High Myopia: Reviews of myopia control strategies and myopia complications

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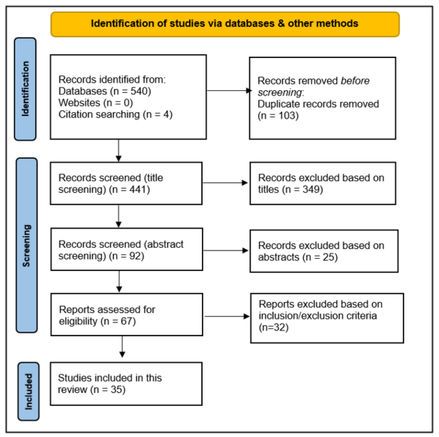
Background

- Myopia is defined as a condition in which the spherical equivalent refractive error (SER) of an eye is ≤-0.50D and high myopia where the spherical equivalent is ≤-5.00D[1] or ≤-6.00D[2] when ocular accommodation is relaxed. [2]
- Myopia and especially high myopia are recognised as major public health concerns because of the significant increase in the risk of vision impairment from associated pathology, especially in high myopia.
- Prevalence of high myopia in young children is low, but 10-20% of high school children in Asia have high myopia with many still progressing.[3;4]
- Most participants in myopia control studies have low and moderate myopia; relatively little is known about myopia control in high myopia.

Methods

- A comprehensive literature search was undertaken to identify publications in English investigating:
  - *AIM 1: The efficacy of myopia control strategies (environmental, pharmacological and optical) in highly myopic patients*
  - *AIM 2: The structural and pathological complications of high myopia*
- MEDLINE and Embase database searches completed on 15th September 2023 and updated on 20th May 2024.
- Outcomes included change in spherical equivalent refractive error (SE) and/or axial length (AL) to evaluate progression of high myopia.

Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram presenting the process of study identifications, screening and selection of relevant published papers



Results

- AIM 1: Twelve studies were identified that reported on the efficacy of optical and pharmacological (none on environmental) interventions for high myopia control summarised in the table

Myopia Control Strategy	Author Year	Sample size/Age/SE	Study type	Methods/ Treatment	Key findings
Atropine	Chou et al.1997	20 highly myopic children, ≤-6.00D in either eye	Prospective clinical effectiveness study	Effectiveness of 0.5% atropine in controlling high myopia in children	0.5% atropine is effective for slowing down myopic progression in highly myopic children.
Atropine	Fan et al. 2007	23 children with moderate & severe myopia	Prospective clinical effectiveness study	Safety & effectiveness of 1% atropine in retarding myopia progression in moderate & severely myopic patients	1% atropine is safe & effective in retarding myopia progression in moderate & severe myopes
Atropine	Polling et al.2016	77 children, up to 16 years. ≤− 3.00D & progression rate ≥1D/year	Prospective clinical effectiveness study	Role of 0.5% atropine in children with progressive myopia	0.5% atropine can be effective with sustained treatment effect on progressive high myopia, but with adverse events
	Polling et al.2020	124 children, 6-16 years <-2.50D in children <10 years or ≤− 5.00D in children >11 years & progression rate ≥1D/year	Prospective clinical effectiveness study	3-year follow-up study of 0.5% atropine in European children with progressive myopia	0.5% was associated with decreased progression in European children with or at risk of high myopia
Atropine	Agarwal et al.2022	60 children (37 eyes intervention arm, 23 eyes control arm), 6-16 years ≤-5.00D in either eye	Prospective non-randomised parallel group study	Role of 0.01% atropine in highly myopic children, India (RAMCOM Study)	Compared to no treatment, 0.01% atropine treatment had a marked effect on myopia progression in highly myopic children.
Optical Intervention (Spectacles)	Liu et al. 2023	10,477 children (3639 patients wearing DIMS, 6838 wearing SV spectacles); 6-16 years; Low myopia (0 to -2.875 D), moderate myopia (-3.00 to -5.875 D), and high myopia (> -5.875 D)	Retrospective analysis of records from diverse clinical settings	Effectiveness of Defocus Incorporated Multiple Segments Spectacle Lenses in slowing myopia progression	DIMS spectacle lenses: greater effectivity in younger patients with lower levels of myopia.
Optical Intervention (Spectacles)	Long et al.2023	180 children (90 wearing DIMS and 90 wearing SV); 6-15 years; -0.50D to -8.00D, ≥ -1.50DC	Retrospective study of 1-year longitudinal data	One year effectiveness of Defocus Incorporated Multiple Segment in Chinese Myopic Children	DIMS spectacle lens: reduced myopia progression in year 1 and effectivity increased with age, greater retardation in low myopia, not sufficient on their own in managing progression in high myopia.
Optical Intervention (Ortho-K)	Charm & Cho. 2013	28 participants; 8-11 years; SER <−5.75D, myopia <-5.00D	Prospective study	Control effect of partial reduction (PR) Ortho-K on axial length elongation in myopic children	PR Ortho-K slowed myopia progression in high myopia with 63% slower ALE in PR Ortho-K group compared to control group.
Optical Intervention (Ortho-K)	Zhu et al. 2014	65 children, 7-14 years; Low myopia (−3.00D < SER < −0.50D), moderate-myopia (−6.00D < SER ≤ −3.00D) and high myopia (SER ≤ −6.00D)	Retrospective study	Control effect of Ortho-K on axial length elongation in myopic children	Ortho-K is effective for reducing myopia progression in children with low, moderate and high myopia by approximately half compared to traditional spectacle lenses
Optical Intervention (Ortho-K)	Yu et al. 2020	65 children, 7-15 years; Moderate myopia in one eye (≤ −3.00 D, but > −6.00 D), high myopia in the other eye (≤ −6.00 D)	Retrospective study	The effect of orthokeratology on axial elongation in moderate and highly myopic fellow eyes	Ortho-K: equally effective in reducing myopia progression in moderately myopic and fellow highly myopic eyes. Axial elongation decreased at the same rate with increasing age irrespective of the baseline myopic refraction
Optical Intervention (Ortho-K)	Lyu et al.2020	102 highly myopic children; -6.00D to -8.75D, ≥ -1.50DC	Prospective study	Comparison of two different partial reduction Ortho-K regimens (targeting 6.00D and 4.00D) change in refractive error and axial length	Both target regimens similar effect in controlling AL and refractive error in children with high myopia. Ortho-K lenses, target reduction of 4.00D to treat high-myopia and any residual refractive error corrected with spectacles for safety reasons
Optical Intervention (Ortho-K)	Wang et al.2023	27 myopic adolescents, 10-17 years; -5.00D to -8.25D	Prospective, non-controlled, non-randomised, observational study	Axial length changes over 2 years of Ortho-K overnight lens wear combined with spectacle lenses	For myopic patients with a refraction <-5.00D, wearing Ortho-K lenses overnight and SV spectacle lenses to correct the residual refractive error during the day: good visual quality and have more myopic RPRE for potential myopia control.
Optical Intervention (Multifocal RGP)	Yu et al. 2023	77 children, 5-17 years ≤ − 6.00 D or baseline AL ≥ 26.50 mm with > −12.00 D	Prospective study	Efficacy of multifocal RGP contact lens is comparable to single vision spectacle lenses for highly myopic patients	Axial length increased at a similar rate in both the control (spectacles) and multifocal rigid gas-permeable lens groups: multifocal rigid gas-permeable lenses have no significant impact on controlling high myopia progression compared with spectacles

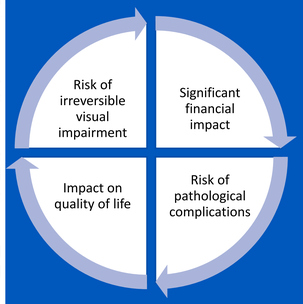
- All four studies using higher dose atropine (0.5 & 1%) found a substantial treatment effect at slowing myopia progression in highly myopic patients. However, there was a higher incidence of side effects and rebound effect on discontinuing therapy[5]
- Lower doses of atropine are less effective. Compared with no treatment, 0.01% atropine showed an effect at slowing myopic progression in highly myopic children. Lower doses had reduced side effects and reduced likelihood of a rebound effect.[5]
- Spectacle optical interventions had a lower efficacy in slowing myopia progression in highly myopic patients compared to moderate and low myopia.
- Ortho-K lenses were equally effective in reducing myopia progression in low, moderate and high myopia.

Discussion

- It is imperative for Eye Care Professionals to identify the key risk factors for high myopia (age and level of baseline myopia) to determine prognosis and necessity for myopia control.
- Five clinical effectiveness studies investigated the role of atropine in high myopia and progressive myopia with a statistically significant reduction in progression of myopia refractive error in high myopia with higher dose atropine (>0.5%).
- Four studies investigated the role of Ortho-K in high myopia. Although Ortho-K lenses are effective in slowing axial elongation for all levels of myopia, higher rates of corneal staining for higher levels of myopia could limit their use in these cases.
  - *Important to consider safety when fitting Ortho-K lenses in very young children*
- There are very few available myopia control strategies for patients with high myopia.
  - *One 'on-label' soft contact lens option for very high refractive error*
  - *Eye Care Professionals may be reluctant to use 'off-label' products*
- The need for effective myopia control interventions in high myopia and for children whose early onset myopia and/or rapid progression could be predictive of subsequent high myopia leads to consideration of different combination strategies for future work:
  - *Environmental + Pharmacological*
  - *Environmental + Optical (spectacle/contact lenses)*
  - *Pharmacological + Optical (spectacles/contact lenses)*
  - *Environmental + Pharmacological + Optical (spectacle/contact lenses)*
- AIM 2: Myopic patients have an increased risk of myopic macular degeneration, retinal detachment, cataract and glaucoma, with the risk increasing with level of myopia. [6]

Conclusions

- High myopia has significant financial impact, impact on quality of life, risk of pathological complications and a risk of irreversible visual impairment. [6]
- Young children, excluding those with syndromic associations, who are fast progressing moderate and high myopes require early intervention and close monitoring.
- In young children with early myopia onset, the aim should be to prevent high myopia through early intervention and treatment, monitoring myopia progression, increasing treatment dose and/or considering combination treatment.[6]
- Further research investigating the efficacy of myopia control strategies in highly myopic patients, both independently and through combination treatments are necessary. [6]



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Acknowledgements

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