clinical trials have shown that repeated red light slows axial elongation(81–84). However, there are reports of adverse events, with reduction in foveal cone density and vision loss reported(85,86). Moreover, there appears to be rebound once treatment is stopped (84,87). The incidence of side effects from RLRL was 0.088 per 100 patient-years (95% CI: 0.02-0.50)(88). In China, devices are now required to meet class III laser safety requirements(89). Currently, there are no devices that meet this standard (90).

Recommendations

At present, RLRL therapy should not be offered as a first-line treatment for myopia control in children. Its use should remain restricted to research settings until further high-quality evidence on long-term safety and managing rebound is available

How to monitor a child using myopia control strategies?

Axial length charts for Myopia Management

Axial length plots have been developed to determine the risk of developing myopia and high myopia. These have been developed for children in the Netherlands(91), Germany(92), Northern Ireland(93), China(94,95) and India(96). Although these may be useful as an illustrative analysis for children and parents at an initial visit, there are limitations to their use as measures of treatment efficacy(97). Such charts combine myopic and non-myopic children and may not accurately reflect myopic eye growth. As such, annualised growth charts can be used to monitor treatment efficacy more effectively (98).

To know if a myopia control intervention is effective, we can utilise two outcomes. The first is to try and ensure that progression is less than the mean for the child's age and ethnicity (broadly classified as East Asian and Non-East Asian). The second, is to aim for emmetropic eye growth, which is the same for East Asian and Non-East Asian children (99). However, this is more difficult in East-Asian myopic children as they progress 40% faster than Non-East Asian Myopes(98). The following tables have been adapted from the literature to support clinicians in determining outcomes.

Table 1: The mean axial length elongation (for the subsequent year) for myopic children as a function of age and ethnicity(100)**:**

Age (years)	**East Asian**	**Non-East-**

	Ethnicity (mm)	Asian (mm)
6	0.71	0.51
7	0.61	0.44
8	0.52	0.37
9	0.44	0.32
10	0.38	0.27
11	0.32	0.23
12	0.28	0.20
13	0.24	0.17
14	0.20	0.15
15	0.17	0.12
16	0.15	0.11
17	0.13	0.09
18	0.11	0.08

Table 2: Expected emmetropic eye growth (mm/year) as a function of age and expected emmetropic axial length(99)

Age	Axial length (95% CI)	Annual growth (mm/year)
6	22.70 [22.57, 23.24]	0.24
7	22.94 [22.83, 23.31]	0.17
8	23.11 [23.02, 23.37]	0.13
9	23.24 [23.16, 23.43]	0.09
10	23.33 [23.25, 23.47]	0.07
11	23.40 [23.33, 23.51]	0.05
12	23.45 [23.38, 23.55]	0.04
13	23.49 [23.42, 23.58]	0.03
14	23.51 [23.45, 23.60]	0.02
15	23.54 [23.47, 23.62]	0.02
16	23.55 [23.48, 23.64]	0.01

Recommendations

Axial length charts show limited value when used to determine progression. However, they may provide contextual value in certain settings

Annualised growth for age and ethnicity is preferred, when determining treatment response over a 12-month period

Emmetropic eye growth values can be used to determine efficacy of a myopia control intervention

What to consider when treatment does not reach target growth?

Children should begin treatment on monotherapy (either optical or pharmaceutical) and monitor progression over 6-12 months. If there is excessive axial elongation then we can consider combining treatment. There is emerging evidence of increased effect when combining low concentration atropine with spectacle myopia control(101,102) and orthokeratology(103). However, at present we do not know who is most likely to respond or not respond to monotherapy. Therefore, starting with monotherapy and avoiding potential side-effects is advisable.

In those children who are at increased risk of developing high-myopia, combination therapy may be considered at the treatment outset. Currently, there is insufficient evidence to recommend this. It is not possible to determine response to monotherapy. Further, atropine therapy is needed for many years and there is a risk of rebound on cessation. These factors should be discussed with children and their caregivers, prior to a treatment decision being reached. An alternative approach would be to begin monotherapy and evaluate at 6-monthly intervals with repeat axial length measurements. Additional myopia control can be added if control is beyond the mean for age and ethnicity of the child.

Recommendations

If low concentration atropine or optical interventions are not reaching target levels of myopia control, combination treatment can be offered

<u>Future Needs</u>

There is a need to explore levels of myopia and progression rates in children in the United Arab Emirates. Further, we need to explore the efficacy of interventions used for myopia control in this population. Some children do not respond to myopia control interventions and understanding patient characteristics would help inform clinical decision-making. Additional areas of research would include combination versus monotherapy, at baseline, in those children at increased risk of developing high myopia. This will allow us to understand the burden of myopia and its control more precisely and allow us to plan interventions and strategies more effectively.

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