Review Article

Management of myopia: a mini-review

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ABSTRACT

Background: Myopia is becoming more common in many populations worldwide, particularly in East Asia. It is primarily driven by axial elongation, a structural change associated with increased risks of myopic maculopathy, retinal detachment, glaucoma, and cataracts. The expanding range of myopia-control options can make treatment selection and management decisions more challenging in routine pediatric care. This narrative review synthesizes contemporary evidence and guidance for delaying myopia onset and slowing progression in children.

Methods: A targeted, non-systematic search was conducted in PubMed/MEDLINE, Embase, and the Cochrane Library for English-language records published between January 2015 and July 2025, supplemented by the inclusion of seminal pre-2015 trials. Eligible records included randomized or comparative clinical studies, systematic reviews/meta-analyses, and professional consensus/guideline statements in participants < 18 years reporting spherical equivalent refraction and/or axial length (AL). Non-comparative studies were included to provide additional information on safety, including adverse events. Findings were synthesized and presented using a narrative approach.

Results: The evidence reviewed indicated that increased outdoor time consistently reduced incident myopia and modestly slowed progression, supporting the adoption of low-cost prevention strategies. Associations between near work and digital exposure and myopia were less consistent, though moderation in these activities remains advisable. Optical interventions showed consistent efficacy compared to single-vision correction, with strong evidence for defocus incorporated multiple segments (DIMS) lens with highly aspherical lenslet technology spectacles, and dual-focus/high-add soft contact lenses. Safety was generally favorable, although contact lens wear requires infection-risk mitigation. Orthokeratology was effective in slowing AL but requires specialist fitting and structured follow-up, and may be followed by rebound after cessation. Atropine showed a concentration-dependent effect; 0.01% atropine produced inconsistent AL benefit in several non-Asian trials, but longer-term European data suggest a cumulative advantage with continued 0.01% treatment versus placebo. Repeated low-level red-light therapy reduced axial elongation in early trials but was limited by protocol heterogeneity, rebound, and uncertainty regarding long-term safety. Combination regimens (notably orthokeratology plus low-dose atropine and DIMS plus atropine) may provide additional slowing of AL, particularly in children with faster progression.

Conclusions: Evidence supports a risk-stratified pathway integrating outdoor time with effective optical and/or pharmacological therapy. Future research should prioritize head-to-head comparative trials with standardized AL endpoints, longer follow-up, inclusion of more diverse populations, validated treatment cessation strategies, and independent safety and performance standards for light-based devices.

KEYWORDS

myopia, clinical progression, axial length, ocular refraction, disease management, children

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INTRODUCTION

Myopia, also known as near-sightedness or shortsightedness, is a refractive error in which parallel rays of light entering the eye are focused anterior to the retina, most often because of excessive axial elongation, producing blurred distance vision [1, 2]. Myopia is classified according to the spherical equivalent refractive (SER) error under relaxed ocular accommodation [1]. A SER ≤ −0.50 D is defined as myopia, with low myopia ranging from SER ≤ −0.50 to > −6.00 D and high myopia classified as SER ≤ −6.00 D. In addition, the concept of pre-myopia has been introduced to describe a refractive state between ≤ +0.75 D and > −0.50 D in children, where baseline refraction, age, and other quantifiable risk factors provide a sufficiently high probability of developing myopia to merit early preventive interventions. High myopia increases the risk of myopic macular degeneration, rhegmatogenous retinal detachment, open angle glaucoma, and cataracts, with risk rising as axial length (AL) and myopic magnitude increase, but elevated risk remains even at low or moderate levels of myopia [3]. Importantly, sight-threatening myopic maculopathy can begin in childhood [4].

The prevalence of myopia is rapidly increasing globally, with significant variations influenced by geography, urbanization, and lifestyle. In East and Southeast Asia, up to 90% of high school graduates are myopic, with 10–20% progressing to high myopia [5–8]. Longitudinal data from China indicate that severe myopia prevalence increased from 7.9% to 16.6% over 15 years in urban youth [9]. Similar upward trends, though from lower baselines, are observed in the Western hemisphere, including the United States, Australia, and some European countries [5–7].

The treatment landscape for myopia is evolving rapidly, with novel technologies, emerging modalities, long-term datasets, systematic reviews, and meta-analyses regularly entering the peer-reviewed literature pool [10–13]. While this expanding evidence base is promising for patients, it may be challenging for physicians when making informed treatment decisions [14].

This narrative review provides an updated overview of current strategies for the management of myopia, emphasizing evidence-based interventions to slow progression and their mechanisms of action, clinical effectiveness, and practical considerations for implementation in pediatric populations. Drawing on selected recent publications, with particular focus on modalities most prescribed in European clinical practice, the review aims to equip practicing physicians with up-to-date information to support informed decision-making and optimize outcomes for children with myopia.

METHODS

This mini-review was conducted as a targeted, non-systematic narrative synthesis of contemporary evidence on interventions intended to delay myopia onset and/or slow progression in pediatric populations. The scope encompassed behavioral/environmental measures, optical interventions (spectacles, soft contact lenses, and orthokeratology), pharmacological therapy (atropine), emerging light-based approaches (repeated low-level red light [RLRL]), and combination regimens, together with guidelines relevant to clinical decision-making in routine practice.

A focused search was performed in PubMed/MEDLINE, Embase, and the Cochrane Library to identify English-language records published between 2015 and 2025, supplemented by the inclusion of seminal pre-2015 trials. Key terms included myopia control or progression in pediatric populations, with an emphasis on refractive and biometric outcomes (SER and AL) and major intervention modalities, including optical, pharmacological, behavioral, and light-based therapies. Records were considered eligible if they included participants aged < 18 years (or provided separable pediatric data) and SER or AL as outcomes. Types of articles included were randomized control trials (RCTs) or other comparative clinical studies, systematic reviews and meta-analyses, and professional consensus statements, guidelines, or position papers. Given the focus on clinical translation, non-comparative studies and case reports/series were not used to estimate comparative efficacy but were eligible for inclusion when they provided clinically relevant safety information, tolerability information, device-related concerns, or post-cessation (rebound) observations. Records were excluded if they enrolled adults only (≥ 18 years) without extractable pediatric outcomes, addressed refractive surgery performed solely for optical correction (rather than for management of myopia progression or its complications), or were conducted in animal models.

The following information was extracted qualitatively from included sources: study design and setting; participant age range and baseline refractive status; intervention characteristics; comparator(s); follow-up duration; and key efficacy and safety outcomes.

RESULTS and DISCUSSION

A brief overview of treatment options for myopia management

Available interventions for myopia management include behavioral, optical, pharmacological, and emerging therapies, with some treatment combinations providing enhanced efficacy [12, 13, 15–17].

Behavioral interventions remain a first-line strategy for clinicians to reduce myopia onset. Increasing time outdoors has been consistently associated with a lower risk of myopia development, possibly due to exposure to higher light intensity and beneficial spectral composition of sunlight. School-based interventions promoting outdoor time have shown preventive benefits, although implementation remains inconsistent across geographical regions [18]. Early intervention is critical, and increased outdoor time can effectively reduce both the onset and refractive error progression in pre-myopic children [19–22]. Outdoor programs are practical and non-invasive, offering a scalable approach to myopia prevention in school-aged populations [23, 24]. In contrast, evidence regarding the role of near work and screen time is less conclusive; nevertheless, recommendations to limit excessive near work and to reduce digital screen use are commonly advised as part of lifestyle-based management [14, 25].

Several optical interventions have shown effectiveness in controlling myopia progression. Multifocal and concentric ring bifocal soft contact lenses (SCL) are effective in modulating axial elongation, with recent data showing no treatment rebound on discontinuation [26]. However, their use in children requires careful consideration due to the associated risk of microbial keratitis. Orthokeratology (Ortho-K), involving overnight wear of rigid gas-permeable lenses to temporarily reshape the cornea, has demonstrated significant efficacy in slowing myopia progression [11, 27–30], although issues with intolerance and higher risk of infection limit widespread use [31, 32]. In addition, myopia-control spectacles, particularly defocus-incorporated designs such as multifocal and peripheral plus lenses, are shown to significantly slow myopic progression [33]. Several novel spectacle lens technologies are emerging in this field, but long-term data are still needed to establish their sustained safety and efficacy. Common terms used to describe current spectacle lens technologies in myopia management include cylindrical annular refractive elements (CARE), defocus incorporated multiple segments (DIMS), diffusion optics technology (DOT), highly aspherical lenslet technology (HAL), progressive-addition lens (PAL), peripheral-defocus modifying spectacle lenses (PDMSL), and peripheral-plus spectacle lenses (PPSL) [15, 33–45].

Pharmacological interventions for myopia control are primarily centered on the use of atropine eye drops. High-dose atropine (≥ 0.5%) is shown to provide moderate efficacy in reducing both myopia progression and axial elongation, while medium- (0.1% to < 0.5%) and low-dose atropine (< 0.1%) exhibit varying levels of effectiveness, with notable differences between Asian and non-Asian populations [15, 17, 46]. Recent developments suggest that novel delivery vehicles, such as deuterated water, may further enhance the efficacy of low-dose atropine [46]. In addition to atropine, other pharmacological agents, including pirenzepine and 7-methylxanthine, are under investigation; however, current clinical evidence supporting their effectiveness remains limited [14, 47–51].

Among novel treatment approaches, RLRL therapy has recently gained attention as non-invasive treatment showing promising results in slowing myopia progression in early clinical studies. Despite these encouraging findings, the long-term safety profile and sustained effectiveness of RLRL remain to be fully validated through larger, longitudinal trials. In contrast, surgical interventions are primarily corrective rather than preventive and are reserved for advanced stages of myopia. These procedures aim to manage complications such as retinal detachment and myopic maculopathy [16], rather than directly addressing myopia progression itself.

Current guidance in myopia management

Several professional societies and expert groups have developed broad guidance on the use of myopia-control interventions, yet a unified consensus on a holistic management approach is still lacking. The European Society of Ophthalmology has proposed a consensus algorithm outlining a tiered strategy: at the primary prevention level, lifestyle advice is recommended for all at-risk children to delay onset; at the secondary level, screening and monitoring of pre-myopia in children under 6 years is emphasized to identify early risk signs [52]. Once progression is confirmed, the algorithm suggests an escalation pathway beginning with defocus spectacles, followed by atropine or Ortho-K, depending on severity, compliance, and risk profile. The European Society of Ophthalmology statement also acknowledges RLRL therapy as a promising, albeit insufficiently validated modality in European trials [52].

The UK & Ireland Modified Delphi Consensus recommends PPSL or specially designed contact lenses as first-line options, with low-dose atropine to be considered once it becomes commercially available in Europe [34]. Lifestyle

advice, particularly encouraging at least 2 hours/day of outdoor time, is also recommended, although evidence on near-work distance and lighting is regarded as insufficient to support formal guidance [34]. The consensus also highlights the importance of equitable access and the reduction of financial barriers to care [34].

At the international level, the World Society of Paediatric Ophthalmology and Strabismus (WSPOS) issued its 2025 Myopia Consensus Statement, which categorized interventions into those that "appear to work" and those that "do not work, or have minimal effect" [35]. Effective strategies included myopia defocus spectacle lenses (e.g., DIMS, HAL), soft dual-focus or high add multifocal contact lenses, Ortho-K, low-dose atropine, increased time outdoors, and reduced near-work intensity [35]. In contrast, interventions such as undercorrection of myopia, pinhole glasses, blue light-blocking spectacles, standard bifocals and PALs, earlier generations of "peripheral defocus" aspheric spectacle designs (as opposed to benefits seen with newer DIMS/HAL designs), single-vision soft contact lenses, and rigid gas permeable lenses were found to be ineffective or minimally effective [35].

Three recent studies in Europe offer insight into current practice for pediatric myopia management. Outdoor time was prescribed most commonly, with low-dose atropine, then SCL and a range of myopia-control spectacles preferred over medium-dose atropine, RLRL, or high-dose atropine [14, 53, 54].

A recent review used qualitative visualization to compare myopia-control modalities by estimated effectiveness, cost, evidence strength, and adverse-event profiles. The rapid expansion of optical, pharmacological, and behavioral options, along with varying guidance between regions, has complicated evidence synthesis. Concise, evidence-based summaries are needed to guide clinicians' decision-making and support individualized, patient-centered care [15].

Myopia intervention: Current evidence and understanding

Behavioral interventions

Increased outdoor time and activity

Spending more time outdoors, particularly in sunlight, has consistently shown to protect against incident myopia and to modestly slow its progression, independent of near-work load, parental myopia, or ethnicity [20, 55, 56]. A meta-analysis of RCTs showed a 24% relative reduction in incident myopia (risk ratio 0.76, 95% confidence interval [CI] 0.67–0.87) and a mean SER benefit of 0.15 D, indicating that outdoor time contributes to prevention of myopia [55]. In a school-based RCT in China, adding approximately 40 minutes of outdoor time per school day reduced myopia onset compared with the usual school curriculum [24]. A subsequent large cluster RCT with objective monitoring (wearable sensors) found that an additional 40 minutes of outdoor time per school day decreased incidence by 16% compared to controls (incidence risk ratio [IRR] 0.84, 95% CI 0.72–0.99) [19]. At a policy level, a Taiwan program mandating at least 80 minutes of outdoor time during school hours was associated with reduced incidence and slower myopic shift, with benefits most apparent among children who were not myopic at baseline [18]. Evidence suggests that light exposure and natural illumination, rather than physical activity, are the key beneficial elements in myopia prevention [56, 57]. Proposed mechanisms remain under study; higher ambient light intensity and the spectral composition of daylight are hypothesized to modulate ocular growth signaling, with experimental work in primates indicating that long wavelength exposure may counteract myopic shifts [56, 58–60]. Overall, the evidence supports recommending increased outdoor time, at least 40 minutes per school day, and up to 80 minutes where feasible, to reduce myopia onset and myopia progression, with the greatest benefit in pre-myopic children [18, 19, 24, 55].

However, a recent study suggests that while the protective effects of increased time outdoors are strongest in children with hyperopia, the benefit for pre-myopic children appears more limited and may require longer durations outdoors [61]. Nonetheless, given the broader health and developmental advantages, increasing outdoor time remains advisable for all children, ideally in combination with other preventive interventions such as low-dose atropine or red-light therapy [61]. Implementation can occur both in schools and at home; large-scale programs adding 40–80 additional minutes outdoors daily have been feasible, though adherence can be influenced by academic pressures and seasonal factors [18, 19, 62]. Outdoor time is broadly accessible and largely cost-neutral, though routine eye and skin protection from sunlight should be encouraged [62].

Monitoring and reducing near-work time

Near work, including sustained use of smartphones and computer screens, has emerged as a modifiable behavioral factor associated with childhood myopia [63]. The COVID-19 period has been identified as particularly important in amplifying exposure to prolonged indoor screen-based activities. In a Hong Kong cohort, mean (standard deviation [SD]) daily screen time increased in children from 2.45 (2.32) to 6.89 (4.42) hours [64]. In a population-based cohort of 5074 children born in Rotterdam, the Netherlands between 2002 and 2006, greater near-work load was associated with

increased risk of myopia by age 9 [65]. Both studies also documented reductions in outdoor time alongside with increased screen exposure.

The association between increased digital screen use and greater risk of myopia suggests that reducing near work may represent a feasible preventive strategy, achievable at home and in schools [63, 66]. However, assessment of near work lacks standardization and objective definitions of "dose" (duration, continuity, and viewing distance) that can reliably predict clinically meaningful refractive or axial changes. As a result, no formal guidelines currently exist regarding the extent to which near work and screen time should be modified [25]. Public health and school-based initiatives in mainland China have begun piloting restrictions on screen time as part of broader myopia-mitigation programs [62]. To enable more precise exposure characterization, wearable sensors that log viewing distance and near-task duration are being trialed [25]. Near-work reduction carries negligible risk and is cost-free unless monitoring hardware is employed, making it an attractive adjunct to established interventions [62].

Optical interventions

Soft contact lenses

SCL are widely employed for pediatric myopia management and include multifocal designs as well as purpose-built myopia-control lenses [67]. There is an expanding evidence base demonstrating that SCL produce clinically meaningful reduction of myopia progression and axial elongation compared with single-vision lenses [10, 68–70]. A recent systematic review of RTCs (2019–2021) estimated a pooled mean difference in myopic progression of 0.39 D (95% CI 0.21–0.56) in favor of SCL [10]. Meta-analytic evidence from studies of concentric ring bifocal and peripheral-add multifocal SCL further supports SCL as a viable intervention for myopia control [68, 71]. The efficacy of myopia control with SCL appears to be dependent on lens optical profile and is demonstrable in children with documented progression. In a 1-year RCT, distance center bifocal soft lenses significantly reduced cycloplegic SER progression and axial elongation versus single-vision soft lenses [72]. Similarly, in a 2-year prospective clinical study, a soft radial refractive gradient lens designed to impose progressively increasing peripheral plus power (reaching approximately +6.00 D at the edge of the optical zone) reduced myopia progression and axial elongation compared with single-vision spectacle controls [73]. Contralateral eye study data show two distinct myopia-control SCL designs delaying progression relative to single-vision lenses [74]. Independent trials from Spain and Malaysia demonstrated comparable slowing of myopia progression with other proprietary SCL, supporting generalizability of this intervention across settings [75, 76]. The Bifocal Lenses In Nearsighted Kids (BLINK) study reported a 36% decrease in axial elongation and a 43% decrease in myopia progression over a 3-year period with a +2.50 D lens [77]. Durability of effect has been evidenced for certain daily disposable dual-focus lenses over a 7-year period [78].

Minimal or no myopia rebound effect has been seen with optical interventions, which is a potential advantage over RLRL, Ortho-K, and pharmaceutical interventions [26]. Adherence to use of SCL is important in optimizing outcomes [70]. While generally well tolerated in children, SCL carry risks such as lens intolerance and infective keratitis, which must be minimized through strict hygiene practices and carefully selected wear schedules [79]. Evidence supports myopia-control SCL as an effective intervention for myopia control in school-age children. The magnitude of the benefit appears to depend on lens design, wear behavior, and adherence, with safety best optimized by daily disposable wear and strict hygiene practices [10, 68–70, 75, 76, 79]. Nevertheless, important knowledge gaps persist, including understanding the variability in exposure metrics (e.g., daily wear time and replacement schedule) and a lack of head-to-head trials comparing refractive and axial outcomes across competing SCL designs [10, 69, 70].

Orthokeratology

Ortho-K are rigid gas permeable lenses worn overnight to temporarily reshape the cornea, providing unaided daytime vision while slowing axial elongation and myopia progression [27, 80]. Modern designs commonly incorporate a central optic zone that flattens the central cornea for refractive correction, a steeper reverse zone, an alignment zone that promotes centration, and a peripheral zone to complete the treatment geometry [80]. The mechanistic hypothesis for the benefit of Ortho-K is that the post-treatment corneal profile imposes relative peripheral myopic defocus that modulates ocular growth, although the precise biological pathways remain incompletely defined [27, 80].

Studies have shown that Ortho-K consistently reduces myopia progression compared with single-vision lenses, with meta-analyses reporting relative reductions of approximately 30–60% over 1–2 years [11, 27–30]. Pooled quantitative estimates show AL benefits of 0.27 mm at 2 years (approximately 45% relative reduction), indicating a moderate but clinically meaningful attenuation of ocular elongation [11, 30]. Recent RCTs evaluating newer lens

architectures, including modified base curves, novel materials (Myopia Control Efficacy and Long-Term Safety of a Novel Orthokeratology Lens [MESOK]) and altered treatment zone geometry (Variation of Orthokeratology Lens Treatment Zone [VOLTZ]) provide additional evidence of efficacy over 12–24 months [81–83]. Effectiveness may diminish with longer treatment duration, and clinically important "rebound" in AL has been observed when Ortho-K is discontinued abruptly, especially if cessation occurs before age 14 [84]. Clinical response appears influenced by ocular characteristics; larger pupils have been associated with stronger Ortho-K-based myopia-control effects, and concurrent astigmatism may blunt treatment efficacy [27].

Safety considerations are important to consider with Ortho-K prescribing in children [27, 31, 32]. Corneal staining is the most common sign during Ortho-K wear and is related to overnight lens wear and modifiable factors such as lens fit, handling, and hygiene practices [27, 31]. From a practical perspective, Ortho-K requires specialized fitting and structured aftercare, with higher costs and care intensity compared to other alternatives [27, 52]. Serious adverse events are rare, but microbial keratitis remains a concern; accordingly, strict hygiene, careful patient selection, and thorough user education are strongly recommended [31, 32]. Consensus guidance advises reserving Ortho-K for children for whom daytime unaided vision is a priority [32].

Myopia-control spectacles

Myopia-control spectacles aim to slow refractive progression and axial elongation by incorporating optical designs that deliver retinal "stop" signals (e.g., simultaneous myopic defocus) or modify retinal contrast. Several RCTs have demonstrated efficacy across a range of study periods [36–39, 85].

DIMS lens uses a 9-mm central correction zone surrounded by about 1-mm +3.50 D lenslets to provide simultaneous myopic defocus [33, 36]. In a 2-year RCT of 8–13-year-olds, DIMS slowed myopia progression by 0.44 D and axial elongation by 0.34 mm versus single-vision lenses, with 21.5% of those using DIMS (versus 7.4% using control) showing progression equal to or below 0.50 D [36]. Over 6 years, maintained benefit was observed when continuing DIMS and no rebound was reported after discontinuation, though later trial phases were not randomized [37, 40, 41]. Observation of choroidal thickening during DIMS wear suggests that choroidal changes at three months may help predict changes in AL after 1 year [42].

HAL creates a 3D "volume of myopic defocus" via concentric rings of highly aspherical lenslets around a central clear zone [33, 85]. In a double-masked RCT, HAL slowed progression by 0.80 D and axial elongation by 0.35 mm over 2 years versus single-vision lenses, with greater effect seen with full-time wear (≥12 h/day) [86]. In the third year of follow-up, children switched from single-vision lenses to HAL had lower 12-month myopic progression (SER −0.33 D versus −0.56 D) and about half the axial elongation (AL +0.14 mm versus +0.28 mm) compared with a new single-vision control group [87]. A head-to-head study in Chinese children suggested HAL was associated with approximately 0.29 D less myopia progression and 0.11 mm less axial elongation than DIMS over a 1-year period, suggesting design-dependent differences between technologies [88]. Five-year outcomes showed significantly less myopia progression of −1.27 with HAL versus an extrapolated single-vision control of −3.03 D; axial elongation was significantly lower (0.67 mm) with HAL, compared with controls (1.40 mm). Long-term HAL wear was assessed to have prevented roughly 3 years' worth of refractive and axial progression and lowered the incidence of high myopia [89].

DOT lenses employ micro-diffusers to reduce retinal contrast. In the Control of Myopia Using Peripheral Diffusion Lenses Efficacy and Safety Study (CYPRESS), 12 months of wear produced 0.40 D less myopic shift and 0.15 mm less axial elongation compared with single-vision lenses [39]. Although efficacy in years 2 and 3 may have been affected by COVID-19, additional benefit was seen in year 4 of wear. [38].

CARE lenses induce local higher-order aberrations using concentric "microcylinders". A 2-year RCT showed less axial elongation with CARE versus single vision (0.19 mm versus 0.32 mm), while SER differences were not significant with effects appearing more pronounced in the second 6 months [43]. Over 24 months, versus single-vision lenses, mean changes in SER and AL favored CARE over controls, with adjusted 24-month between-group differences of 0.44 D in SER and 0.20 mm in AL; effects were similar with both the CARE and CARE-S designs [44]. At 12 months, the Shamir Myopia Control (SMC) lens reduced axial elongation by 0.11 mm without a significant effect on SER, suggesting only modest efficacy [90].

A recent systematic review and meta-analysis of DIMS, HAL, DOT, and CARE spectacles found significant pooled benefits at 12 months for SER but no significant differences at 24 months, reflecting limited longer-term data and study heterogeneity [37]. A separate meta-analysis of 23 RCTs (13,315 children) found that myopia-control spectacle lenses significantly reduced axial elongation (−0.15 mm) and slowed SER progression (−0.31 D) versus

single-vision lenses. Among designs, HAL lenses showed the largest pooled effects (AL −0.28 mm, SER −0.52 D) and DIMS lenses significantly reduced SER (−0.45 D), with the effect on AL being less clear because only one eligible trial reported these data; other lens types had modest or variable efficacy. Across follow-up durations, spectacle lenses showed time-dependent benefits: in short-term studies (< 12 months), AL elongation decreased by −0.10 mm and SER progression by −0.18 D (both $P < 0.00001$); in intermediate-term studies (12–36 months), reductions were −0.15 mm for AL ($P < 0.04$) and −0.30 D for SER ($P < 0.004$); and in long-term studies (> 36 months) effects were greatest, with −0.19 mm AL and −0.56 D SER reductions ($P < 0.001$ and $P < 0.003$, respectively) [91].

Myopia-control spectacles show favorable safety and acceptability compared to pharmacological and contact lens options, with minor complaints such as midperipheral blur [15]. Their cosmetic similarity to single-vision lenses supports adherence, making them a practical, noninvasive option. From a care pathway perspective, they may serve as a first-line or adjunct intervention for children unable or unwilling to use contact lenses or atropine, with the strongest evidence supporting DIMS and HAL lenses, and emerging data for DOT, CARE, and SMC technologies [15, 37, 45]. Myopia-control spectacles typically cost US $500–$1,000 per pair, which is more expensive than standard spectacles; this may limit accessibility to patients and must be considered in shared decision-making [15]. However, a recent European study into the lifetime costs of myopia found that myopia-control spectacles offered the greatest overall lifetime cost savings and demonstrated cost benefits in both rapidly and slowly progressing myopia [92].

Current evidence is derived largely from East Asian cohorts, and more studies are required in non-Asian populations, as well as independent longer-term RCTs to clarify durability of the effect, treatment responders, and potential rebound after cessation [15, 33, 37].

Pharmacological interventions

Atropine

Atropine is a non-selective muscarinic antagonist with the longest clinical history for myopia control; it is currently used in most countries off-label, in a compounded formulation [14, 15]. A summary of selected key trials investigating the role of atropine in the management of pediatric myopia in European [93–102] and non-European [103–111] populations is presented in Tables 1 and 2, respectively.

Evidence from RCTs began with high-dose atropine regimens. In the Atropine for the Treatment of Myopia 1 (ATOM1) trial (Singapore, n = 400, ages 6–12), nightly monocular 1% atropine for 2 years reduced myopia progression from −1.20 D to −0.28 D and halted axial elongation (0.38 mm vs −0.02 mm) [112, 113]. A 1-year washout revealed marked rebound, with eyes prior treated with atropine showing −1.14 D SER and 0.31 mm AL changes compared with −0.38 D and 0.14 mm in prior-vehicle eyes. Concerns about adverse events and rebound shifted attention toward lower doses of atropine [114]. In ATOM2 (n = 400), children were randomized to 0.5%, 0.1%, or 0.01% atropine bilaterally for 2 years without a control group [103], with mean refractive changes −0.30, −0.38, and −0.49 D and axial elongation 0.27, 0.28, and 0.41 mm, respectively [103]. These results evidenced a dose-response relationship, although 0.01% atropine showed limited effect on axial elongation when compared with its refractive effect and with historical ATOM1 controls. A 1-year washout in ATOM2 showed dose-dependent rebound, greatest in the 0.5% atropine group [115, 116]. During years 3–5 many children were restarted on 0.01%, and over the full 5-year period cumulative SER and AL change were lowest in the 0.01% arm. Long-term follow-up (10–20 years) of ATOM1 and ATOM2 participants found no significant group differences in final SER or AL [117]. Building on these findings, ATOM3 is currently enrolling high-risk children with a family history of myopia and low hyperopia or low myopia who were randomized to atropine or placebo for 2–2.5 years and will be followed by a 1-year washout [118].

The Low-Concentration Atropine for Myopia Progression (LAMP) studies were pivotal in defining atropine dose-response relationship and guiding dose selection and cessation strategies. In LAMP phase I (year 1; Hong Kong; 438 children, 4–12 years), children randomized to 0.05%, 0.025%, 0.01% atropine or placebo showed a clear concentration-dependent effect: mean SER progression was −0.27, −0.46, −0.59, and −0.81 D, respectively, with corresponding AL increases of 0.20, 0.29, 0.36, and 0.41 mm; 0.05% was most effective and well tolerated [104]. In phase II (year 2), the placebo group was crossed over to 0.05% atropine, which halved refractive progression compared with 0.01% atropine [106]. In phase III (year 3) children were randomized to continued therapy or washout; rebound was slightly greater with 0.05% atropine than with lower doses, yet the cumulative 3-year benefit remained highest in the 0.05% atropine arm [107]. LAMP2 extended these investigations to children with pre-myopia: over 2 years, 0.05% reduced incident myopia by 29% compared with placebo, whereas 0.01% had no preventive effect [109].

Table 1. Selected trials investigating the efficacy and safety of atropine in the management of pediatric myopia in European populations

Author (Year)	Study design	Doses	Duration	Key findings (SER/AL)	Notes (tolerability/other)
Joachimsen et al. (2019) [93]	Germany pilot cohort	0.01% nightly	12 months	Annual SER progression reduced (≈−1.05 D/y pretreatment to −0.40 D/y on treatment)	Anisocoria of ~1 mm at 08:00 a.m.; well tolerated
Joachimsen et al. (2021) [94]	Germany (side effects)	0.05% versus 0.01%	1-day assessments	-	0.05% yielded larger anisocoria (2.9 ± 1.1 mm) and greater hypo-accommodation (−4.2 ± 3.8 D) versus 0.01% (0.8 ± 0.7 mm; −0.05 ± 2.5 D)
Zadnik et al. (2023) [95]	CHAMP (North America/Europe; Phase III; n = 573)	0.01%, 0.02% (NVK002 [Vyluma]) versus placebo	3 years	0.02% primary endpoint not met; 0.01% increased responders (<0.50 D at 36 months; OR 4.54) and reduced SER (Δ 0.24 D) and AL (Δ −0.13 mm) versus placebo	No serious ocular AEs.
Hvid-Hansen et al. (2023) [96]	Denmark multicenter RCT (interim, 6 months)	0.1% load to 0.01% versus 0.01% versus placebo	6 months	Dose response: AL 0.13 mm shorter (0.1% load) and 0.06 mm shorter (0.01%) versus placebo	No serious AEs; pupil/accommodation changes dose related
Hansen et al. (2023) [97]	Denmark multicenter RCT (year 1)	As above (switch after 6 months in load arm)	12 months	SER/AL reductions modest; not significant after multiplicity adjustment	AEs mostly mild; more during initial 0.1% phase
Hansen et al. (2024) [98]	Denmark multicenter RCT (year 2)	0.01% (± initial 0.1% load) versus placebo	2 years	0.01% reduced SER by 0.26 D and AL by 0.10 mm versus placebo (both significant); IOP stable	All AEs mild; iris color not effect-modifying
Loughman et al. (2024) [99]	MOSAIC (Ireland; double masked RCT; predominantly White)	0.01% versus placebo	2 years	AL reduced by −0.07 mm versus placebo; no overall SER difference	Similar AE/dropout rates to placebo
Moriche-Carretero et al. (2024) [100]	Spain/Portugal randomized clinical setting study	0.01% every night versus controls	5 years	SER progression decreased ~31.5% and AL growth ~46.9% versus controls	No safety concerns over 5 years
Loughman et al. (2025) [101]	MOSAIC year 3 extension (MOSAIC2; randomized)	Start 0.05% in year 3 versus discontinue 0.01%/placebo	36 months total	Initiating 0.05% in year 3 reduced further SER (−0.13 D) and AL (−0.06 mm) versus discontinuation groups	More near blur and photophobia on 0.05%; completion similar
Hansen et al. (2025) [102]	Denmark multicenter RCT (year 3)	0.1% load to 0.01% versus 0.01% versus placebo	3 years	6-month 0.1% loading dose did not improve efficacy versus 0.01%	The 0.1% loading dose showed a rebound effect after dose switching

Abbreviations: SER, spherical equivalent refractive error; AL, axial length; D, diopter; mm, millimeters; CHAMP, the Childhood Atropine for Myopia Progression; OR, odds ratio; AEs, adverse events; Δ, least squares mean difference; RCT, randomized clinical trial; MOSAIC, the Myopia Outcome Study of Atropine in Children.

Two large trials in the U.S. and Western countries evaluated low-dose atropine in predominantly non-Asian cohorts. The Childhood Atropine for Myopia Progression (CHAMP) trial randomized 576 children, primarily of North American and European descent, to 0.01% or 0.02% atropine or placebo for 3 years [95]; although secondary analyses suggested that 0.01% atropine slowed progression by 0.24 D and reduced axial elongation by 0.13 mm compared with placebo, the primary endpoint was not met, and overall treatment effects were modest [95]. Similarly, an NIH-funded US trial conducted by the Pediatric Eye Disease Investigator Group (PEDIG) group randomized 187 children to 0.01% atropine or placebo for 2 years and found no significant difference in SER or AL change, leading the authors to advise against routine use of 0.01% atropine in this population [110].

In the Western Australia Atropine for the Treatment of Myopia (WA-ATOM) (n = 153) study, 2 years of 0.01% atropine showed only small, non-significant differences versus placebo for both refraction (−0.14 D) and AL (0.04 mm) [108, 119]. After a 1-year washout, rebound effects favored placebo, eliminating any cumulative difference at 3 years [119, 120]. Similarly, The Myopia Outcome Study of Atropine in Children (MOSAIC), a European RCT (n = 250, 2:1 randomization to 0.01% atropine or placebo), found no SER benefit and a minimal AL effect (0.07 mm) after two years [99]. The MOSAIC2 trial included 199 of the 250 MOSAIC patients and randomized them to placebo for 2 years followed by 1 year of 0.05% atropine; 2 years of 0.01% atropine followed by placebo; or tapering of 0.01% atropine over 1 year. The group receiving 0.05% atropine had 0.13 D less myopia progression than the group receiving 0.01% atropine followed by placebo, but with a greater incidence of adverse events [101].

Table 2. Selected trials investigating the efficacy and safety of atropine in the management of pediatric myopia in non-European populations

Author (Year)	Study design	Doses	Duration	Key findings (SER/AL)	Notes (tolerability/other)
Chia et al. (2016) [103]	ATOM2 RCT (Singapore)	0.5%, 0.1%, 0.01%	5 years	Lowest cumulative progression with 0.01% (SER −1.38 D; AL +0.75 mm) vs. higher doses	Minimal mydriasis (~0.8 mm) and small accommodation loss (~2–3 D) with 0.01%; greater rebound effect at higher doses
Yam et al. (2019) [104]	LAMP Phase I (Hong Kong; double-masked RCT; n = 438)	0.05%, 0.025%, 0.01% vs. placebo	1 year	SER: −0.27, −0.46, −0.59 vs. −0.81 D; AL: +0.20, +0.29, +0.36 vs. +0.41 mm (dose response)	Modest, dose-related mydriasis/hypoaccommodation; quality of life unchanged
Wei et al. (2020) [105]	China RCT (Beijing; double-masked; n = 220)	0.01% vs. placebo	12 months	SER: −0.49 vs. −0.76 D (Δ 0.26 D); AL: +0.32 vs. +0.41 mm	No serious ocular AEs; follow-up ~70–75%
Yam et al. (2020) [106]	LAMP Phase II (extension)	0.05%, 0.025%, 0.01% (continued); prior placebo→0.05%	2 years	SER over 2 years: 0.55 D (0.05%), 0.85 D (0.025%), 1.12 D (0.01%); AL: +0.39, +0.50, +0.59 mm	0.05% showed twice the efficacy of 0.01%, switching to 0.05% reduced progression.
Yam et al. (2022) [107]	LAMP Phase III (continued vs. washout; rebound)	0.05%, 0.025%, 0.01%	3 years	Continued therapy superior to washout (e.g., 0.05% SER −0.28 D vs. −0.68 D; AL +0.17 vs. +0.33 mm); rebound small, dose-dependent	Older age/lower dose at cessation associated with smaller rebound effects
Lee et al. (2022) [108]	WA-ATOM (Australia; n = 153)	0.01% vs. placebo	2 years	Non-significant for both SER and AL	Rebound favored placebo
Yam et al. (2023) [109]	LAMP2 (pre-myopes; Hong Kong RCT; n = 474)	0.05%, 0.01% vs. placebo	2 years	Myopia incidence: 28.4% (0.05%) vs. 45.9% (0.01%) vs. 53.0% (placebo); only 0.05% effective	Photophobia most common AE (12.2–18.9% by group, year 2)
Repka et al. (2023) [110]	PEDIG (US; double-masked RCT; n = 187)	0.01% vs. placebo	24 months	No reduction in SER or AL vs. placebo	Authors conclude data do not support 0.01% for US children
Zhang et al. (2024) [111]	LAMP Phase IV (5-year outcomes; n = 270 completers)	Continued original doses; PRN after year 3 stop	5 years	Cumulative SER: −1.34 D (0.05%), −1.97 D (0.025%), −2.34 D (0.01%); similar AL trend	87.9% required PRN retreatment after year 3; restarting 0.05% restored control

Abbreviations: SER, spherical equivalent refractive error; AL, axial length; ATOM, Atropine for the Treatment of Myopia; RCT, randomized clinical trial; D, diopter; mm, millimeters; AEs, adverse events; LAMP, the Low-Concentration Atropine for Myopia Progression Study; n, number of participants; Δ, mean difference; WA-ATOM, The Western Australia ATOM study; PEDIG, the Pediatric Eye Disease Investigator Group; PRN, as needed.

In a German pilot study of 56 schoolchildren (median age 11 years), nightly 0.01% atropine for 12 months reduced estimated myopia progression from 1.05 D/year pre-treatment to 0.40 D/year. Safety testing using a 1-day delayed fellow-eye design showed about 1 mm anisocoria, without clinically meaningful hypoaccommodation or near-vision loss [94].

In a 5-year randomized trial, a prospective study of 361 European children, nightly 0.01% atropine was compared with no treatment. At 5 years, 0.01% atropine reduced myopia progression (SER −0.63 D vs −0.92 D) and axial elongation (0.26 mm vs 0.49 mm), with no reported side effects [100]. A study in Danish children (n = 97) compared 0.01% atropine, a 6-month 0.1% loading dose followed by 0.01% atropine for 18 months, and placebo, with a 12-month washout [97, 98]. At the most recent 3-year (including washout) data release, neither active regimen differed from placebo for AL or SER; the 0.1% loading dose arm showed a rebound after dose switching, and responder proportions did not differ between groups [102].

Taken together, most of the trial evidence indicates that rebound is dose-related, most pronounced at higher concentrations, and generally limited at 0.01% atropine; however, WA-ATOM documented rebound after cessation of 0.01% atropine [115, 107, 119, 121]. Safety at low doses is generally favorable and there was a dose-response effect in LAMP for 0.05% atropine, whereas 0.01% atropine showed modest or null effects, particularly for AL, in several non-Asian populations [15, 45]. Emerging evidence also suggests that efficacy may be influenced not only by concentration but by dosing frequency: a recent study [122] comparing once-nightly and twice-daily regimens of 0.01% atropine over 12 months found that both reduced AL elongation versus control (control 0.48 mm; once-nightly, 0.26 mm; twice-daily, 0.15 mm), with twice-daily dosing being significantly more efficacious than once-nightly. SER outcomes paralleled these findings, with twice-daily dosing (−0.15 D) providing greater benefit than once-nightly (−0.41 D; P = 0.02) [122].

Regulatory-approved low-dose atropine

In June 2025, Ryjunea® (atropine 0.1 mg/mL; equivalent to 0.01%; Santen SA) received European Medicines Agency/European Commission marketing authorization for slowing the progression of myopia in pediatric patients. Treatment may be initiated in children aged 3–14 years with documented progression of 0.5 D or more per year and baseline myopia between −0.5 D and −6.0 D [123]. Approval was supported by the Phase 3, double-masked, vehicle-controlled Study of Atropine for the Reduction of Myopia Progression (STAR) trial (48 months; n = 852; age 3–14 y; baseline −0.50 to −6.0 D) [123–125]. Children were randomized to 0.01% atropine, 0.03% atropine, or vehicle; at month 36, the active arms were re-randomized to continue or switch to vehicle [126]. The primary endpoint (difference in mean annual progression rate through 24 months) favored 0.01% atropine by 0.13 D versus vehicle. Larger effects were observed in younger children, with treatment benefits detectable as early as 6 months [124]. Full publication of these data is awaited.

Ryjunea® is currently commercially available in Germany with additional European launches planned [127]. A standardized, commercially manufactured product may address limitations of pharmacy-compounded formulations. In one analysis of 24 bottles of 0.01% atropine from nine pharmacies, measured concentration ranged from 70–104% of the labeled value, with 25% underdosed (< 90% of label). Marked variability was also noted in pH, osmolarity, viscosity, bottle size, and storage instructions [128].

In Poland, a formulation of 0.01% atropine (MioFree; POLPHARMA SA) has been approved for the treatment of myopia in patients aged 6–18 years [129]. While the approval of standardized 0.01% atropine products is an important milestone, evidence from the LAMP study indicates that 0.05% atropine provides greater efficacy than 0.01% [104, 106, 107], which has been associated with inconsistent results in modifying AL in different populations [95, 98, 101]. However, tolerability of atropine is dose-dependent, with 0.05% atropine associated with relatively higher incidence of mydriasis and hypoaccommodation [101]. Further studies are needed to determine whether the regulatory-approved concentration will deliver clinically meaningful benefits across diverse populations, and it remains critical to individualize treatment. Physicians should consider the merits of low-dose atropine with a positive risk-benefit profile, potentially with adjunct optical therapy, alongside the merits of a higher-dose single treatment that may be less well-tolerated.

Repeated low-level red light

RLRL therapy delivers visible red light (600–700 nm; most clinical trials use 650 nm) to the eye to modulate ocular growth signaling in children with myopia [130–132]. Mechanistic hypotheses, extrapolated from photobiomodulation, include mitochondrial activation, mitigation of tissue hypoxia, and downregulation of proinflammatory cytokines; however, the precise pathway by which RLRL influences refractive development remains uncertain [130, 131, 133]. In a multicenter RCT using a 650 nm desktop device, RLRL significantly reduced axial elongation at 12 months, with sustained benefits at 24 months among children continuing treatment [132, 134]. At 24 months, cumulative axial elongation was smallest in continuous RLRL recipients (mean [SD], 0.16 [0.37] mm) and greatest in single-vision spectacle controls (mean [SD], 0.64 [0.29] mm; $P < 0.001$) [132, 134]. Another RCT reported a median 6-month AL change of −0.06 mm in the RLRL group compared to 0.14 mm in controls [135]. Treatment efficacy was also demonstrated in children with high myopia, with 53.3% showing substantial AL shortening and nearly half maintaining shortening at 12 months [136]. In a multi-ethnic, parallel-group RCT (n = 34; age 8–13 years), twice-daily RLRL therapy (3-minute sessions on weekdays) was compared with single-vision spectacles in an interim three-month analysis. RLRL was associated with significant AL shortening (−0.06 mm) versus AL elongation with single-vision spectacles (0.02 mm; $P < 0.001$), with a small hyperopic shift in SER in the RLRL group (+0.23 D) versus a smaller change in the single-vision spectacles (+0.04 D) group; no severe adverse events were observed [137].

Conversely, a separate RCT confirmed AL benefit during treatment but documented a rebound effect after cessation, highlighting the need to understand post-treatment trajectories [138]. A 2023 systematic review and meta-analysis concluded that RLRL slows myopia progression, while emphasizing the need for larger, longer, independently monitored trials to confirm durability and safety [139]. Safety concerns have been reported. A case report described bilateral vision loss with disruption of the ellipsoid and interdigitation zones following months of RLRL exposure, with partial recovery following cessation [140]. In addition, bench testing of two RLRL devices revealed thermal and photochemical outputs approaching or exceeding maximum permissible exposure limits [141].

Collectively, current evidence indicates that 650 nm RLRL can slow axial elongation. However, generalizability

is constrained by the geographic concentration of trials, short-to-moderate follow-up, and heterogeneity in treatment protocols and devices [132, 135, 138, 139]. Given unresolved safety thresholds and rare but serious adverse events, RLRL should be regarded as investigational until independent safety validation and longer-term data across diverse populations become available [139, 141].

Combination therapies: Current evidence for efficacious combinations

Ortho-K combined with low-dose atropine is the most consistently supported combination. Two RCTs showed greater AL slowing compared to monotherapy, particularly in younger children with shorter baseline AL [142, 143]. A meta-analysis estimated the effect of Ortho-K plus low-dose atropine at −0.30 mm/year (95% CI −0.54 to −0.07) in AL versus controls, with no significant effect on SER (0.24 D; 95% CI −0.29 to 0.77). The analysis concluded that combination is superior to 0.01% atropine alone, but not clearly better than Ortho-K alone [13].

Spectacle-atropine combinations have also been tested. Adding 0.01% atropine to DIMS lenses produced greater myopia-control efficacy than either monotherapy in both Chinese and European cohorts [144, 145]; benefits have also been observed by adding 0.025% atropine to DIMS in a Spanish cohort [146]. In contrast, in the Bifocal and Atropine in Myopia (BAM) trial, combining 0.01% atropine with +2.50 D add SCL did not provide additional benefit over SCL monotherapy [147]. Evidence on higher atropine concentrations (e.g., 0.05%) combined with Ortho-K or DIMS is lacking, underscoring the need for further RCTs, particularly in fast progressors and high-risk phenotypes. A combination of peripheral-defocus contact lenses and 0.05% atropine was examined in a retrospective, one-year study of rapidly progressing myopic children. Combination therapy with 0.05% atropine plus MF60 lenses (n = 15) slowed progression more than either MF60 lenses alone (n = 12) or routine care controls (n = 14); changes in SER were −0.43 D, −0.74 D, and −1.30 D, respectively, and AL changes were 0.22 mm, 0.36 mm, and 0.65 mm, respectively. No adverse reactions were observed on biannual assessment, and increased outdoor time did not add measurable benefit in the study [148].

Light-based combinations are beginning to emerge. In one trial, RLRL added to Ortho-K produced AL suppression in children with poor response to Ortho-K alone [149]. Currently, the most efficacious multimodal regimens are Ortho-K-based (Ortho-K plus atropine and Ortho-K plus RLRL), particularly in children with rapid progression or suboptimal response to single intervention [142, 143, 149].

Scope and limitations of this review

Evidence was synthesized narratively, with emphasis on higher-level evidence (randomized and comparative clinical studies, systematic reviews, and meta-analyses) for efficacy estimates. However, because this was a targeted, non-systematic review, no protocol registration, PRISMA-based study flow reporting, formal risk-of-bias assessment, or quantitative meta-analysis was undertaken. Longer follow-up studies and consensus or guideline statements were also considered to contextualize implementation in practice to inform durability, cessation effects, and clinical implementation. Further investigation is warranted to establish comparative efficacy through rigorously designed head-to-head RCTs incorporating standardized AL and SER outcomes, extended follow-up durations, broader population representation, clearly defined discontinuation protocols, and independently validated safety and performance benchmarks for light-based interventions.

CONCLUSIONS

The evidence for myopia control has expanded considerably, with multiple interventions demonstrating clinically meaningful efficacy in slowing refractive progression and axial elongation. Time outdoors remains the most accessible and cost-neutral strategy, while optical interventions such as DIMS and HAL spectacles, Ortho-K, and soft multifocal contact lenses offer evidence-based but variable efficacy in slowing myopia progression. Pharmacological treatment with low-dose atropine is supported by robust Asian trial data, though findings in Western cohorts are less consistent and the optimal concentration continues to be debated. Recent regulatory approval of a standardized 0.01% atropine preparation represents a milestone; still, correct patient selection and judicious use of single and combination therapy is advised.

Emerging modalities such as RLRL therapy show promising efficacy, also for the treatment of high myopia, but remain investigational given unresolved safety thresholds, geographic concentration of studies, and limited long-term follow-up. Combination approaches, especially Ortho-K with low-dose atropine or Ortho-K with RLRL, are beginning to evidence additive benefits and may hold particular promise for fast progressors or children with suboptimal response to monotherapy.

Direct comparisons between interventions remain limited, as few head-to-head RCTs exist and many treatment effect estimates are indirect. Methodological heterogeneity further complicates interpretation, with studies differing in participant age ranges, predominance of East-Asian versus non-Asian cohorts, and variable dosing regimens in pharmacological trials. Treatment outcomes are also inconsistently defined, with variation in criteria for patient selection, measures of intervention "success," and protocols for washout or crossover. Adverse events and adherence are often assessed using non-standard, self-reported measures over short follow-up periods, which may underestimate adverse experiences while overestimating compliance. Risk of bias remains a recurrent concern, particularly regarding randomization and allocation concealment, missing data, and the absence of prespecified analyses. Consequently, despite the influx of new research, the overall level of evidence supporting both short- and long-term use of specific interventions remains relatively low.

Taken together, current strategies allow for a more tailored, evidence-informed approach to pediatric myopia management, yet the field remains dynamic. Treatment selection should be individualized to risk, rate of progression, age, ocular profile, preferences, and access. Ongoing research into optimal dosing, combination regimens, novel mechanisms, and implementation pathways will be essential to refine and expand effective, safe, and scalable options for children worldwide.

ETHICAL DECLARATIONS

Ethical approval: No ethical approval was required.

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REFERENCES

1. Flitcroft DI, He M, Jonas JB, Jong M, Naidoo K, Ohno-Matsui K, Rahi J, Resnikoff S, Vitale S, Yannuzzi L. IMI - Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies. Invest Ophthalmol Vis Sci. 2019 Feb 28;60(3):M20-M30. doi: 10.1167/iovs.18-25957. Erratum in: Invest Ophthalmol Vis Sci. 2024 Nov 4;65(13):19. doi: 10.1167/iovs.65.13.19. PMID: 30817826; PMCID: PMC6735818.
2. Baird PN, Saw SM, Lanca C, Guggenheim JA, Smith Iii EL, Zhou X, Matsui KO, Wu PC, Sankaridurg P, Chia A, Rosman M, Lamoureux EL, Man R, He M. Myopia. Nat Rev Dis Primers. 2020 Dec 17;6(1):99. doi: 10.1038/s41572-020-00231-4. PMID: 33328468.
3. Haarman AEG, Enthoven CA, Tideman JWL, Tedja MS, Verhoeven VJM, Klaver CCW. The Complications of Myopia: A Review and Meta-Analysis. Invest Ophthalmol Vis Sci. 2020 Apr 9;61(4):49. doi: 10.1167/iovs.61.4.49. PMID: 32347918; PMCID: PMC7401976.
4. Jiang F, Wang D, Xiao O, Guo X, Yin Q, Luo L, He M, Li Z. Four-Year Progression of Myopic Maculopathy in Children and Adolescents With High Myopia. JAMA Ophthalmol. 2024 Mar 1;142(3):180-186. doi: 10.1001/jamaophthalmol.2023.6319. PMID: 38270935; PMCID: PMC10811590.
5. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, Wong TY, Naduvilath TJ, Resnikoff S. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016 May;123(5):1036-42. doi: 10.1016/j.ophtha.2016.01.006. Epub 2016 Feb 11. PMID: 26875007.
6. Moreira-Rosário A, Lanca C, Grzybowski A. Prevalence of myopia in Europe: a systematic review and meta-analysis of data from 14 countries. Lancet Reg Health Eur. 2025 May 22;54:101319. doi: 10.1016/j.lanepe.2025.101319. PMID: 40672053; PMCID: PMC12266183.
7. Williams KM, Bertelsen G, Cumberland P, Wolfram C, Verhoeven VJ, Anastasopoulos E, Buitendijk GH, Cougnard-Grégoire A, Creuzot-Garcher C, Erke MG, Hogg R, Höhn R, Hysi P, Khawaja AP, Korobelnik JF, Ried J, Vingerling JR, Bron A, Dartigues JF, Fletcher A, Hofman A, Kuijpers RW, Luben RN, Oxele K, Topouzis F, von Hanno T, Mirshahi A, Foster PJ, van Duijn CM, Pfeiffer N, Delcourt C, Klaver CC, Rahi J, Hammond CJ; European Eye Epidemiology (E(3)) Consortium. Increasing Prevalence of Myopia in Europe and the Impact of Education. Ophthalmology. 2015 Jul;122(7):1489-97. doi: 10.1016/j.ophtha.2015.03.018. Epub 2015 May 13. PMID: 25983215; PMCID: PMC4504030.

8. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. Lancet. 2012 May 5;379(9827):1739-48. doi: 10.1016/S0140-6736(12)60272-4. PMID: 22559900.
9. Chen M, Wu A, Zhang L, Wang W, Chen X, Yu X, Wang K. The increasing prevalence of myopia and high myopia among high school students in Fenghua city, eastern China: a 15-year population-based survey. BMC Ophthalmol. 2018 Jul 3;18(1):159. doi: 10.1186/s12886-018-0829-8. PMID: 29970057; PMCID: PMC6029024.
10. Lanca C, Pang CP, Grzybowski A. Effectiveness of myopia control interventions: A systematic review of 12 randomized control trials published between 2019 and 2021. Front Public Health. 2023 Mar 23;11:1125000. doi: 10.3389/fpubh.2023.1125000. Erratum in: Front Public Health. 2024 Sep 25;12:1460156. doi: 10.3389/fpubh.2024.1460156. PMID: 37033047; PMCID: PMC10076805.
11. Lanca C, Repka MX, Grzybowski A. Topical Review: Studies on Management of Myopia Progression from 2019 to 2021. Optom Vis Sci. 2023 Jan 1;100(1):23-30. doi: 10.1097/OPX.0000000000001947. Epub 2022 Oct 19. PMID: 36705712.
12. Lanca C, Repka MX, Grzybowski A. Controversies in Myopia Control Treatment: What Does It Mean for Future Research? Am J Ophthalmol. 2025 Apr;272:79-86. doi: 10.1016/j.ajo.2024.12.029. Epub 2025 Jan 9. PMID: 39793686.
13. Zaabaar E, Asiamah R, Kyei S, Ankamah S. Myopia control strategies: A systematic review and meta-meta-analysis. Ophthalmic Physiol Opt. 2025 Jan;45(1):160-176. doi: 10.1111/opo.13417. Epub 2024 Nov 12. PMID: 39530399.
14. Wolffsohn JS, Whayeb Y, Logan NS, Weng R; International Myopia Institute Ambassador Group*. IMI-Global Trends in Myopia Management Attitudes and Strategies in Clinical Practice-2022 Update. Invest Ophthalmol Vis Sci. 2023 May 1;64(6):6. doi: 10.1167/iovs.64.6.6. Erratum in: Invest Ophthalmol Vis Sci. 2023 May 1;64(5):12. doi: 10.1167/iovs.64.5.12. PMID: 37126357; PMCID: PMC10155870.
15. Eppenberger LS, Grzybowski A, Schmetterer L, Ang M. Myopia Control: Are We Ready for an Evidence Based Approach? Ophthalmol Ther. 2024 Jun;13(6):1453-1477. doi: 10.1007/s40123-024-00951-w. Epub 2024 May 7. PMID: 38710983; PMCID: PMC11109072.
16. Maulvi FA, Desai DT, Kalaiselvan P, Shah DO, Willcox MDP. Current and emerging strategies for myopia control: a narrative review of optical, pharmacological, behavioural, and adjunctive therapies. Eye (Lond). 2025 Oct;39(14):2635-2644. doi: 10.1038/s41433-025-03949-1. Epub 2025 Aug 1. PMID: 40750999; PMCID: PMC12446493.
17. Zhang XJ, Zaabaar E, French AN, Tang FY, Kam KW, Tham CC, Chen LJ, Pang CP, Yam JC. Advances in myopia control strategies for children. Br J Ophthalmol. 2025 Jan 28;109(2):165-176. doi: 10.1136/bjo-2023-323887. PMID: 38777389.
18. Wu PC, Chen CT, Lin KK, Sun CC, Kuo CN, Huang HM, Poon YC, Yang ML, Chen CY, Huang JC, Wu PC, Yang IH, Yu HJ, Fang PC, Tsai CL, Chiou ST, Yang YH. Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial. Ophthalmology. 2018 Aug;125(8):1239-1250. doi: 10.1016/j.ophtha.2017.12.011. Epub 2018 Jan 19. PMID: 29371008.
19. He X, Sankaridurg P, Wang J, Chen J, Naduvilath T, He M, Zhu Z, Li W, Morgan IG, Xiong S, Zhu J, Zou H, Rose KA, Zhang B, Weng R, Resnikoff S, Xu X. Time Outdoors in Reducing Myopia: A School-Based Cluster Randomized Trial with Objective Monitoring of Outdoor Time and Light Intensity. Ophthalmology. 2022 Nov;129(11):1245-1254. doi: 10.1016/j.ophtha.2022.06.024. Epub 2022 Jun 30. PMID: 35779695.
20. 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.
21. Li D, Min S, Li X. Is Spending More Time Outdoors Able to Prevent and Control Myopia in Children and Adolescents? A Meta-Analysis. Ophthalmic Res. 2024;67(1):393-404. doi: 10.1159/000539229. Epub 2024 May 6. PMID: 38710180.
22. Wu PC, Tsai CL, Yang YH. Outdoor activity during class recess prevents myopia onset and shift in premyopic children: Subgroup analysis in the recess outside classroom study. Asia Pac J Ophthalmol (Phila). 2025 Jan-Feb;14(1):100140. doi: 10.1016/j.apjo.2025.100140. Epub 2025 Jan 11. PMID: 39805427.
23. Mei Z, Zhang Y, Jiang W, Lam C, Luo S, Cai C, Luo S. Efficacy of outdoor interventions for myopia in children and adolescents: a systematic review and meta-analysis of randomized controlled trials. Front Public Health. 2024 Aug 13;12:1452567. doi: 10.3389/fpubh.2024.1452567. PMID: 39193200; PMCID: PMC11347293.
24. He M, Xiang F, Zeng Y, Mai J, Chen Q, Zhang J, Smith W, Rose K, Morgan IG. Effect of Time Spent Outdoors at School on the Development of Myopia Among Children in China: A Randomized Clinical Trial. JAMA. 2015 Sep 15;314(11):1142-8. doi: 10.1001/jama.2015.10803. PMID: 26372583.
25. Gajjar S, Ostrin LA. A systematic review of near work and myopia: measurement, relationships, mechanisms and clinical corollaries. Acta Ophthalmol. 2022 Jun;100(4):376-387. doi: 10.1111/aos.15043. Epub 2021 Oct 7. PMID: 34622560.
26. Bullimore MA, Brennan NA. Efficacy in myopia control-The impact of rebound. Ophthalmic Physiol Opt. 2025 Jan;45(1):100-110. doi: 10.1111/opo.13403. Epub 2024 Oct 8. PMID: 39377894.

27. Hiraoka T. Myopia Control With Orthokeratology: A Review. Eye Contact Lens. 2022 Mar 1;48(3):100-104. doi: 10.1097/ICL.0000000000000867. PMID: 34860723.
28. Charm J. Orthokeratology: clinical utility and patient perspectives. Clin Optom (Auckl). 2017 Feb 7;9:33-40. doi: 10.2147/OPTO.S104507. PMID: 30214358; PMCID: PMC6095568.
29. Santodomingo-Rubido J, Villa-Collar C, Gilmartin B, Gutiérrez-Ortega R, Sugimoto K. Long-term Efficacy of Orthokeratology Contact Lens Wear in Controlling the Progression of Childhood Myopia. Curr Eye Res. 2017 May;42(5):713-720. doi: 10.1080/02713683.2016.1221979. Epub 2016 Oct 21. PMID: 27767354.
30. Sun Y, Xu F, Zhang T, Liu M, Wang D, Chen Y, Liu Q. Orthokeratology to control myopia progression: a meta-analysis. PLoS One. 2015 Apr 9;10(4):e0124535. doi: 10.1371/journal.pone.0124535. Erratum in: PLoS One. 2015 Jun 11;10(6):e0130646. doi: 10.1371/journal.pone.0130646. PMID: 25855979; PMCID: PMC4391793.
31. Liu YM, Xie P. The Safety of Orthokeratology--A Systematic Review. Eye Contact Lens. 2016 Jan;42(1):35-42. doi: 10.1097/ICL.0000000000000219. PMID: 26704136; PMCID: PMC4697954.
32. VanderVeen DK, Kraker RT, Pineles SL, Hutchinson AK, Wilson LB, Galvin JA, Lambert SR. Use of Orthokeratology for the Prevention of Myopic Progression in Children: A Report by the American Academy of Ophthalmology. Ophthalmology. 2019 Apr;126(4):623-636. doi: 10.1016/j.ophtha.2018.11.026. Epub 2018 Nov 23. PMID: 30476518.
33. Atchison DA, Charman WN. Optics of spectacle lenses intended to treat myopia progression. Optom Vis Sci. 2024 May 1;101(5):238-249. doi: 10.1097/OPX.0000000000002140. PMID: 38857035.34.
34. Dahlmann-Noor AH, Ghorbani-Mojarrad N, Williams KM, Ghoneim A, Allen PM, Beach ML, Bruce G, Buckhurst HD, Buckhurst PJ, Cruickshank FE, Cufflin MP, Day MD, Doyle L, Evans BJW, Flitcroft DI, Gray LS, Grewal I, Guggenheim JA, Hammond CJ, Higginbotham JC, Jawaid I, Kearney S, Lawrenson JG, Logan NS, Loughman J, Mallen EAH, McCullough SJ, Nagra M, Saunders KJ, Seidel D, Shah T, Strang NC, Webber KJ, Wolffsohn JS, Young AL. 2024 UK and Ireland modified Delphi consensus on myopia management in children and young people. Ophthalmic Physiol Opt. 2024 Nov;44(7):1368-1391. doi: 10.1111/opo.13381. Epub 2024 Sep 18. PMID: 39295273.
35. World Society of Paediatric Ophthalmology & Strabismus (2025). 'Myopia Consensus Statement 2025. Available at: https://wspos.org/wp-content/uploads/2025/05/Myopia-Consensus-Statement2025.pdf?utm_id=myopia2025-download (Accessed: February 10, 2026).
36. 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.
37. Perea-Romero J, Signes-Soler I, Badenes-Ribera L, Tauste A. Efficacy of spectacle lenses specifically designed for myopia control: systematic review and meta-analysis. Graefes Arch Clin Exp Ophthalmol. 2025 Apr;263(4):909-924. doi: 10.1007/s00417-024-06706-4. Epub 2024 Dec 9. PMID: 39652182.
38. Laughton D, Hill JS, McParland M, Tasso V, Woods J, Zhu X, Young G, Craven R, Hunt C, Neitz J, Neitz M, Chalberg TW, Jones D, Wolffsohn JS. Control of myopia using diffusion optics spectacle lenses: 4-year results of a multicentre randomised controlled, efficacy and safety study (CYPRESS). BMJ Open Ophthalmol. 2024 Oct 9;9(1):e001790. doi: 10.1136/bmjophth-2024-001790. PMID: 39384223; PMCID: PMC11733789.
39. Rappon J, Chung C, Young G, Hunt C, Neitz J, Neitz M, Chalberg T. Control of myopia using diffusion optics spectacle lenses: 12-month results of a randomised controlled, efficacy and safety study (CYPRESS). Br J Ophthalmol. 2023 Nov;107(11):1709-1715. doi: 10.1136/bjo-2021-321005. Epub 2022 Sep 1. PMID: 36126105; PMCID: PMC10646852.
40. Lam CS, Tang WC, Lee PH, Zhang HY, Qi H, Hasegawa K, To CH. Myopia control effect of defocus incorporated multiple segments (DIMS) spectacle lens in Chinese children: results of a 3-year follow-up study. Br J Ophthalmol. 2022 Aug;106(8):1110-1114. doi: 10.1136/bjophthalmol-2020-317664. Epub 2021 Mar 17. PMID: 33731364; PMCID: PMC9340033.
41. Lam CSY, Tang WC, Zhang HY, Lee PH, Tse DYY, Qi H, Vlasak N, To CH. Long-term myopia control effect and safety in children wearing DIMS spectacle lenses for 6 years. Sci Rep. 2023 Apr 4;13(1):5475. doi: 10.1038/s41598-023-32700-7. PMID: 37015996; PMCID: PMC10073092.
42. Chun RKM, Zhang H, Liu Z, Tse DYY, Zhou Y, Lam CSY, To CH. Defocus incorporated multiple segments (DIMS) spectacle lenses increase the choroidal thickness: a two-year randomized clinical trial. Eye Vis (Lond). 2023 Sep 15;10(1):39. doi: 10.1186/s40662-023-00356-z. PMID: 37715201; PMCID: PMC10502972.
43. Chen X, Wu M, Yu C, Ohlendorf A, Rifai K, Boeck-Maier C, Wahl S, Yang Y, Zhu Y, Li L, Sankaridurg P. Slowing myopia progression with cylindrical annular refractive elements (CARE) spectacle lenses-Year 1 results from a 2-year prospective, multi-centre trial. Acta Ophthalmol. 2025 Dec;103(8):929-938. doi: 10.1111/aos.16795. Epub 2024 Nov 15. PMID: 39548605; PMCID: PMC12604440.

44. Chen X, Wu M, Yu C, Ohlendorf A, Li W, Liu N, Yang Y, Li L, Sankaridurg P. Efficacy of Cylindrical Annular Refractive Elements (CARE) Spectacle Lenses in Slowing Myopia Progression Over 2 Years. Am J Ophthalmol. 2025 Oct;278:203-211. doi: 10.1016/j.ajo.2025.06.017. Epub 2025 Jun 13. PMID: 40517999.
45. Khanal S, Tomiyama ES, Harrington SC. Childhood Myopia Part I: Contemporary Treatment Options. Invest Ophthalmol Vis Sci. 2025 Jun 5;66(7):6. doi: 10.1167/iovs.66.7.6. Erratum in: Invest Ophthalmol Vis Sci. 2025 Jul 1;66(9):46. doi: 10.1167/iovs.66.9.46. PMID: 40471570; PMCID: PMC12151248.
46. Brennan NA, Cheng X, Jong M, Bullimore MA. Commonly Held Beliefs About Myopia That Lack a Robust Evidence Base: 2025 Update. Eye Contact Lens. 2025 May 21;51(8):319-335. doi: 10.1097/ICL.0000000000001191. PMID: 40397787.
47. Prousali E, Haidich AB, Fontalis A, Ziakas N, Brazitikos P, Mataftsi A. Efficacy and safety of interventions to control myopia progression in children: an overview of systematic reviews and meta-analyses. BMC Ophthalmol. 2019 May 9;19(1):106. doi: 10.1186/s12886-019-1112-3. PMID: 31072389; PMCID: PMC6506938.
48. Russo A, Boldini A, Romano D, Mazza G, Bignotti S, Morescalchi F, Semeraro F. Myopia: Mechanisms and Strategies to Slow Down Its Progression. J Ophthalmol. 2022 Jun 14;2022:1004977. doi: 10.1155/2022/1004977. PMID: 35747583; PMCID: PMC9213207.
49. Lai L, Trier K, Cui DM. Role of 7-methylxanthine in myopia prevention and control: a mini-review. Int J Ophthalmol. 2023 Jun 18;16(6):969-976. doi: 10.18240/ijo.2023.06.21. PMID: 37332548; PMCID: PMC10250936.
50. Liu Y, Dang Y. New Advances in Drug Research for Myopia Control in Adolescents. Curr Drug Targets. 2025;26(6):382-393. doi: 10.2174/0113894501359801250102055530. PMID: 39838677.
51. Singh H, Singh H, Latief U, Tung GK, Shahtaghi NR, Sahajpal NS, Kaur I, Jain SK. Myopia, its prevalence, current therapeutic strategy and recent developments: A Review. Indian J Ophthalmol. 2022 Aug;70(8):2788-2799. doi: 10.4103/ijo.IJO_2415_21. PMID: 35918918; PMCID: PMC9672758.
52. Tapasztó B, Flitcroft DI, Aclimandos WA, Jonas JB, De Faber JHN, Nagy ZZ, Kestelyn PG, Januleviciene I, Grzybowski A, Vidinova CN, Guggenheim JA, Polling JR, Wolffsohn JS, Tideman JWL, Allen PM, Baraas RC, Saunders KJ, McCullough SJ, Gray LS, Wahl S, Smirnova IY, Formenti M, Radhakrishnan H, Resnikoff S, Németh J; SOE Myopia Consensus Group. Myopia management algorithm. Annexe to the article titled Update and guidance on management of myopia. European Society of Ophthalmology in cooperation with International Myopia Institute. Eur J Ophthalmol. 2024 Jul;34(4):952-966. doi: 10.1177/11206721231219532. Epub 2023 Dec 12. PMID: 38087768; PMCID: PMC11295429.
53. Eppenberger LS, Sturm V. Myopia Management in Daily Routine - A Survey of European Pediatric Ophthalmologists. Klin Monbl Augenheilkd. 2023 Apr;240(4):581-586. doi: 10.1055/a-2013-2713. Epub 2023 Apr 25. PMID: 37164443; PMCID: PMC10129410.
54. Martínez-Pérez C, Santodomingo-Rubido J, Villa-Collar C, Whayeb Y, Wolffsohn JS. European trends in attitudes and strategies for myopia management in clinical practice. Cont Lens Anterior Eye. 2025 Jul;48(4):102390. doi: 10.1016/j.clae.2025.102390. Epub 2025 Mar 10. PMID: 40069039.
55. Cao K, Wan Y, Yusufu M, Wang N. Significance of Outdoor Time for Myopia Prevention: A Systematic Review and Meta-Analysis Based on Randomized Controlled Trials. Ophthalmic Res. 2020;63(2):97-105. doi: 10.1159/000501937. Epub 2019 Aug 20. PMID: 31430758.
56. 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.
57. Liao S, Li X, Bai N, Wu D, Yang W, Wang F, Ji HZ. An empirical study on the effect of outdoor illumination and exercise intervention on Children's vision. Front Public Health. 2023 Dec 12;11:1270826. doi: 10.3389/fpubh.2023.1270826. PMID: 38155899; PMCID: PMC10754518.
58. Hung LF, Arumugam B, She Z, Ostrin L, Smith EL 3rd. Narrow-band, long-wavelength lighting promotes hyperopia and retards vision-induced myopia in infant rhesus monkeys. Exp Eye Res. 2018 Nov;176:147-160. doi: 10.1016/j.exer.2018.07.004. Epub 2018 Jul 4. PMID: 29981345; PMCID: PMC6215717.
59. Smith EL 3rd, Hung LF, Arumugam B, Holden BA, Neitz M, Neitz J. Effects of Long-Wavelength Lighting on Refractive Development in Infant Rhesus Monkeys. Invest Ophthalmol Vis Sci. 2015 Oct;56(11):6490-500. doi: 10.1167/iovs.15-17025. PMID: 26447984; PMCID: PMC4604957.
60. Pan CW, Qian DJ, Saw SM. Time outdoors, blood vitamin D status and myopia: a review. Photochem Photobiol Sci. 2017 Mar 16;16(3):426-432. doi: 10.1039/c6pp00292g. PMID: 27921098.
61. Chen J, Qi Z, Morgan I, Rose K, Zhu Z, Ding X, Wang J, Zhang B, Du L, Yang J, Zhu J, Gao W, Zou H, He M, Xu X, He X. Time outdoors prevents myopia in hyperopic children, but protection is weaker in premyopic children: a post-hoc analysis of a cluster-randomised trial. Br J Ophthalmol. 2025 Oct 8:bjo-2025-327768. doi: 10.1136/bjo-2025-327768. Epub ahead of print. PMID: 41062253.

62. 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.
63. Foreman J, Salim AT, Praveen A, Fonseka D, Ting DSW, Guang He M, Bourne RRA, Crowston J, Wong TY, Dirani M. Association between digital smart device use and myopia: a systematic review and meta-analysis. Lancet Digit Health. 2021 Dec;3(12):e806-e818. doi: 10.1016/S2589-7500(21)00135-7. Epub 2021 Oct 5. PMID: 34625399.
64. Zhang X, Cheung SSL, Chan HN, Zhang Y, Wang YM, Yip BH, Kam KW, Yu M, Cheng CY, Young AL, Kwan MYW, Ip P, Chong KK, Tham CC, Chen LJ, Pang CP, Yam JCS. Myopia incidence and lifestyle changes among school children during the COVID-19 pandemic: a population-based prospective study. Br J Ophthalmol. 2022 Dec;106(12):1772-1778. doi: 10.1136/bjophthalmol-2021-319307. Epub 2021 Aug 2. PMID: 34340973.
65. Enthoven CA, Tideman JWL, Polling JR, Yang-Huang J, Raat H, Klaver CCW. The impact of computer use on myopia development in childhood: The Generation R study. Prev Med. 2020 Mar;132:105988. doi: 10.1016/j.ypmed.2020.105988. Epub 2020 Jan 15. Erratum in: Prev Med. 2025 Apr;193:108243. doi: 10.1016/j.ypmed.2025.108243. PMID: 31954142.
66. Wong CW, Tsai A, Jonas JB, Ohno-Matsui K, Chen J, Ang M, Ting DSW. Digital Screen Time During the COVID-19 Pandemic: Risk for a Further Myopia Boom? Am J Ophthalmol. 2021 Mar;223:333-337. doi: 10.1016/j.ajo.2020.07.034. Epub 2020 Jul 30. PMID: 32738229; PMCID: PMC7390728.
67. Efron N, Morgan PB, Woods CA, Santodomingo-Rubido J, Nichols JJ; International Contact Lens Prescribing Survey Consortium. International survey of contact lens fitting for myopia control in children. Cont Lens Anterior Eye. 2020 Feb;43(1):4-8. doi: 10.1016/j.clae.2019.06.008. Epub 2019 Jul 3. PMID: 31279577.
68. Li SM, Kang MT, Wu SS, Meng B, Sun YY, Wei SF, Liu L, Peng X, Chen Z, Zhang F, Wang N. Studies using concentric ring bifocal and peripheral add multifocal contact lenses to slow myopia progression in school-aged children: a meta-analysis. Ophthalmic Physiol Opt. 2017 Jan;37(1):51-59. doi: 10.1111/opo.12332. Epub 2016 Nov 23. PMID: 27880992.
69. Chamberlain P, Peixoto-de-Matos SC, Logan NS, Ngo C, Jones D, Young G. A 3-year Randomized Clinical Trial of MiSight Lenses for Myopia Control. Optom Vis Sci. 2019 Aug;96(8):556-567. doi: 10.1097/OPX.0000000000001410. PMID: 31343513.
70. Sankaridurg P, Bakaraju RC, Naduvilath T, Chen X, Weng R, Tilia D, Xu P, Li W, Conrad F, Smith EL 3rd, Ehrmann K. 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. 2019 Jul;39(4):294-307. doi: 10.1111/opo.12621. Epub 2019 Jun 10. PMID: 31180155; PMCID: PMC6851825.
71. Walline JJ. Myopia Control: A Review. Eye Contact Lens. 2016 Jan;42(1):3-8. doi: 10.1097/ICL.0000000000000207. PMID: 26513719.
72. Aller TA, Liu M, Wildsoet CF. Myopia Control with Bifocal Contact Lenses: A Randomized Clinical Trial. Optom Vis Sci. 2016 Apr;93(4):344-52. doi: 10.1097/OPX.0000000000000808. PMID: 26784710.
73. Pauné J, Morales H, Armengol J, Quevedo L, Faria-Ribeiro M, González-Méijome JM. Myopia Control with a Novel Peripheral Gradient Soft Lens and Orthokeratology: A 2-Year Clinical Trial. Biomed Res Int. 2015;2015:507572. doi: 10.1155/2015/507572. Epub 2015 Oct 28. PMID: 26605331; PMCID: PMC4641166.
74. Weng R, Lan W, Bakaraju R, Conrad F, Naduvilath T, Yang ZK, Sankaridurg P. Efficacy of contact lenses for myopia control: Insights from a randomised, contralateral study design. Ophthalmic Physiol Opt. 2022 Nov;42(6):1253-1263. doi: 10.1111/opo.13042. Epub 2022 Aug 25. PMID: 36006761; PMCID: PMC9805073.
75. Garcia-Del Valle AM, Blázquez V, Gros-Otero J, Infante M, Culebras A, Verdejo A, Sebastián J, García M, Bueno S, Piñero DP. Efficacy and safety of a soft contact lens to control myopia progression. Clin Exp Optom. 2021 Jan;104(1):14-21. doi: 10.1111/cxo.13077. PMID: 32342559.
76. Raffa LH, Allinjawi K, Sharanjeet-Kaur, Akhir SM, Mutalib HA. Myopia control with soft multifocal contact lenses: 18-month follow-up. Saudi J Ophthalmol. 2022 Jun 13;35(4):325-331. doi: 10.4103/1319-4534.347305. PMID: 35814985; PMCID: PMC9266467.
77. Walline JJ, Walker MK, Mutti DO, Jones-Jordan LA, Sinnott LT, Giannoni AG, Bickle KM, Schulle KL, Nixon A, Pierce GE, Berntsen DA; BLINK Study Group. 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 Aug 11;324(6):571-580. doi: 10.1001/jama.2020.10834. PMID: 32780139; PMCID: PMC7420158.
78. Chamberlain P, Hammond DS, Bradley A, Arumugam B, Richdale K, McNally J, Hunt C, Young G. Eye growth and myopia progression following cessation of myopia control therapy with a dual-focus soft contact lens. Optom Vis Sci. 2025 May 1;102(5):353-358. doi: 10.1097/OPX.0000000000002244. Epub 2025 Mar 24. PMID: 40132119; PMCID: PMC12101879.
79. Bullimore MA. The Safety of Soft Contact Lenses in Children. Optom Vis Sci. 2017 Jun;94(6):638-646. doi: 10.1097/OPX.0000000000001078. PMID: 28514244; PMCID: PMC5457812.

80. 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.
81. Choi KY, Cheung JKW, Wong GTK, Li PH, Chan SSH, Lam TC, Chan HHL. Myopia Control Efficacy and Long-Term Safety of a Novel Orthokeratology Lens (MESOK Study)-A Randomized Controlled Clinical Trial Combining Clinical and Tear Proteomics Data. J Clin Med. 2023 Apr 29;12(9):3210. doi: 10.3390/jcm12093210. PMID: 37176650; PMCID: PMC10179394.
82. Guo B, Cheung SW, Kojima R, Cho P. Variation of Orthokeratology Lens Treatment Zone (VOLTZ) Study: A 2-year randomised clinical trial. Ophthalmic Physiol Opt. 2023 Nov;43(6):1449-1461. doi: 10.1111/opo.13208. Epub 2023 Aug 6. PMID: 37545099.
83. Liu T, Chen C, Ma W, Yang B, Wang X, Liu L. One-year results for myopia control with aspheric base curve orthokeratology lenses: A prospective randomised clinical trial. Ophthalmic Physiol Opt. 2023 Nov;43(6):1469-1477. doi: 10.1111/opo.13213. Epub 2023 Aug 16. PMID: 37584271.
84. Cho P, Cheung SW. Discontinuation of orthokeratology on eyeball elongation (DOEE). Cont Lens Anterior Eye. 2017 Apr;40(2):82-87. doi: 10.1016/j.clae.2016.12.002. Epub 2016 Dec 27. PMID: 28038841.
85. Bao J, Yang A, Huang Y, Li X, Pan Y, Ding C, Lim EW, Zheng J, Spiegel DP, Drobe B, Lu F, Chen H. One-year myopia control efficacy of spectacle lenses with aspherical lenslets. Br J Ophthalmol. 2022 Aug;106(8):1171-1176. doi: 10.1136/bjophthalmol-2020-318367. Epub 2021 Apr 2. PMID: 33811039; PMCID: PMC9340037.
86. Bao J, Huang Y, Li X, Yang A, Zhou F, Wu J, Wang C, Li Y, Lim EW, Spiegel DP, Drobe B, Chen H. Spectacle Lenses With Aspherical Lenslets for Myopia Control vs Single-Vision Spectacle Lenses: A Randomized Clinical Trial. JAMA Ophthalmol. 2022 May 1;140(5):472-478. doi: 10.1001/jamaophthalmol.2022.0401. PMID: 35357402; PMCID: PMC8972151.
87. Li X, Huang Y, Yin Z, Liu C, Zhang S, Yang A, Drobe B, Chen H, Bao J. Myopia Control Efficacy of Spectacle Lenses With Aspherical Lenslets: Results of a 3-Year Follow-Up Study. Am J Ophthalmol. 2023 Sep;253:160-168. doi: 10.1016/j.ajo.2023.03.030. Epub 2023 Apr 10. PMID: 37040846.
88. Guo H, Li X, Zhang X, Wang H, Li J. Comparing the effects of highly aspherical lenslets versus defocus incorporated multiple segment spectacle lenses on myopia control. Sci Rep. 2023 Feb 21;13(1):3048. doi: 10.1038/s41598-023-30157-2. PMID: 36810369; PMCID: PMC9942655.
89. Li X, Huang Y, Liu C, Chang X, Cui Z, Yang Q, Drobe B, Bullimore MA, Chen H, Bao J. Myopia control efficacy of spectacle lenses with highly aspherical lenslets: results of a 5-year follow-up study. Eye Vis (Lond). 2025 Mar 5;12(1):10. doi: 10.1186/s40662-025-00427-3. PMID: 40038807; PMCID: PMC11881363.
90. Yuval C, Otzem C, Laura BS, Shirel R, Dana GN, Atalia W, Noam B, Nir E, Yair M. Evaluating the Effect of a Myopia Control Spectacle Lens Among Children in Israel: 12-Month Results. Am J Ophthalmol. 2024 Jan;257:103-112. doi: 10.1016/j.ajo.2023.08.019. Epub 2023 Sep 9. Erratum in: Am J Ophthalmol. 2024 Mar;259:197. doi: 10.1016/j.ajo.2023.12.015. PMID: 37690499.
91. D'Andrea L, Rinaldi M, Piscopo R, Iorio F, La Padula S, Maqsood S, Elalfy M, Melenzane A, Confalonieri F, Ozkan O, Utine CA, Costagliola C. Efficacy of spectacle lenses for myopia control: a meta-analysis of randomised controlled trials. Br J Ophthalmol. 2026 Jan 22;110(2):125-132. doi: 10.1136/bjo-2025-327629. PMID: 40912901; PMCID: PMC12911582.
92. Lee L, De Angelis L, Barclay E, Tahhan N, Saunders K, McConnell E, Ghorbani-Mojarrad N, Dahlmann-Noor A, Jaselsky A, Leveziel N, Bremond-Gignac D, Resnikoff S, Fricke TR. Factors Affecting the Lifetime Cost of Myopia and the Impact of Active Myopia Treatments in Europe. Am J Ophthalmol. 2025 Oct;278:212-221. doi: 10.1016/j.ajo.2025.06.034. Epub 2025 Jun 20. PMID: 40545012.
93. Joachimsen L, Böhringer D, Gross NJ, Reich M, Stifter J, Reinhard T, Lagrèze WA. A Pilot Study on the Efficacy and Safety of 0.01% Atropine in German Schoolchildren with Progressive Myopia. Ophthalmol Ther. 2019 Sep;8(3):427-433. doi: 10.1007/s40123-019-0194-6. Epub 2019 Jun 12. PMID: 31190219; PMCID: PMC6692800.
94. Joachimsen L, Farassat N, Bleul T, Böhringer D, Lagrèze WA, Reich M. Side effects of topical atropine 0.05% compared to 0.01% for myopia control in German school children: a pilot study. Int Ophthalmol. 2021 Jun;41(6):2001-2008. doi: 10.1007/s10792-021-01755-8. Epub 2021 Feb 25. PMID: 33634343; PMCID: PMC8172502.
95. Zadnik K, Schulman E, Flitcroft I, Fogt JS, Blumenfeld LC, Fong TM, Lang E, Hemmati HD, Chandler SP; CHAMP Trial Group Investigators. Efficacy and Safety of 0.01% and 0.02% Atropine for the Treatment of Pediatric Myopia Progression Over 3 Years: A Randomized Clinical Trial. JAMA Ophthalmol. 2023 Oct 1;141(10):990-999. doi: 10.1001/jamaophthalmol.2023.2097. Erratum in: JAMA Ophthalmol. 2023 Oct 1;141(10):1005. doi: 10.1001/jamaophthalmol.2023.4206. PMID: 37261839; PMCID: PMC10236322.

96. Hvid-Hansen A, Jacobsen N, Møller F, Bek T, Ozenne B, Kessel L. Myopia Control with Low-Dose Atropine in European Children: Six-Month Results from a Randomized, Double-Masked, Placebo-Controlled, Multicenter Study. J Pers Med. 2023 Feb 14;13(2):325. doi: 10.3390/jpm13020325. PMID: 36836559; PMCID: PMC9960354.
97. Hansen NC, Hvid-Hansen A, Møller F, Bek T, Larsen DA, Jacobsen N, Kessel L. Safety and efficacy of 0.01% and 0.1% low-dose atropine eye drop regimens for reduction of myopia progression in Danish children: a randomized clinical trial examining one-year effect and safety. BMC Ophthalmol. 2023 Oct 30;23(1):438. doi: 10.1186/s12886-023-03177-9. PMID: 37904082; PMCID: PMC10614417.
98. Hansen NC, Hvid-Hansen A, Møller F, Bek T, Larsen DA, Jacobsen N, Kessel L. Two-Year Results of 0.01% Atropine Eye Drops and 0.1% Loading Dose for Myopia Progression Reduction in Danish Children: A Placebo-Controlled, Randomized Clinical Trial. J Pers Med. 2024 Feb 2;14(2):175. doi: 10.3390/jpm14020175. Erratum in: J Pers Med. 2025 Dec 17;15(12):628. doi: 10.3390/jpm15120628. PMID: 38392608; PMCID: PMC10890135.
99. Loughman J, Kobia-Acquah E, Lingham G, Butler J, Loskutova E, Mackey DA, Lee SSY, Flitcroft DI. Myopia outcome study of atropine in children: Two-year result of daily 0.01% atropine in a European population. Acta Ophthalmol. 2024 May;102(3):e245-e256. doi: 10.1111/aos.15761. Epub 2023 Sep 11. PMID: 37694816.
100. Moriche-Carretero M, Revilla-Amores R, Gutiérrez-Blanco A, Moreno-Morillo FJ, Martinez-Perez C, Sánchez-Tena MÁ, Alvarez-Peregrina C. Five-year results of atropine 0.01% efficacy in the myopia control in a European population. Br J Ophthalmol. 2024 May 21;108(5):715-719. doi: 10.1136/bjo-2022-322808. PMID: 37268328.
101. Loughman J, Lingham G, Nkansah EK, Kobia-Acquah E, Flitcroft DI. Efficacy and Safety of Different Atropine Regimens for the Treatment of Myopia in Children: Three-Year Results of the MOSAIC Randomized Clinical Trial. JAMA Ophthalmol. 2025 Feb 1;143(2):134-144. doi: 10.1001/jamaophthalmol.2024.5703. PMID: 39786755; PMCID: PMC11843376.
102. Hansen N, Hvid-Hansen A, Møller F, Bek T, Larsen D, Jacobsen N, Kessel L. 3-year results of 0.01% and 0.1% loading dose atropine treatment including washout in Danish children with myopia: a placebo-controlled, randomised clinical trial. Br J Ophthalmol. 2025 Aug 20;109(9):1056-1063. doi: 10.1136/bjo-2024-326918. PMID: 40122578; PMCID: PMC12418564.
103. Chia A, Chua WH, Cheung YB, Wong WL, Lingham A, Fong A, Tan D. Atropine for the treatment of childhood myopia: safety and efficacy of 0.5%, 0.1%, and 0.01% doses (Atropine for the Treatment of Myopia 2). Ophthalmology. 2012 Feb;119(2):347-54. doi: 10.1016/j.ophtha.2011.07.031. Epub 2011 Oct 2. PMID: 21963266.
104. Yam JC, Jiang Y, Tang SM, Law AKP, Chan JJ, Wong E, Ko ST, Young AL, Tham CC, Chen LJ, Pang CP. 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 Jan;126(1):113-124. doi: 10.1016/j.ophtha.2018.05.029. Epub 2018 Jul 6. PMID: 30514630.
105. Wei S, Li SM, An W, Du J, Liang X, Sun Y, Zhang D, Tian J, Wang N. Safety and Efficacy of Low-Dose Atropine Eyedrops for the Treatment of Myopia Progression in Chinese Children: A Randomized Clinical Trial. JAMA Ophthalmol. 2020 Nov 1;138(11):1178-1184. doi: 10.1001/jamaophthalmol.2020.3820. PMID: 33001210; PMCID: PMC7530823.
106. Yam JC, Li FF, Zhang X, Tang SM, Yip BHK, Kam KW, Ko ST, Young AL, Tham CC, Chen LJ, Pang CP. Two-Year Clinical Trial of the Low-Concentration Atropine for Myopia Progression (LAMP) Study: Phase 2 Report. Ophthalmology. 2020 Jul;127(7):910-919. doi: 10.1016/j.ophtha.2019.12.011. Epub 2019 Dec 21. PMID: 32019700.
107. Yam JC, Zhang XJ, Zhang Y, Wang YM, Tang SM, Li FF, Kam KW, Ko ST, Yip BHK, Young AL, Tham CC, Chen LJ, Pang CP. Three-Year Clinical Trial of Low-Concentration Atropine for Myopia Progression (LAMP) Study: Continued Versus Washout: Phase 3 Report. Ophthalmology. 2022 Mar;129(3):308-321. doi: 10.1016/j.ophtha.2021.10.002. Epub 2021 Oct 7. PMID: 34627809.
108. Lee SS, Lingham G, Blaszkowska M, Sanfilippo PG, Koay A, Franchina M, Chia A, Loughman J, Flitcroft DI, Hammond CJ, Azuara-Blanco A, Crewe JM, Clark A, Mackey DA. Low-concentration atropine eyedrops for myopia control in a multi-racial cohort of Australian children: A randomised clinical trial. Clin Exp Ophthalmol. 2022 Dec;50(9):1001-1012. doi: 10.1111/ceo.14148. Epub 2022 Sep 9. PMID: 36054556; PMCID: PMC10086806.
109. Yam JC, Zhang XJ, Zhang Y, Yip BHK, Tang F, Wong ES, Bui CHT, Kam KW, Ng MPH, Ko ST, Yip WWK, Young AL, Tham CC, Chen LJ, Pang CP. Effect of Low-Concentration Atropine Eyedrops vs Placebo on Myopia Incidence in Children: The LAMP2 Randomized Clinical Trial. JAMA. 2023 Feb 14;329(6):472-481. doi: 10.1001/jama.2022.24162. Erratum in: JAMA. 2023 Apr 4;329(13):1123. doi: 10.1001/jama.2023.3989. PMID: 36786791; PMCID: PMC9929700.
110. Repka MX, Weise KK, Chandler DL, Wu R, Melia BM, Manny RE, Kehler LAF, Jordan CO, Raghuram A, Summers AI, Lee KA, Petersen DB, Erzurum SA, Pang Y, Lenhart PD, Ticho BH, Beck RW, Kraker RT, Holmes JM, Cotter SA; Pediatric Eye Disease Investigator Group. Low-Dose 0.01% Atropine Eye Drops vs Placebo for Myopia Control: A Randomized Clinical Trial. JAMA Ophthalmol. 2023 Aug 1;141(8):756-765. doi: 10.1001/jamaophthalmol.2023.2855. PMID: 37440213; PMCID: PMC10346510.

111. Zhang XJ, Zhang Y, Yip BHK, Kam KW, Tang F, Ling X, Ng MPH, Young AL, Wu PC, Tham CC, Chen LJ, Pang CP, Yam JC. Five-Year Clinical Trial of the Low-Concentration Atropine for Myopia Progression (LAMP) Study: Phase 4 Report. Ophthalmology. 2024 Sep;131(9):1011-1020. doi: 10.1016/j.ophtha.2024.03.013. Epub 2024 Mar 16. PMID: 38494130.
112. Chua WH, Balakrishnan V, Chan YH, Tong L, Ling Y, Quah BL, Tan D. Atropine for the treatment of childhood myopia. Ophthalmology. 2006 Dec;113(12):2285-91. doi: 10.1016/j.ophtha.2006.05.062. Epub 2006 Sep 25. PMID: 16996612.
113. Tong L, Huang XL, Koh AL, Zhang X, Tan DT, Chua WH. Atropine for the treatment of childhood myopia: effect on myopia progression after cessation of atropine. Ophthalmology. 2009 Mar;116(3):572-9. doi: 10.1016/j.ophtha.2008.10.020. Epub 2009 Jan 22. PMID: 19167081.
114. Bullimore MA, Berntsen DA. Low-Dose Atropine for Myopia Control: Considering All the Data. JAMA Ophthalmol. 2018 Mar 1;136(3):303. doi: 10.1001/jamaophthalmol.2017.6638. PMID: 29423500.
115. Chia A, Chua WH, Wen L, Fong A, Goon YY, Tan D. Atropine for the treatment of childhood myopia: changes after stopping atropine 0.01%, 0.1% and 0.5%. Am J Ophthalmol. 2014 Feb;157(2):451-457.e1. doi: 10.1016/j.ajo.2013.09.020. Epub 2013 Dec 4. PMID: 24315293.
116. Chia A, Lu QS, Tan D. Five-Year Clinical Trial on Atropine for the Treatment of Myopia 2: Myopia Control with Atropine 0.01% Eyedrops. Ophthalmology. 2016 Feb;123(2):391-399. doi: 10.1016/j.ophtha.2015.07.004. Epub 2015 Aug 11. PMID: 26271839.
117. Li Y, Yip M, Ning Y, Chung J, Toh A, Leow C, Liu N, Ting D, Schmetterer L, Saw SM, Jonas JB, Chia A, Ang M. Topical Atropine for Childhood Myopia Control: The Atropine Treatment Long-Term Assessment Study. JAMA Ophthalmol. 2024 Jan 1;142(1):15-23. doi: 10.1001/jamaophthalmol.2023.5467. PMID: 38019503; PMCID: PMC10690578.
118. Singapore National Eye Centre (2025). 'The Use of Atropine 0.01% in the Prevention and Control of Myopia (ATOM3)'. NCT03140358. Available at: https://clinicaltrials.gov/study/NCT03140358 (Accessed: February 10, 2026).
119. Lee SS, Nilagiri VK, Lingham G, Blaszkowska M, Sanfilippo PG, Franchina M, Clark A, Mackey DA. Myopia progression following 0.01% atropine cessation in Australian children: Findings from the Western Australia - Atropine for the Treatment of Myopia (WA-ATOM) study. Clin Exp Ophthalmol. 2024 Jul;52(5):507-515. doi: 10.1111/ceo.14368. Epub 2024 Feb 23. PMID: 38400607.
120. Lee SH, Tsai PC, Chiu YC, Wang JH, Chiu CJ. Myopia progression after cessation of atropine in children: a systematic review and meta-analysis. Front Pharmacol. 2024 Jan 22;15:1343698. doi: 10.3389/fphar.2024.1343698. PMID: 38318144; PMCID: PMC10838978.
121. Hieda O, Hiraoka T, Fujikado T, Ishiko S, Hasebe S, Torii H, Takahashi H, Tanaka S, Kinoshita S; ATOM-J Study Group. Assessment of myopic rebound effect after discontinuation of treatment with 0.01% atropine eye drops in Japanese school-age children. Jpn J Ophthalmol. 2023 Sep;67(5):602-611. doi: 10.1007/s10384-023-01012-8. Epub 2023 Aug 7. PMID: 37548816.
122. Xu S, Wang M, Qu Y, Wang Y, Jiang J, Zhou F, Zhao W, Zheng B, Chen W, Lei X, Li Z, Hu Y, Yang X. Twice-daily administration improves the effectiveness of 0.01% atropine for controlling myopia in slowing axial elongation and refractive progression. Ophthalmic Physiol Opt. 2025 Nov;45(7):1856-1866. doi: 10.1111/opo.13558. Epub 2025 Jul 23. PMID: 40698880.
123. Santen Pharmaceutical Company (2025). 'European Commission Approves Santen's Ryjunea® to Slow Progression of Paediatric Myopia'. Available at: https://www.santen.com/en/news/2025/2025_1/20250605 (Accessed: February 10, 2026).
124. Committee for Medicinal Products for Human Use (CHMP) (2025). 'SUMMARY OF PRODUCT CHARACTERISTICS: Ryjunea 0.1 mg/ml eye drops, solution (EMA/134905/2025)'. Available at: https://www.ema.europa.eu/en/medicines/human/EPAR/ryjunea (Accessed: February 10, 2026).
125. European Medicines Agency: Assessment report: EMA/134905/2025, Committee for Medicinal Products for Human Use (CHMP) (2025). 'Ryjunea, International non-proprietary name: atropine sulfate, Procedure No. EMEA/H/C/006324/0000'. Available at: https://www.ema.europa.eu/en/documents/assessment-report/ryjunea-epar-public-assessment-report_en.pdf (Accessed: February 10, 2026).
126. Johnson P, Widder K, Cheetham J, Kirkeby L. Methods and baseline of a large, multicenter, phase 3 study with low-dose atropine (SYD-101) for the treatment of myopia progression in over 800 children (STAR Study). Investigative Ophthalmology & Visual Science. 2025 Jun 30;66(8):2825-. Link
127. Santen Pharmaceutical Company (2025). 'Santen Launches Ryjunea® in Germany for the Treatment of Pediatric Myopia'. Available at: https://www.santen.com/en/news/2025/2025_1/20250722 (Accessed: February 10, 2026).
128. Richdale K, Skidmore KV, Tomiyama ES, Bullimore MA. Compounded 0.01% Atropine-What's in the Bottle? Eye Contact Lens. 2023 Jun 1;49(6):219-223. doi: 10.1097/ICL.0000000000000990. Epub 2023 Apr 5. PMID: 37022143; PMCID: PMC10194055.

129. Polypharma (2020).'Miofree - 100 mcg/ml, Eye drops, solution (Atropini sulfas); Summary of Product Characteristics (SmPC)'. Available at: https://polpharma.pl/produkty/miofree-krople-do-oczu-01-mg-ml-25ml/ (Accessed: February 10, 2026).
130. Huang Z, He T, Zhang J, Du C. Red light irradiation as an intervention for myopia. Indian J Ophthalmol. 2022 Sep;70(9):3198-3201. doi: 10.4103/ijo.IJO_15_22. PMID: 36018087; PMCID: PMC9675534.
131. Yang W, Lin F, Li M, Wei R, Zhou J, Zhou X. Immediate Effect in the Retina and Choroid after 650 nm Low-Level Red Light Therapy in Children. Ophthalmic Res. 2023;66(1):312-318. doi: 10.1159/000527787. Epub 2022 Oct 31. PMID: 36315988.
132. Jiang Y, Zhu Z, Tan X, Kong X, Zhong H, Zhang J, Xiong R, Yuan Y, Zeng J, Morgan IG, He M. Effect of Repeated Low-Level Red-Light Therapy for Myopia Control in Children: A Multicenter Randomized Controlled Trial. Ophthalmology. 2022 May;129(5):509-519. doi: 10.1016/j.ophtha.2021.11.023. Epub 2021 Dec 1. PMID: 34863776.
133. Zhu Q, Cao X, Zhang Y, Zhou Y, Zhang J, Zhang X, Zhu Y, Xue L. Repeated Low-Level Red-Light Therapy for Controlling Onset and Progression of Myopia-a Review. Int J Med Sci. 2023 Sep 4;20(10):1363-1376. doi: 10.7150/ijms.85746. PMID: 37786442; PMCID: PMC10542022.
134. Xiong R, Zhu Z, Jiang Y, Kong X, Zhang J, Wang W, Kiburg K, Yuan Y, Chen Y, Zhang S, Xuan M, Zeng J, Morgan IG, He M. Sustained and rebound effect of repeated low-level red-light therapy on myopia control: A 2-year post-trial follow-up study. Clin Exp Ophthalmol. 2022 Dec;50(9):1013-1024. doi: 10.1111/ceo.14149. Epub 2022 Sep 7. PMID: 36054314; PMCID: PMC10086781.
135. Tian L, Cao K, Ma DL, Zhao SQ, Lu LX, Li A, Chen CX, Ma CR, Ma ZF, Jie Y. Investigation of the Efficacy and Safety of 650 nm Low-Level Red Light for Myopia Control in Children: A Randomized Controlled Trial. Ophthalmol Ther. 2022 Dec;11(6):2259-2270. doi: 10.1007/s40123-022-00585-w. Epub 2022 Oct 8. PMID: 36208391; PMCID: PMC9587157.
136. Xu Y, Cui L, Kong M, Li Q, Feng X, Feng K, Zhu H, Cui H, Shi C, Zhang J, Zou H. Repeated Low-Level Red Light Therapy for Myopia Control in High Myopia Children and Adolescents: A Randomized Clinical Trial. Ophthalmology. 2024 Nov;131(11):1314-1323. doi: 10.1016/j.ophtha.2024.05.023. Epub 2024 Jun 6. PMID: 38849054.
137. Deen N, Zhu Z, Qi Z, Aung YY, Bulloch G, Miao D, He M. Three-Month Interim Analyses of Repeated Low-Level Red-Light Therapy in Myopia Control in Schoolchildren: A Pilot Multi-Ethnic Randomized Controlled Trial. Ophthalmic Epidemiol. 2025 May 19:1-9. doi: 10.1080/09286586.2025.2500020. Epub ahead of print. PMID: 40388203.
138. Chen H, Wang W, Liao Y, Zhou W, Li Q, Wang J, Tang J, Pei Y, Wang X. Low-intensity red-light therapy in slowing myopic progression and the rebound effect after its cessation in Chinese children: a randomized controlled trial. Graefes Arch Clin Exp Ophthalmol. 2023 Feb;261(2):575-584. doi: 10.1007/s00417-022-05794-4. Epub 2022 Aug 17. PMID: 35976467.
139. Tang J, Liao Y, Yan N, Dereje SB, Wang J, Luo Y, Wang Y, Zhou W, Wang X, Wang W. Efficacy of Repeated Low-Level Red-Light Therapy for Slowing the Progression of Childhood Myopia: A Systematic Review and Meta-analysis. Am J Ophthalmol. 2023 Aug;252:153-163. doi: 10.1016/j.ajo.2023.03.036. Epub 2023 Apr 7. PMID: 37030495.
140. Liu H, Yang Y, Guo J, Peng J, Zhao P. Retinal Damage After Repeated Low-level Red-Light Laser Exposure. JAMA Ophthalmol. 2023 Jul 1;141(7):693-695. doi: 10.1001/jamaophthalmol.2023.1548. PMID: 37227712.
141. Ostrin LA, Schill AW. Red light instruments for myopia exceed safety limits. Ophthalmic Physiol Opt. 2024 Mar;44(2):241-248. doi: 10.1111/opo.13272. Epub 2024 Jan 5. PMID: 38180093; PMCID: PMC10922340.
142. Kinoshita N, Konno Y, Hamada N, Kanda Y, Shimmura-Tomita M, Kaburaki T, Kakehashi A. Efficacy of combined orthokeratology and 0.01% atropine solution for slowing axial elongation in children with myopia: a 2-year randomised trial. Sci Rep. 2020 Jul 29;10(1):12750. doi: 10.1038/s41598-020-69710-8. PMID: 32728111; PMCID: PMC7391648.
143. Tan Q, Ng AL, Cheng GP, Woo VC, Cho P. Combined 0.01% atropine with orthokeratology in childhood myopia control (AOK) study: A 2-year randomized clinical trial. Cont Lens Anterior Eye. 2023 Feb;46(1):101723. doi: 10.1016/j.clae.2022.101723. Epub 2022 May 31. PMID: 35654683.
144. Huang Z, Chen XF, He T, Tang Y, Du CX. Synergistic effects of defocus-incorporated multiple segments and atropine in slowing the progression of myopia. Sci Rep. 2022 Dec 24;12(1):22311. doi: 10.1038/s41598-022-25599-z. Erratum in: Sci Rep. 2023 Jun 14;13(1):9650. doi: 10.1038/s41598-023-36663-7. PMID: 36566245; PMCID: PMC9789944.
145. Nucci P, Lembo A, Schiavetti I, Shah R, Edgar DF, Evans BJW. 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 Feb 16;18(2):e0281816. doi: 10.1371/journal.pone.0281816. PMID: 36795775; PMCID: PMC9934319.
146. Guemes-Villahoz N, Talavero González P, Porras-Ángel P, Bella-Gala R, Ruiz-Pomeda A, Martin-Garcia B, Hernandez-Garcia E, Gomez de Liaño N, Shah R, Garcia-Feijoo J, Gomez-de-Liaño R. Atropine and Spectacle lens Combination Treatment (ASPECT): 12-month results of a randomised controlled trial for myopia control using a combination of Defocus Incorporated Multiple Segments (DIMS) lenses and 0.025% atropine. Br J Ophthalmol. 2025 Aug 20;109(9):1074-1080. doi: 10.1136/bjo-2024-326852. PMID: 40345841; PMCID: PMC12418587.

147. Jones JH, Mutti DO, Jones-Jordan LA, Walline JJ. Effect of Combining 0.01% Atropine with Soft Multifocal Contact Lenses on Myopia Progression in Children. Optom Vis Sci. 2022 May 1;99(5):434-442. doi: 10.1097/OPX.0000000000001884. Epub 2022 Feb 25. PMID: 35511120; PMCID: PMC9072981.
148. Erdinest N, Atar-Vardi M, London N, Landau D, Smadja D, Pras E, Lavy I, Morad Y. Treatment of Rapid Progression of Myopia: Topical Atropine 0.05% and MF60 Contact Lenses. Vision (Basel). 2024 Jan 19;8(1):3. doi: 10.3390/vision8010003. PMID: 38391084; PMCID: PMC10885127.
149. Xiong R, Wang W, Tang X, He M, Hu Y, Zhang J, Du B, Jiang Y, Zhu Z, Chen Y, Zhang S, Kong X, Wei R, Yang X, He M. Myopia Control Effect of Repeated Low-Level Red-Light Therapy Combined with Orthokeratology: A Multicenter Randomized Controlled Trial. Ophthalmology. 2024 Nov;131(11):1304-1313. doi: 10.1016/j.ophtha.2024.05.015. Epub 2024 May 18. PMID: 38763303.