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Interventions In Myopia Control Strategies For Children -A Narrative

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ABSTRACT

BACKGROUND

Myopia, a growing global health concern, is increasingly prevalent among children. Its progression can lead to many ocular complications, making effective control strategies essential. Thus, it is essential and urgent to put into practice efficient myopia control strategies, which may involve delaying the advancement of myopia in school-age children as well as avoiding its onset.

OBJECTIVE

This review aims to summarize recent advancements in myopia prevention and control strategies for school-aged children, focusing on clinical and lifestyle interventions.

METHODS

This review was conducted by a thorough search of academic resources such as Google Scholar, and PubMed, specific search terms like 'myopia,' 'myopia prevention,' 'school-aged children,' 'clinical trials,' 'atropine,' 'contact lenses,' 'orthokeratology,' and 'myopia progression.'

CONCLUSION

Combining pharmacological, optical, and behavioural interventions offers the best potential for managing progression. Recent advances highlight the importance of a multifaceted approaches to myopia control in children. Future research should focus on long-term safety, cost-effectiveness, and the development of individualized treatment protocols to optimize care for children with myopia.

KEYWORDS : Myopia, Lowdoseatropinecontrol, Defocus mechanisms, Orthokeratology, myopia control.

INTRODUCTION

Over the past three decades, the prevalence of axial myopia has risen significantly, particularly among younger populations worldwide. This trend is especially pronounced in East and Southeast Asia, where myopia affects 80–90% of secondary school students, compared to 20–40% in many Western countries and less than 5–10% in less developed regions⁽¹⁾. By 2050, it is estimated that half of the global population will be affected by myopia. The development of myopia is influenced by both genetic and environmental factors. However, the rapid rise in cases suggests that environmental factors, such as increased educational demands, prolonged screen use, reduced outdoor activities, and limited sunlight exposure, play a critical role. Early onset of myopia significantly increases the risk of progression to high myopia, which is associated with severe complications like myopic maculopathy, retinal detachment, and glaucoma. These complications can lead to permanent vision loss and significantly impact quality of life, as seen in countries like Japan and China⁽¹⁾. The association between myopia prevalence and parental myopia is well-established. Moreover, numerous twin-eye studies highlight the significance of genetic factors in the development of myopia. Researchers have explored various potential risk factors for myopia, including educational attainment, time spent on near work, accommodation and convergence functions, and outdoor activity levels. Various interventions have been proposed for myopia control in children, including high-dose atropine (1% or 0.5%), moderate-dose atropine (0.1%), low-dose atropine (0.01%), bifocal and progressive addition spectacle lenses, prismatic bifocal lenses, single-vision lenses (corrected and under-corrected), cyclopentolate, timolol, pirenzepine, orthokeratology, rigid gas-permeable and soft contact lenses, peripheral defocus-modifying contact and spectacle lenses, as well as strategies like increased outdoor activities⁽²⁾.

Recent clinical trials have shown that low-dose atropine eye drops, such as 0.01%, effectively slow myopia progression while causing significantly fewer side effects compared to higher-concentration formulations⁽³⁾. A spectacle lens designed for myopia control using the Myopic defocus mechanism, named the Defocus Incorporated Multiple Segments (DIMS) spectacle lens, was developed⁽⁴⁾. Repeated low-level red-light (RLRL) therapy is a promising treatment for myopia control, with no reported functional or structural damage⁽⁵⁾. Another comprehensive meta-analysis has evaluated the effects of various interventions, including eye drops, spectacles, and contact lenses, in children⁽⁶⁾.

METHODS

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REVIEW OF CURRENT STRATEGIES

Recent developments in myopia control for children have resulted in the creation of several strategies focused on preventing the condition and slowing its progression, with the aim of minimizing the risk of complications

like myopic maculopathy and optic neuropathy, which can lead to permanent vision loss. The following measures have been introduced.

- **Outdoor activities**

In recent years, significant research has explored the link between myopia and outdoor activities in school-aged children ⁽¹⁾. Outdoor time has been the only factor identified as protective in preventing the onset of myopia. However, its effectiveness in controlling progression in already myopic eyes remains inconclusive. While several theories, such as increased light exposure, dopamine release from the retina, and enhanced depth of field, have been proposed to explain the protective effect of outdoor time ⁽⁷⁾. Outdoor activities, particularly those that involve extended outside periods time of 2–3 h per day for schoolchildren, are crucial in preventing myopia in school-aged children ⁽¹⁾.

- **Reduced near work and screen time**

Over the past 20 years, electronic devices such as computers and smartphones have become integral to daily life, with many countries incorporating them into their educational systems. As a result, it is plausible to associate increased use of digital devices with more time spent indoors and engaging in near-work activities, which may raise the likelihood of myopia onset and progression in children ⁽¹⁾. Kim SJ et al study says that myopic students consumed significantly more smartphone data than their non-myopic peers, with an average of 1,130.71 MB per day compared to 613.63 MB. Although the total time spent using smartphones was similar between the two groups, myopia was found to be statistically linked to increased data usage, older age, and having more myopic parents ⁽⁸⁾. Langham G. Et al. reviewed the evidence supporting and opposing eight factors related to spending time outdoors includes brighter light, reduced peripheral defocus, higher vitamin D levels, different chromatic light spectra, increased physical activity, regulated circadian rhythms, less time spent on near work, and greater high spatial frequency (SF) energies ⁽⁹⁾.

- **Pharmacological interventions to control myopia progression in children**

Atropine eye drops, a nonselective muscarinic antagonist, have been used to treat myopia for several years. A recent Cochrane review ⁽¹⁰⁾ found that, after one year, children who were given atropine eye drops, pirenzepine gel, or cyclopentolate eye drops showed a significant slowdown in the progression of myopic refractive error compared to those who received placebo eye drops ⁽¹⁾. Atropine is the only medication that has been demonstrated to be consistently effective in slowing myopic progression. After myopia develops in a child, the progression rate is estimated to be approximately –1 D per year in East Asian populations and around –0.5 D per year in Caucasian populations. Higher concentrations of atropine, such as 1% or 0.5%, have proven highly effective in slowing myopia progression. However, the high incidence of photophobia as a side effect (affecting up to 100% of users) has led to significant dropout rates, ranging from 16% to 58%. Recent studies from Asia have demonstrated the effectiveness of 0.01% atropine in controlling myopia, with significantly lower rates of side effects. This has reignited interest in its clinical use for myopia management. The precise mechanism of

action for topical atropine remains unclear, though it is hypothesized to involve the up regulation and down regulation of retinal and scleral muscarinic receptors, affecting the scleral matrix.

- Atropine has been shown to prevent myopia development in both mammalian and avian eyes. Unlike mammals, avian eyes have striated ciliary muscles controlled by nicotinic rather than muscarinic receptors. This suggests that atropine may act at lower doses via M1/M4 receptors in the retina rather than through the accommodation system. Additionally, atropine's direct impact on scleral fibroblasts could also play a role in its effectiveness⁽³⁾.

- **Optical interventions to control myopia in children**

Studies on optical under-correction of myopia have produced mixed results, suggesting it either had no impact or may have accelerated myopia progression. Research suggests that peripheral myopic defocus may be beneficial, as shown in studies comparing children wearing progressive addition lenses to those using single-vision lenses. Bifocal spectacles have shown promise in slowing myopia progression, particularly in children with an annual progression rate of at least 0.50 D over three years. Prismatic bifocals appear especially effective for children with minimal accommodative lag, offering a targeted myopia management approach. Three key optical interventions include⁽¹⁾:

1. Defocus Incorporated Multiple Segments (DIMS) eyeglasses:

Several years ago developed a concentric dual-power soft contact lens, known as the Defocus Incorporated Soft Contact (DISC) lens, for myopia control. This lens imposes myopic defocus (MD) on both the central and peripheral retinas. Clinical trials demonstrated that DISC lens wear reduced myopia progression in schoolchildren by 25% over two years compared to single-vision (SV) contact lenses, and by 60% in children who wore the lenses for more than 8 hours per day. Building on this concept, we have now designed the Defocus Incorporated Multiple Segments (DIMS) spectacle lens, which delivers the same optical stimulus as the DISC lens but without the limitations associated with contact lens use. This study aims to know the effectiveness of DIMS lenses in slowing myopia progression in schoolchildren⁽⁴⁾.

2. Dual-focus soft contact lenses with concentric zones to correct vision and induce myopic defocus:

In recent years, soft contact lenses have gained significant attention as a strategy to slow myopia progression. Soft multifocal contact lenses are designed to enhance visual acuity and reduce ocular growth by focusing some light directly on the retina and some in front of it. Multiple randomized controlled trials have evaluated their effectiveness, revealing an average reduction in myopia progression by 36.4% and axial elongation by 37.9 %⁽¹⁾.

3. Orthokeratology (OK) contact lenses, which reshape the cornea overnight to correct vision temporarily.

Axial elongation and myopia progression has become a critical public health concern. Orthokeratology (OrthoK), originally prescribed to temporarily correct refractive errors, has been shown to significantly slow axial elongation and myopia progression in children. The efficacy, benefits, and risks of OrthoK for managing myopia in children, comparing it to other interventions. It also explores factors such as patient suitability, its impact on vision-related quality of life, and the potential benefits of combining OrthoK with pharmaceutical

treatments. When precisely fitted, closely monitored, and accompanied by proper lens cleaning and disinfection practices, OrthoK is a safe and effective approach for controlling axial elongation in children⁽¹¹⁾.

The use of repeated low-level red-light (RLRL) therapy for myopia control in children. The approach involves delivering 650 nm red light directly to the retina in brief, repeated sessions, leveraging its established safety profile from widespread use in amblyopia treatment in China. Anecdotal evidence from amblyopia treatments suggested benefits such as increased choroidal thickness, enhanced blood flow, and stabilized axial elongation. A recent study also demonstrated that a similar device significantly reduced myopia progression and axial elongation over six months, achieving outcomes comparable to orthokeratology when compared with single-vision spectacle wear and safety of RLRL therapy for managing myopia in children.

DISCUSSIONS:

The rising prevalence of myopia in children has prompted significant research into strategies to slow its progression and minimize future ocular risks. This review explores advancements in optical, pharmaceutical, and behavioural approaches, offering insights into current myopia management methods. Advancements in optical devices, including orthokeratology (OrthoK) lenses, defocus-incorporated multiple segments (DIMS) spectacle lenses, and dual-focus soft contact lenses, have shown effectiveness in slowing axial elongation. OrthoK provides outcomes similar to low-dose atropine while offering the added benefit of temporary refractive error correction. Meanwhile, DIMS lenses and other myopia control spectacles present a non-invasive option, particularly suitable for younger children or those unable to use contact lenses. Nevertheless, challenges such as patient compliance and adaptation to these optical solutions require continued focus. Additionally, advancements in imaging and diagnostic technologies could facilitate earlier detection and personalized treatments for children at high risk of myopia. Further investigation into the mechanisms underlying myopia progression will be crucial in shaping the development of next-generation therapeutic approaches.

CONCLUSION

Current approaches in managing myopia progression highlight the effectiveness of pharmacological options like atropine eye drops. Despite notable progress, challenges persist in optimizing treatment regimens and understanding their long-term effects. Future research should aim to enhance these strategies and explore innovative solutions to address the global impact of myopia. Expanding knowledge in this area will contribute to better clinical practices and improved outcomes for patients.

REFERENCES

1. Tariq F, Mobeen R, Wang X, Lin X, Bao Q, Liu J, Gao H. Advances in myopia prevention strategies for school-aged children: a comprehensive review. *Front Public Health*. 2023 Aug 15;11:1226438. Doi: 10.3389/fpubh.2023.1226438. PMID: 37655278; PMCID: PMC10466414.
2. Wnękowicz-Augustyn E, Teper S, Wylęgała E. Preventing the Progression of Myopia in Children-A Review of the Past Decade. *Medicina (Kaunas)*. 2023 Oct 19;59(10):1859. Doi: 10.3390/medicina59101859. PMID: 37893579; PMCID: PMC10608552.
3. Wu PC, Chuang MN, Choi J, Chen H, Wu G, Ohno-Matsui K, Jonas JB, Cheung CMG. Update in myopia and treatment strategy of atropine use in myopia control. *Eye (Lond)*. 2019 Jan;33(1):3-13. Doi: 10.1038/s41433-018-0139-7. Epub 2018 Jun 11. PMID: 29891900; PMCID: PMC6328548.
4. Lam CSY, Tang WC, Tse DY, Lee RPK, Chun RKM, Hasegawa K, Qi H, Hatanaka T, To CH. Defocus Incorporated Multiple Segments (DIMS) spectacle lenses slow myopia progression: a 2-year randomised clinical trial. *Br J Ophthalmol*. 2020 Mar;104(3):363-368. Doi: 10.1136/bjophthalmol-2018-313739. Epub 2019 May 29. PMID: 31142465; PMCID: PMC7041503.
5. Dong J, Zhu Z, Xu H, He M. Myopia Control Effect of Repeated Low-Level Red-Light Therapy in Chinese Children: A Randomized, Double-Blind, Controlled Clinical Trial. *Ophthalmology*. 2023 Feb;130(2):198-204. Doi: 10.1016/j.optha.2022.08.024. Epub 2022 Aug 29. PMID: 36049646.
6. Ha A, Kim SJ, Shim SR, Kim YK, Jung JH. Efficacy and Safety of 8 Atropine Concentrations for Myopia Control in Children: A Network Meta-Analysis. *Ophthalmology*. 2022 Mar;129(3):322-333. Doi: 10.1016/j.optha.2021.10.016. Epub 2021 Oct 22. PMID: 34688698.
7. Xiong S, Sankaridurg P, Naduvilath T, Zang J, Zou H, Zhu J, Lv M, He X, Xu X. Time spent in outdoor activities in relation to myopia prevention and control: a meta-analysis and systematic review. *Acta Ophthalmol*. 2017 Sep;95(6):551-566. Doi: 10.1111/aos.13403. Epub 2017 Mar 2. PMID: 28251836; PMCID: PMC5599950.
8. Mccrann S, Loughman J, Butler JS, Paudel N, Flitcroft DI. Smartphone use as a possible risk factor for myopia. *Clin Exp Optom*. 2021 Jan;104(1):35-41. Doi: 10.1111/cxo.13092. PMID: 32452059.
9. Lingham G, Mackey DA, Lucas R, Yazar S. How does spending time outdoors protect against myopia? A review. *Br J Ophthalmol*. 2020 May;104(5):593-599. Doi: 10.1136/bjophthalmol-2019-314675. Epub 2019 Nov 13. PMID: 31722876.
10. Walline, JJ, Lindsley, K, Vedula, SS, Cotter, SA, Mutti, DO, Twelker, JD, et al. Interventions to slow progression of myopia in children. *Cochrane Database Syst Rev*. (2011) 1:CD004916. Doi: 10.1002/14651858.CD004916.pub3
11. Lipson MJ. The Role of Orthokeratology in Myopia Management. *Eye Contact Lens*. 2022 May 1;48(5):189-193. Doi: 10.1097/ICL.0000000000000890. Epub 2022 Mar 24. PMID: 35333801.