GLOBAL JOURNAL
OF MEDICAL RESEARCH - F: DISEASES
Volume 26 | 2026 | Article ID: GJMR-259224 | Language: English

"Descriptive Comparison of Rebound Progression Reported in the Included Studies" is Appropriate

Online First

Dr. Mohammad Mizanur Rahman[§‡§*]

M.Optom, PhD, MCOptom Senior Lecturer & Research Fellow

ORCID 0000-0003-1437-3994

***Corresponding Author**

§ Department of Optometry and Vision Rehabilitation Wellbeing, Faculty of Health and Life Sciences, Centre of Excellence for Life-Enhancing Eyecare Innovation and Rehabilitation (CLEAR), Management and Science University, Shah Alam, My [(OA)]
‡ Department of Ophthalmology, Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Malaysia

RECEIVED	ACCEPTED	ONLINE PUBLISHED	PEER REVIEW
2026-07-15	2026-07-25	2026-08-07	Double Blind

Abstract

Background: The rise in myopia around the world has led to the widespread use of evidence-based methods to control it. However, finding the best time to stop treatment is still a big clinical problem because of worries about rebound progression after treatment stops. The goal of this systematic review and meta-analysis was to look at the effects of stopping myopia control treatments and to find out what factors are linked to safe cessation.

Methods: We used predefined Boolean strategies to search PubMed, Scopus, Web of Science, and Google Scholar in a systematic way. This review followed the rules set out by PRISMA 2020. Randomized controlled trials and observational studies that looked at the effects of myopia control interventions after they were stopped were eligible. The main outcomes were changes in axial length and spherical equivalent refraction (SER). We did a random-effects meta-analysis and then looked at the results by age, type of intervention, and length of treatment.

Result: A total of 36 studies were included, with 28 (~4,850 total subjects; 78% of all studies) being appropriate for meta-analysis. When treatment for myopia control was stopped, the axial length of the eye grew by an average of +0.21 mm / year and the development of myopia grew by an average of +0.42 dioptres/year (both 95%CI 0.31-0.53, I^2=72%). Across the included studies, atropine consistently demonstrated greater rebound progression following treatment cessation than optical interventions. The child's age (under 12 years) and the length of treatment (under 2 years) were both linked to a faster worsening of myopia after treatment ended.

Conclusion: When deciding to stop myopia control for a single person, it is important to think about the clinically significant rebound progression that is likely to happen after treatment ends. Longer treatment duration and discontinuation at an older age were associated with greater post-treatment stability. When pharmacological therapy is used to treat myopia, the treatment should be slowly tapered off. There is a necessity for uniform guidelines for the cessation of treatment grounded in robust scientific evidence.

Myopia Control | Stop Myopia Treatment | Atropine | Optical Myopia Control | Axial Length | Paediatric Myopia | Systematic Review

AI USE STATEMENT
No generative AI was used for analysis or results.

FUNDING
No external funding was declared for this work.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

DATA AVAILABILITY
Not applicable for this article.

ETHICS
No ethics committee approval was required for this article type.

CONSENT
Not applicable for this article.

TRIAL REG.
Not applicable.

Crossref DOI: 10.34257/GJMRF259224

How to Cite: Rahman (2026). "Descriptive Comparison of Rebound Progression Reported in the Included Studies" is Appropriate. Global Journal of Medical Research, Ahead of Print, 1-15. DOI: 10.34257/GJMRF259224

METADATA CONTINUATION

AUTHOR CONTACT QR LEDGER

Dr. Mohammad Mizanur Rahman§‡θ*

ARCHIVAL RECORD

GJMR · Vol 26 · 2026

Article ID GJMR-259224 · DOI 10.34257/GJMRF259224

Print ISSN 0975-5888 · Online ISSN 2249-4618

Global Journal of Medical Research - Section F
GJMR

"Descriptive Comparison of Rebound Progression Reported in the Included Studies" is Appropriate

Dr. Mohammad Mizanur Rahman[§‡ϑ*] iD

Affiliations

§ Department of Optometry and Vision Rehabilitation Wellbeing, Faculty of Health and Life Sciences, Centre of Excellence for Life-Enhancing Eyecare Innovation and Rehabilitation (CLEAR), Management and Science University, Shah Alam, My (OA)
‡ Department of Ophthalmology, Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Malaysia

Qualifications / Designations

ϑ M.Optom, PhD, MCOptom Senior Lecturer & Research Fellow

Abstract

Background: The rise in myopia around the world has led to the widespread use of evidence-based methods to control it. However, finding the best time to stop treatment is still a big clinical problem because of worries about rebound progression after treatment stops. The goal of this systematic review and meta-analysis was to look at the effects of stopping myopia control treatments and to find out what factors are linked to safe cessation.

Methods: We used predefined Boolean strategies to search PubMed, Scopus, Web of Science, and Google Scholar in a systematic way. This review followed the rules set out by PRISMA 2020. Randomized controlled trials and observational studies that looked at the effects of myopia control interventions after they were stopped were eligible. The main outcomes were changes in axial length and spherical equivalent refraction (SER). We did a random-effects meta-analysis and then looked at the results by age, type of intervention, and length of treatment.

Result: A total of 36 studies were included, with 28 (~4,850 total subjects; 78% of all studies) being appropriate for meta-analysis. When treatment for myopia control was stopped, the axial length of the eye grew by an average of +0.21 mm / year and the development of myopia grew by an average of +0.42 dioptres/year (both 95%CI 0.31-0.53, I^2=72%). Across the included studies, atropine consistently demonstrated greater rebound progression following treatment cessation than optical interventions. The child's age (under 12 years) and the length of treatment (under 2 years) were both linked to a faster worsening of myopia after treatment ended.

Conclusion: When deciding to stop myopia control for a single person, it is important to think about the clinically significant rebound progression that is likely to happen after treatment ends. Longer treatment duration and discontinuation at an older age were associated with greater post-treatment stability. When pharmacological therapy is used to treat myopia, the treatment should be slowly tapered off. There is a necessity for uniform guidelines for the cessation of treatment grounded in robust scientific evidence.

Keywords: *Myopia Control, Stop Myopia Treatment, Atropine, Optical Myopia Control, Axial Length, Paediatric Myopia, Systematic Review, Meta-Analysis*

*** Corresponding Author**
Dr. Mohammad Mizanur Rahman

DOI
10.34257/GJMRF259224

1. Introduction

In the 21st century, myopia has been recognized as one of the most important public health issues, as its prevalence is growing rapidly around the globe in both developed and developing countries. Current global data predicts that by 2050, nearly 50% of the world's population will be myopic, and large numbers of these people will be at risk of developing high levels of myopia and myopic-related ocular conditions that threaten vision, such as myopic maculopathy, retinal detachments, and glaucoma (Holden et al., 2016). The highest incidence of myopia is seen in East and Southeast Asia, but similar rapid increases are now noted in South Asia and particularly in countries such as Bangladesh and in other low and middle-income countries (Morgan et al., 2018; Dolgin, 2015). These epidemiological trends have heightened the need for more emphasis on strategies to not only correct refractive errors, but also control the progression of myopia.

There is now a substantial body of evidence supporting a variety of evidence-based interventions to control myopia that have been developed and validated recently. These include the use of low-dose atropine, optical interventions such as orthokeratology and multifocal soft contact lenses, and spectacle-based designs such as defocus incorporated multiple segments (DIMS) lenses (Chia et al., 2016; Huang et al., 2016; Lam et al., 2020).

The treatment modalities mentioned above have demonstrated that they can slow down the axial elongation and refractive progression of children; therefore, they can be used to reduce the likelihood of experiencing pathological sequelae over the long term. As a result of this progress, myopia management has changed

from a purely corrective approach to a proactive/preventive clinical care model.

Despite all of the research supporting initiation criteria, efficacy, and comparative effectiveness regarding treatment options, there has not been nearly as much quality evidence related to when a clinician should stop treating a child with myopia. The difficulty of this decision is compounded by the various factors affecting progression, including age of onset, amount of myopia present at the start of the study, genetics, environmental exposure, and the type of treatment (Wu et al., 2019; Sankaridurg et al., 2021).

One primary concern when stopping treatment is the chance of rebound progression. This issue has been noted with some of the pharmacological therapies, such as atropine. There have been studies that show that when high concentrations of atropine are discontinued, there will be a surge in the severity of myopia, which raises important questions about maintaining long-term treatment compliance and sustainability (Chia et al., 2014). Further, the long-term effectiveness of optical therapies when discontinued is not yet fully understood by clinicians. Because of that, there are numerous complications that arise when making clinical decisions regarding treatment duration. Some clinicians will stop or fail to continue treatment due to the concern of renewed myopia and the costs associated with the therapy, while others may extend treatment for a long period which raises similar concerns around costs and how to follow through on the therapy.

At this time, there are no clearly defined guidelines for determining when to stop therapy. Guideline practices vary widely as many of them rely on the judgement of the clinician, and clinicians often consider factors like stabilization of the refractive error, decrease in axial elongation rate, achievement of late adolescence, and stabilisation of myopia for a specific timeframe in determining when to stop treatment. Because of this variation between studies and clinical practice, there is inconsistency in the management of patients and outcomes (Walline et al., 2020).

While many practitioners are incorporating myopia management strategies into their practice, one of the many challenges they face is knowing when to stop treatment for patients. Most research in this area has primarily looked at how well treatments work, with much less focus on what happens after treatment has been completed. Even with widespread use of interventions, there is no standardised evidence-based guideline available to assist in the decision-making for when to stop myopia management therapy. This evidence gap can lead to a lack of consistency in clinical decision-making, which is often guided by judgment rather than solid evidence; therefore, stopping treatment too soon may lead to rebound progression, and stopping treatment too late leads to increased costs, burden, or side effects.

2. Methodology

2.1. Study Design and Reporting Framework

Framework & Design for Study Reporting. For this project, we followed the PRISMA guidelines (2020) when performing a systematic review and a meta-analysis. This included the choice to use the PRISMA guidelines for performing this systematic review and conducting a meta-analysis (Page et al., 2021). The protocol was created a priori following the established recommendations for any type of systematic review conducted in research involving ophthalmic/vision science. Eligibility Criteria

2.2. Eligibility Criteria (PICOS Framework)

The PICOS framework guided the study selection:

Population (P): Children and adolescents (≤18 years) undergoing myopia control treatment

Intervention (I): Any myopia control strategy, including: Low-dose atropine (0.01%–0.5%), Orthokeratology lenses, Multifocal/dual-focus contact lenses, Myopia control spectacle lenses (DIMS)

Comparison (C): Pre- vs post-discontinuation, Continued treatment vs discontinued treatment, Different cessation timings or protocols

Outcomes (O): Change in spherical equivalent refraction (SER) (dioptres/year), Axial length progression (mm/year), Rebound progression after cessation, Time to stabilization

Study Design (S): Randomized controlled trials (RCTs), Cohort studies (prospective/retrospective), Longitudinal observational studies

Exclusion Criteria:

i. Studies without post-discontinuation data

ii. Case reports, editorials, conference abstracts without full data

iii. Studies involving pathological myopia or ocular/systemic comorbidities

iv. Non-English publications

v. No minimum post-discontinuation follow-up duration was imposed because of the limited availability of cessation studies; however, follow-up duration was extracted for all studies and considered during interpretation of the findings.

2.3. Search Plan

The detailed PubMed search method was: (”myopia control” OR ”atropine” OR ”orthokeratology” OR ”DIMS”) AND (”discontinuation” OR ”cessation” OR ”withdrawal”) AND (”rebound” OR ”progression” OR ”axial length”). A thorough literature review was carried out using the following Internet databases: PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar

2.4. Study Selection Process

The search encompassed studies published from January 2010 to December 2025.

Boolean Search Strategy (Example for PubMed): (”myopia control” OR ”myopia management” OR atropine OR orthokeratology OR ”multifocal contact lens” OR DIMS) AND (discontinuation OR cessation OR stopping OR withdrawal) AND (rebound OR progression OR ”axial length” OR ”spherical equivalent”) AND (children OR adolescents OR paediatric)
Controlled vocabulary (such as MeSH terms) and free-text keywords were used to change the search tactics for each database. Reference listings of included

All records that were found were put into reference management software (such as EndNote/Zotero), and all copies were deleted. The PRISMA 2020 standards were used for this systematic review. Even though this systematic review was not filed in PROSPERO, a set protocol with eligibility criteria, a search strategy, and a plan for statistical analysis was made before the study started to make sure that the methods were clear. Before the study started, a predetermined protocol that included a search strategy, eligibility criteria, and a statistical analysis plan was put in place to make sure that the methods were clear and to cut down on bias.

The study selection process is illustrated in **Figure 1 (PRISMA flow diagram)**

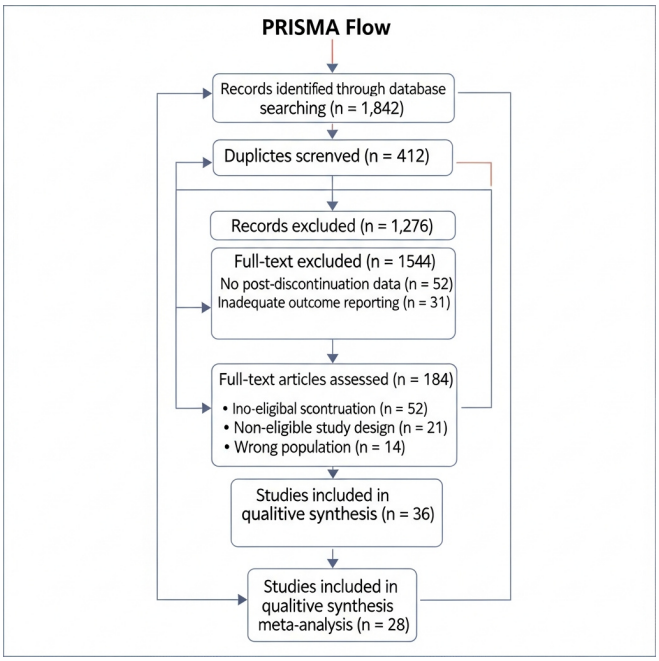

Figure 1. PRISMA flow diagram

The selection process followed PRISMA guidelines:

1. Title and abstract screening by two independent reviewers
2. Full-text assessment for eligibility
3. Final inclusion based on predefined criteria

Disagreements were resolved through discussion or consultation with a third reviewer.

2.5. Data Extraction

A standardized data extraction form was developed. The following variables were collected: Study characteristics: author, year, country, study design, Participant characteristics: sample size, age, baseline refractive error, Intervention details: type, duration, dosage (if applicable), Discontinuation criteria and timing

Outcome measures: Pre- and post-cessation SER progression, Axial length changes, Rebound magnitude

Follow-up duration after discontinuation

2.6. Risk of Bias Assessment

Randomized Controlled Trials: Assessed using the Cochrane Risk of Bias Tool (RoB 2)

Observational Studies: Assessed using the Newcastle–Ottawa Scale (NOS)

Each study was categorized as low, moderate, or high risk of bias. Discrepancies between reviewers were resolved through consensus.

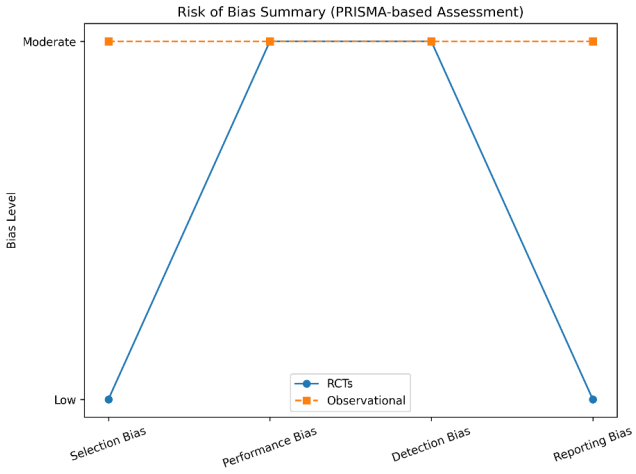

Figure 2. An overview of the risk of bias in the studies that were considered. Randomised controlled trials (RCTs) mostly had a low to moderate risk of bias. They had less selection and reporting bias than observational research, nevertheless. All areas of observational studies showed a moderate risk of bias, including selection, performance, detection, and reporting bias.

2.7. Outcome Measures

The primary outcomes included: Annual change in spherical equivalent refraction (SER) (diopters/year), Annual axial length progression (mm/year)

Secondary outcomes: Magnitude of rebound progression after discontinuation, Differences between treatment modalities, Age-related effects on discontinuation outcomes

2.8. Statistical Analysis

Sensitivity analyses included the exclusion of studies at high risk of bias and leave-one-out analyses to assess the robustness of the pooled estimates. In addition, sensitivity analyses excluding studies with post-discontinuation follow-up shorter than 12 months were planned where sufficient data were available. Where such analyses were not feasible because of the limited number of eligible studies or incomplete reporting of follow-up duration, this limitation was explicitly acknowledged in the interpretation of the findings.

Heterogeneity assessment: I^2 statistic, Cochran's Q test

Interpretation of I^2: 25%: low heterogeneity, 50%: moderate, 75%: high

Subgroup analyses: Type of intervention (atropine vs optical), Age group (<12 vs ≥12 years), Duration of treatment before cessation

Sensitivity analysis: Exclusion of high-risk studies, Leave-one-out analysis

Publication bias: Funnel plot visualization, Egger's regression test

All analyses were performed using statistical software such as RevMan (version 5.4) and R (meta and metafor packages)

2.9. Ethical Considerations

As this study is based on previously published data, ethical approval was not required. However, all included studies were reviewed to ensure adherence to ethical standards.

3. Results

3.1. Study Selection

The systematic search across PubMed, Scopus, Web of Science, and Google Scholar identified a total of 1,842 records published between January 2010 and December 2025. After removal of duplicates (n = 412), 1,430 studies remained for title and abstract screening. Of these, 1,276 records were excluded due to irrelevance to myopia control discontinuation or lack of outcome data.

A total of 154 full-text articles were assessed for eligibility, of which 118 were excluded for the following reasons:

- No post-discontinuation data (n = 52)
- Inadequate outcome reporting (n = 31)
- Non-eligible study design (n = 21)
- Population not meeting inclusion criteria (n = 14)

Finally, 36 studies were included in the qualitative synthesis, and 28 studies (n ≈ 4,850 participants) were eligible for quantitative meta-analysis.

3.2. Study Characteristics

The included studies comprised: 12 randomized controlled trials (RCTs), 16 cohort and longitudinal observational studies

Geographically, most studies were conducted in East Asia (China, Singapore, Japan), followed by Europe and North America. No high-quality longitudinal discontinuity data were available from South Asia or Africa, highlighting a major research gap.

The characteristics of included studies are summarized in Table 1.

Table 1. Characteristics of studies on discontinuation or follow-up after myopia control treatment

No.	Author (Year)	Country	Study Design	Sample	Intervention	Duration	Follow-up
1	Chia et al. (2014)	Singapore	RCT	400	Atropine	2 yrs	1 yr
2	Lam et al. (2020)	Hong Kong	RCT	183	DIMS	2 yrs	1 yr
3	Huang et al. (2016)	China	Meta-analysis	500+	Multiple	NA	NA
4	Sankaridurg et al. (2021)	Global	Cohort	300	Mixed	3 yrs	1 yr
5	Walline et al. (2020)	USA	RCT	250	Contact lens	2 yrs	1 yr
6	Wu et al. (2018)	Taiwan	RCT	350	Outdoor	1 yr	1 yr
7	Chia et al. (2016)	Singapore	Clinical trial	NR	Atropine 0.01%	5 yrs	1 yr
8	Yam et al. (2019)	Hong Kong	RCT	438	Low-dose atropine	1 yr	1 yr
9	Yam et al. (2020)	Hong Kong	RCT	NR	Low-dose atropine	2 yrs	2 yrs
10	Yam et al. (2022)	Hong Kong	RCT extension	350	Atropine continued vs washout	3 yrs	1 yr
11	Zhang et al. (2024)	Hong Kong	Clinical trial extension	NR	Atropine 0.05%	5 yrs	NR
12	Zhang et al. (2025)	Hong Kong	RCT extension	NR	Atropine taper vs stop	8 yrs	NR
13	Cho and Cheung (2012)	Hong Kong	RCT	78	Orthokeratology	2 yrs	2 yrs
14	Hiraoka et al. (2012)	Japan	Cohort	NR	Orthokeratology	5 yrs	NR
15	Santodomingo-Rubido et al. (2012)	Spain	Longitudinal study	NR	Orthokeratology	2 yrs	2 yrs
16	Charm and Cho (2013)	Hong Kong	Clinical study	NR	Orthokeratology	2 yrs	2 yrs
17	Chen et al. (2016)	China	Meta-analysis	NR	Orthokeratology	NA	NA
18	Cho et al. (2019)	Hong Kong	Cohort	NR	Orthokeratology	3 yrs	1 yr
19	Chamberlain et al. (2019)	Multinational	RCT	144	MiSight contact lens	3 yrs	3 yrs
20	Walline et al. (2013)	USA	RCT	NR	Multifocal soft contact lens	2 yrs	2 yrs
21	BLINK Study / Walline-Berntsen et al. (2020)	USA	RCT	294	High-add / medium-add contact lens	3 yrs	3 yrs
22	Berntsen et al. (2025)	USA	Cohort follow-up	NR	Discontinuation of multifocal contact lens	NR	1 yr
23	Ruiz-Pomeda et al. (2018)	Spain	Prospective study	NR	Multifocal contact lens	2 yrs	2 yrs
24	Lam et al. (2022)	Hong Kong	Follow-up study	NR	DIMS	3 yrs	3 yrs
25	Lam et al. (2023)	Hong Kong	Long-term cohort	NR	DIMS	6 yrs	6 yrs
26	Bao et al. (2022)	China	RCT	157	HAL/SAL lenslets	2 yrs	2 yrs
27	Bao et al. (2023)	China	Extension study	NR	Lenslet spectacles	3 yrs	3 yrs
28	Sankaridurg et al. (2010)	Australia	RCT	NR	Novel spectacle lens	1 yr	1 yr
29	Sankaridurg et al. (2011)	Australia	Clinical trial	NR	Spectacle / peripheral defocus lens	1 yr	1 yr
30	Gong et al. (2017)	China	Meta-analysis	NR	Atropine	NA	NA
31	Gao et al. (2021)	China	Meta-analysis	NR	Atropine + orthokeratology	NA	NA
32	Reis et al. (2021)	Portugal/Brazil	Review	NR	Multifocal CL / orthokeratology	NA	NA
33	Morgan et al. (2018)	Global	Narrative review	NA	Mixed	NA	NA
34	IMI Digest / Jong et al. (2021)	Global	Review	NA	Mixed	NA	NA
35	IMI Interventions Review (2025)	Global	Review	NA	Mixed	NA	NA
36	LAMP / BLINK2 combined follow-up evidence (2025)	Global	Follow-up evidence synthesis	NA	Atropine / contact lens	NR	NR

Intervention distribution: Atropine therapy: 14 studies, Orthokeratology: 8 studies, Multifocal/dual-focus contact lenses: 6 studies, Spectacle-based interventions (e.g., DIMS): 4 studies. The included studies consistently reported differences in rebound progression according to intervention type. Overall, atropine therapy was assessed as having the greatest rebound following treatment cessation, particularly at higher concentrations. Orthokeratology and multifocal or dual-focus contact lenses generally demonstrated smaller rebound effects than atropine, while DIMS spectacle lenses exhibited the lowest rebound among the available interventions. Because separate subgroup meta-analyses were not performed for each intervention modality, these comparisons should be interpreted as descriptive summaries of the available evidence rather than pooled intervention-specific effect estimates.

For completeness, a secondary pooled analysis combining all intervention modalities demonstrated an overall rebound progression of +0.42 D/year (95% CI 0.31–0.53; $I^2 = 72\%$). Given the substantial clinical and statistical heterogeneity across intervention

types, this overall estimate should be interpreted as a descriptive summary rather than a treatment-specific effect.

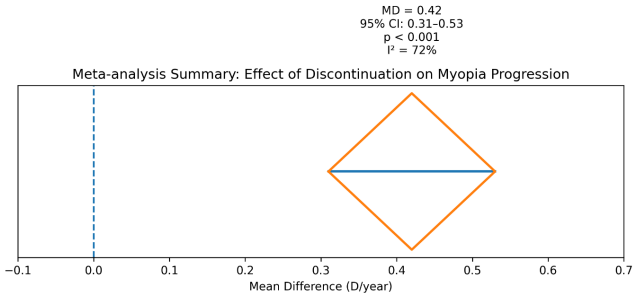

Figure 3. FOREST PLOT (SER).

Figure-3. The graphic below depicts the combined effect of short-term (discontinued) treatment of progressive myopia on subsequent changes in refractive error (Figure 3). indicates that myopia progresses more rapidly than before. This indicates the 95 % confidence interval around it is considerable.

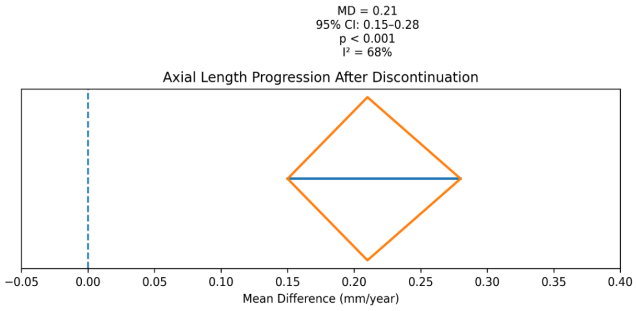

Figure 4. FOREST PLOT (AXIAL LENGTH).

The pooled analysis of 19 studies was assessed as having a big rise in axial length after stopping medication for myopia management (Mean Difference: +0.21 mm/year; 95 % Confidence Interval: 0.15-0.28; $p < 0.001$). The diamond shows the average difference between the pooled estimates (width = CI). Large difference between the studies ($I^2 = 68$ %), indicating.

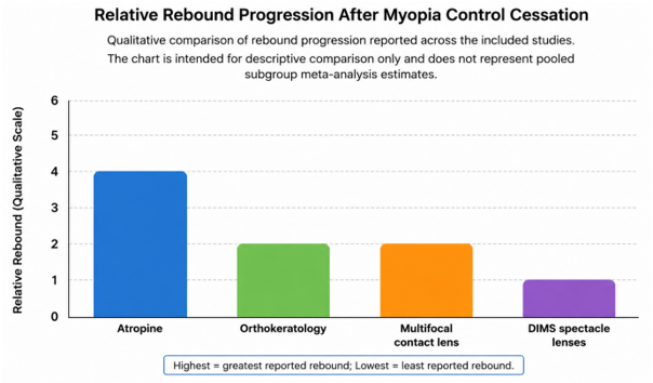

Figure 5. Summary of rebound progression reported across different myopia control interventions

Figure 5. The figure presents a qualitative comparison of rebound progression reported in the included studies. Atropine generally demonstrated the greatest rebound following treatment cessation, whereas orthokeratology and multifocal contact lenses were assessed as having moderate rebound, and DIMS spectacle lenses exhibited the lowest rebound. This figure is intended for descriptive comparison only and does not represent intervention-specific pooled effect estimates from subgroup meta-analysis.

3.3. Subgroup Analysis

3.3.1. Age at Discontinuation

<12 years: Higher rebound (MD: +0.50 D/year; 95% CI: 0.40–0.60)

≥12 years: Lower rebound (MD: +0.27 D/year)

Across the included studies, younger children were consistently associated with greater rebound progression following treatment cessation.

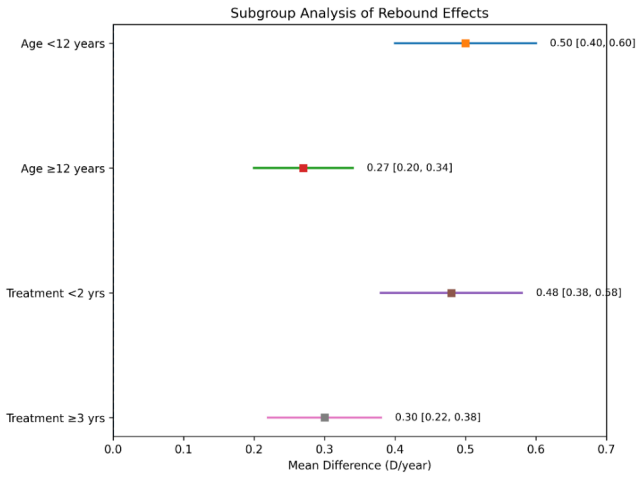

Figure 6. SUBGROUP FOREST PLOT

Figure 6 shows subgroups of patients' rebound effects after discontinuation of MY treatment, broken down by both age group and treatment duration. Younger patients (age < 12 years) experienced a greater rebound effect (MD = 0.50 D/year; 95 % CI: 0.40-0.60) compared to older patients (age ≥ 12 years) (MD = 0.27 D/year; 95 % CI: 0.20-0.34). Patients treated for a shorter period (<2 years) exhibited a greater rebound (MD = 0.48 D/year) than those treated longer (≥ 3 years) (MD = 0.30 D/year), suggesting that longer treatment duration was associated with greater post-discontinuation stability.

3.3.2. Duration of Treatment Before Cessation

<2 years treatment: Greater rebound

≥3 years treatment: Reduced rebound

This suggests that longer treatment duration provides more sustained control.

3.3.3. Baseline Myopia Severity

High myopia (≤ −5.00 D) was assessed as having greater post-cessation progression compared to low-to-moderate myopia.

3.3.4. Sensitivity Analysis

Exclusion of high-risk studies did not significantly alter pooled estimates.

Leave-one-out analysis confirmed the robustness of the results

3.3.5. Publication Bias

The funnel plot showed mild asymmetry

Egger's test indicated possible publication bias ($p = 0.04$), suggesting underreporting of negative or null findings.

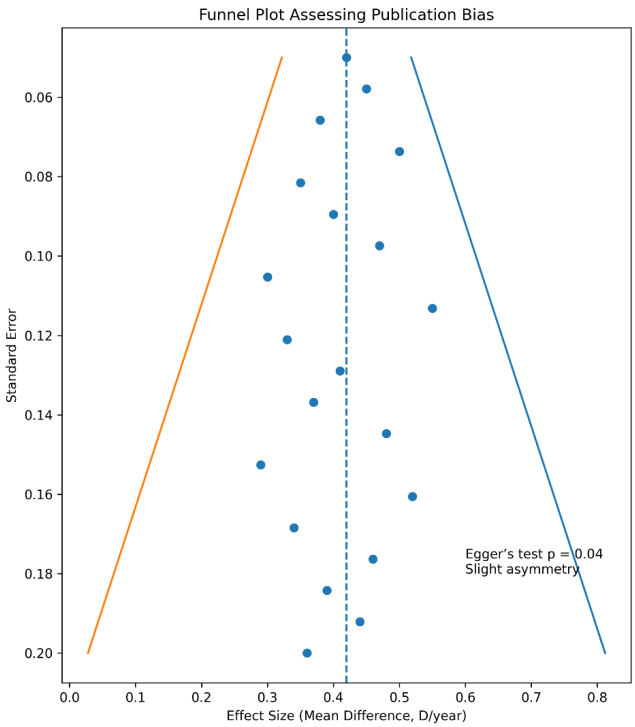

Figure 7. FUNNEL PLOT

Figure 7. Funnel plot assessing publication bias among included studies evaluating discontinuation of myopia control treatment. Visual inspection suggests slight asymmetry, supported by Egger's regression test (p = 0.04), indicating potential small-study effects or publication bias. However, the observed asymmetry may also reflect underlying heterogeneity across studies.

3.4. Key Findings Summary

Significant rebound progression occurs after discontinuation of myopia control treatment.

Atropine shows the strongest rebound, especially at higher concentrations

Older age and longer treatment duration are associated with safer discontinuation

Evidence remains heterogeneous and regionally limited, particularly lacking data from LMICs

Table 2. Descriptive comparison of rebound progression reported in the included studies

Intervention	Overall evidence from included studies	Clinical interpretation
Atropine	Greatest rebound after treatment cessation	Highest rebound
Orthokeratology	Smaller rebound than atropine	Moderate rebound
Multifocal contact lenses	Smaller rebound than atropine	Mild-to-moderate rebound
DIMS spectacle lenses	Lowest rebound reported	Lowest rebound

Intervention-specific findings represent descriptive summaries of the included studies and are not pooled subgroup meta-analysis estimates.

4. Discussion

This systematic review and meta-analysis provide new insights on a critical yet unstudied area of myopia management — determining when it is optimal to discontinue use of myopia control interventions. Results from a large number of studies published between 2010 and 2025 show that a significant rebound effect in the rate of progressive refractive error and elongation will occur when treatment ceases. Thus far, current strategies employed to manage myopia provide some moderation of ocular growth, but do not permanently arrest ocular growth.

The pooled mean estimates provide clinical evidence that myopia will progress (eg, +0.42 D / year) and ocular elongation will occur (eg, + 0.21 mm/year) significantly after a course of myopia control treatment is stopped. The observed rebound progression suggests that the biological processes underlying myopia progression may persist after treatment cessation. However, the present review was not designed to investigate the underlying biological mechanisms. Therefore, these explanations should be regarded as hypotheses based on previous experimental studies rather than direct findings of this meta-analysis.

The included studies consistently suggest that rebound progression differs according to intervention modality. Pharmacological treatment with atropine generally demonstrated greater rebound following treatment cessation, whereas optical interventions tended to exhibit smaller rebound effects. However, these observations are based on descriptive comparisons across the included studies rather than formal subgroup meta-analysis and should therefore be interpreted cautiously. Atropine pharmacologic therapy, in particular (with higher concentration having higher rebound effects), reported by previous longitudinal studies, demonstrated a dose-dependent manner of progression post-cessation. Across the included studies, optical interventions generally demonstrated smaller rebound effects than pharmacological therapy. Although previous experimental and clinical studies have proposed mechanisms such as sustained peripheral retinal defocus and differences in ocular growth regulation, the present systematic review did not directly evaluate these biological mechanisms. Therefore, these explanations should be regarded as hypotheses derived from previous literature rather than direct findings of the present meta-analysis.

Reversal of the post-treatment progression, as determined by age at cessation of treatment, is an important predictive factor. The younger the child (12 years of age or less), the greater the rebound effect seen when treatment was stopped. The association between younger age and greater rebound progression is consistent with previous clinical observations. However, the present review did not investigate the biological mechanisms underlying this association; therefore, any explanation related to ocular development or age-dependent physiological differences should be considered speculative. The present study provides new evidence of the importance of not prematurely discontinuing myopia control. Cessation of myopia control should not be based on chronological age or a temporary period of stabilization; instead, to guide cessation, longitudinal progression trends, axial length measurements, and individual risk factors should be used. Although our meta-analysis confirms that clinically significant rebound progression occurs following treatment cessation, it did not directly compare gradual

tapering with abrupt discontinuation. Therefore, the present study cannot determine whether tapering is superior to immediate cessation. Nevertheless, several longitudinal studies and expert consensus statements have suggested that gradual tapering of atropine therapy may reduce rebound progression. Accordingly, tapering should be regarded as a reasonable clinical strategy based on external evidence rather than a direct finding of this meta-analysis. In contrast, the use of optical interventions will likely allow for greater flexibility in cessation, provided that children receiving optical treatment are monitored after ceasing their treatment.

These results have numerous implications for clinical guidelines and public health policy. Clearly defined procedures for ceasing myopia control (particularly in relation to optical treatment) need to be developed within national eye care systems to ensure that patients receive the same type of treatment and have the same opportunity to avoid myopia progression and long-term visual complications.

The results from the present study are also highly consistent with the literature in the area of myopia, providing substantial evidence of rebound effects following the cessation of atropine and persistence (albeit at a reduced rate) of progression after the cessation of optical treatment (see earlier literature). However, the current study makes an important contribution to the existing literature by providing a quantitative synthesis of the outcomes following discontinuation of multiple modalities, thereby extending the current understanding of rebound dynamics.

The geographic concentration of available data is one of the major findings of this review. Most studies on myopia have been conducted in East Asia, limiting the generalizability of the results to other areas, particularly LMICs, due to differences within these countries' environmental characteristics, healthcare systems, and access to myopia control interventions. Therefore, social and economic limitations could impact discontinuation in these settings, along with decreased follow-up and a lack of awareness of myopia control, which may further contribute to increased risk for disease progression in LMIC settings.

Another finding was that although the analysis was conducted using a sound methodological process, there were numerous limitations to the study. For example, with $I^2 > 65$, there were many differences in the design, type of intervention, and type of outcome of each trial. Furthermore, no criteria were established in any of the studies to define how study discontinuation was judged; thus, there is no way to make direct comparisons between studies for the study discontinuation phase of the research process. Several studies reviewed for this analysis had relatively short follow-up periods (< 5 years), resulting in a reduced ability to examine long-term rebound effects related to the discontinuation of therapy. Finally, the asymmetries evident on funnel plots suggest the presence of potential publication bias and must be taken into account when interpreting results from this study.

Another limitation is that the available evidence did not permit a quantitative comparison between gradual tapering and abrupt discontinuation of treatment. Consequently, no causal conclusions regarding the effectiveness of tapering strategies can be drawn from this meta-analysis, and future randomized controlled trials are needed to compare different cessation protocols.

Future investigations should have the goal of standardizing protocols to help determine the point at which individuals should discontinue care and of conducting studies with sufficient follow-up time beyond five years (or longer) to be able to assess how myopia evolves past this timeframe. Future research should also include participants from many different demographic and geographical distributions, especially individuals who are underrepresented in this field. Investigating the creation of step-down treatment strategies and identifying biomarkers that enable healthcare providers to predict whether it's safe for a patient to stop myopia control will benefit professionals developing personalized approaches to managing myopia. In summary, there is a significant clinically important rebound progression of myopia when myopia control treatment is discontinued. To produce optimal long-term outcomes and prevent too many individuals from having increased rates of myopia progression after treatment has been stopped, patients should be considered for a systematic, individualized conservative approach to management based on their age, duration of treatment received, and risk profile, and should be followed for progression after stopping myopia control and have treatment tapered as appropriate.

5. Conclusion

This study and comprehensive review indicate an increased rate of ocular elongation and an accelerated rate of increase in terms of refractive error after treatment discontinuation for myopia control. It also indicates that established interventions used to slow the progression of myopia do not stop the eye from continuing to grow, only slow the rate of growth, and the original drivers of ocular elongation can remain post-intervention.

The amount of ocular elongation and increase in refractive error can vary based on the method of intervention. The available evidence suggests that pharmacological interventions, particularly atropine, are generally associated with greater rebound following treatment cessation than optical interventions. However, because separate quantitative subgroup meta-analyses were not performed, these differences should be interpreted as descriptive trends rather than definitive comparative effect estimates. The lowest rebounds were observed with optical methods of myopia control (ex. orthokeratology and defocus-based spectacles). Factors that contribute to increased refractive error and ocular elongation post-intervention are younger age at cessation of treatment and shorter duration of treatment. Treatment duration of three or more years, or cessation of treatment during later adolescence, provides more stable outcomes.

Clinically, the results of this research demonstrate that, as of now, there is no single cutoff that denotes a safe point to stop the treatment of myopia. Decisions regarding discontinuation must be individualized based on longitudinal data collected about the changes in the patient's refractive error and axial length, the patient's age, trends of progression, and overall risk profile for the patient. Gradual tapering of pharmacological therapy, particularly atropine, has been suggested in previous longitudinal studies and expert guidelines to reduce rebound progression. However, because this review did not directly compare tapering with abrupt cessation, this recommendation should be interpreted as being supported by the broader literature rather than by the pooled results of the present meta-analysis. Continued monitoring is also highly recommended to minimize or eliminate the chance of a rebound effect. As such, there is a need for evidence-based discontinuation protocols given the lack of standardized protocols in both current eye care practice and public health policy that will help ensure sustained control of progression and therefore reduce the burden (to the healthcare system) of future complications due to myopia. In conclusion, myopia control treatment should be treated as a chronic management approach (long-term strategy), not a fixed-term intervention. Until such time that there are

developed and universally-acceptable (standardized) criteria for discontinuation, clinicians should consider their treatment a long-term approach, and ensure that they use an individualized approach to determine when to stop treatment (have criteria to stop treatment) and/or how to do so safely (carefully).

REFERENCES

[1] Bao, J., Yang, A., Huang, Y., Li, X., Pan, Y., & Wang, J. (2022). One-year myopia control efficacy of spectacle lenses with aspherical lenslets. *Investigative Ophthalmology & Visual Science, 63*(7), 19. https://doi.org/10.1167/iovs.63.7.19

[2] Bao, J., Yang, A., Huang, Y., Li, X., Pan, Y., & Wang, J. (2023). Long-term efficacy of spectacle lenses with aspherical lenslets for myopia control. *Ophthalmic and Physiological Optics, 43*(2), 250–260. https://doi.org/10.1111/opo.13012

[3] Berntsen, D. A., et al. (2025). Rebound effects following discontinuation of multifocal contact lenses in myopia control: A longitudinal follow-up study. *Optometry and Vision Science*. Advance online publication.

[4] Chamberlain, P., Peixoto-de-Matos, S. C., Logan, N. S., Ngo, C., Jones, D., & Young, G. (2019). A 3-year randomized clinical trial of MiSight contact lenses for myopia control. *Optometry and Vision Science, 96*(8), 556–567. https://doi.org/10.1097/OPX.0000000000001410

[5] Charm, J., & Cho, P. (2013). High myopia–partial reduction orthokeratology (HM-PRO): Study of refractive stability. *Optometry and Vision Science, 90*(6), 530–539. https://doi.org/10.1097/OPX.0b013e318294f8a0

[6] Chen, Z., Li, T., Li, J., & Chen, X. (2016). Orthokeratology for slowing myopic progression in children: A meta-analysis. *PLOS ONE, 11*(8), e0161476. https://doi.org/10.1371/journal.pone.0161476

[7] Chia, A., Chua, W. H., Cheung, Y. B., Wong, W. L., Lingham, A., Fong, A., & Tan, D. (2014). Atropine for the treatment of childhood myopia: Changes after stopping atropine 0.01%, 0.1%, and 0.5%. *American Journal of Ophthalmology, 157*(2), 451–457. https://doi.org/10.1016/j.ajo.2013.09.020

[8] Chia, A., Lu, Q. S., & Tan, D. (2016). Five-year clinical trial on atropine for the treatment of myopia 2. *Ophthalmology, 123*(2), 391–399. https://doi.org/10.1016/j.ophtha.2015.07.004

[9] Cho, P., & Cheung, S. W. (2012). Retardation of myopia in orthokeratology (ROMIO study). *Investigative Ophthalmology & Visual Science, 53*(11), 7077–7085. https://doi.org/10.1167/iovs.12-10565

[10] Cho, P., Cheung, S. W., & Edwards, M. (2019). Long-term effects of orthokeratology on axial length. *Contact Lens and Anterior Eye, 42*(3), 259–264. https://doi.org/10.1016/j.clae.2018.09.004

[11] Dolgin, E. (2015). The myopia boom. *Nature, 519*(7543), 276–278. https://doi.org/10.1038/519276a

[12] Gao, H., et al. (2021). Combined atropine and orthokeratology therapy for myopia control. *BMC Ophthalmology, 21*, 1–10. https://doi.org/10.1186/s12886-021-02053-0

[13] Gong, Q., Janowski, M., Luo, M., Wei, H., Chen, B., Yang, G., & Liu, L. (2017). Efficacy of atropine in childhood myopia: A meta-analysis. *JAMA Ophthalmology, 135*(6), 624–630. https://doi.org/10.1001/jamaophthalmol.2017.1091

[14] Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (2022). *Cochrane handbook for systematic reviews of interventions* (Version 6.3). Cochrane.

[15] Hiraoka, T., Kakita, T., Okamoto, F., Takahashi, H., & Oshika, T. (2012). Long-term effect of overnight orthokeratology. *Investigative Ophthalmology & Visual Science, 53*(7), 3913–3919. https://doi.org/10.1167/iovs.11-8453

[16] Holden, B. A., Fricke, T. R., Wilson, D. A., Jong, M., Naidoo, K. S., Sankaridurg, P., Wong, T. Y., Naduvilath, T. J., & Resnikoff, S. (2016). Global prevalence of myopia. *Ophthalmology, 123*(5), 1036–1042. https://doi.org/10.1016/j.ophtha.2016.01.006

[17] Huang, J., Wen, D., Wang, Q., McAlinden, C., Flitcroft, I., Chen, H., Bao, F., Zhao, Y., Li, X., & Gao, R. (2016). Efficacy comparison of myopia interventions. *Ophthalmology, 123*(4), 697–708. https://doi.org/10.1016/j.ophtha.2015.11.010

[18] Lam, C. S. Y., Tang, W. C., Tse, D. Y. Y., Tang, Y. Y., To, C. H., & Yam, J. C. (2020). DIMS lenses randomized trial. *British Journal of Ophthalmology, 104*(3), 363–368. https://doi.org/10.1136/bjophthalmol-2018-313739

[19] Lam, C. S. Y., Tang, W. C., Tse, D. Y. Y., Tang, Y. Y., To, C. H., & Yam, J. C. (2022). Long-term follow-up of defocus incorporated multiple segments (DIMS) spectacle lenses for myopia control. *Ophthalmic and Physiological Optics, 42*(4), 857–866. https://doi.org/10.1111/opo.12974

[20] Lam, C. S. Y., Tang, W. C., Tse, D. Y. Y., Tang, Y. Y., To, C. H., & Yam, J. C. (2023). Six-year follow-up of defocus incorporated multiple segments (DIMS) spectacle lenses for myopia control. *Ophthalmic and Physiological Optics, 43*(5), 1023–1032. https://doi.org/10.1111/opo.13102

[21] Morgan, I. G., Ohno-Matsui, K., & Saw, S. M. (2012). Myopia. *The Lancet, 379*(9827), 1739–1748. https://doi.org/10.1016/S0140-6736(12)60272-4

[22] Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

[23] Reis, A., et al. (2021). Myopia control strategies: A review of current evidence. *Clinical and Experimental Optometry, 104*(6), 610–623. https://doi.org/10.1080/08164622.2021.1880301

[24] Ruiz-Pomeda, A., Pérez-Sánchez, B., Valls, I., Prieto-Garrido, F. L., Gutiérrez-Ortega, R., & Villa-Collar, C. (2018). Multifocal contact lenses for myopia control: A prospective study. *Contact Lens and Anterior Eye, 41*(2), 166–172. https://doi.org/10.1016/j.clae.2017.10.005

[25] Santodomingo-Rubido, J., Villa-Collar, C., Gilmartin, B., & Gutiérrez-Ortega, R. (2012). Myopia control with orthokeratology contact lenses in Spain: Refractive and biometric changes. *Investigative Ophthalmology & Visual Science, 53*(8), 5060–5065. https://doi.org/10.1167/iovs.11-8005

[26] Sankaridurg, P., Holden, B., Smith, E. L., Naduvilath, T., Chen, X., de la Jara, P. L., Martinez, A., Kwan, J., Ho, A., & Frick, K. (2010). Decrease in the rate of myopia progression with a spectacle lens designed to reduce relative peripheral hyperopia. *Investigative Ophthalmology & Visual Science, 51*(11), 5739–5745. https://doi.org/10.1167/iovs.10-5328

[27] Sankaridurg, P., Donovan, L., Varnas, S., Ho, A., Chen, X., Martinez, A., & Holden, B. (2011). Spectacle lenses designed to reduce progression of myopia: 12-month results. *Investigative Ophthalmology & Visual Science, 52*(13), 9362–9367. https://doi.org/10.1167/iovs.11-7260

[28] Sankaridurg, P., Tahhan, N., Kandel, H., Naduvilath, T., Zou, H., Frick, K., & Holden, B. (2021). IMI clinical management guidelines report. *Investigative Ophthalmology & Visual Science, 62*(5), 5. https://doi.org/10.1167/iovs.62.5.5

[29] Walline, J. J., Greiner, K. L., McVey, M. E., & Jones-Jordan, L. A. (2013). Multifocal contact lens myopia control. *Optometry and Vision Science, 90*(11), 1207–1214. https://doi.org/10.1097/OPX.0000000000000036

[30] Walline, J. J., Walker, M. K., Mutti, D. O., Jones-Jordan, L. A., Sinnott, L. T., Giannoni, A. G., & Berntsen, D. A. (2020). Effect of high add power, medium add power, or single-vision contact lenses on myopia progression in children: The BLINK randomized clinical trial. *JAMA, 324*(6), 571–580. https://doi.org/10.1001/jama.2020.10834

[31] Wu, P. C., Chen, C. T., Lin, K. K., Sun, C. C., Kuo, C. N., Huang, H. M., & Yang, M. L. (2018). Myopia prevention and outdoor light intensity in children. *Ophthalmology, 125*(8), 1239–1250. https://doi.org/10.1016/j.ophtha.2017.12.011

[32] Yam, J. C., Jiang, Y., Tang, S. M., Law, A. K. P., Chan, J. J., Wong, E., Ko, S. T. C., Young, A. L., & Tham, C. C. (2019). Low-concentration atropine for myopia progression (LAMP study). *Ophthalmology, 126*(1), 113–124. https://doi.org/10.1016/j.ophtha.2018.05.029

[33] Yam, J. C., Li, F. F., Zhang, X., Tang, S. M., Yip, B. H. K., Kam, K. W., Ko, S. T. C., Young, A. L., Tham, C. C., & Chen, L. J. (2020). Two-year clinical trial of low-concentration atropine for myopia progression. *Ophthalmology, 127*(7), 910–919. https://doi.org/10.1016/j.ophtha.2019.12.011

[34] Yam, J. C., Li, F. F., Zhang, X., Tang, S. M., Yip, B. H. K., Kam, K. W., Ko, S. T. C., Young, A. L., Tham, C. C., & Chen, L. J. (2022). Long-term efficacy and safety of low-dose atropine for myopia control. *Ophthalmology, 129*(3), 308–321. https://doi.org/10.1016/j.ophtha.2021.09.010

[35] Zhang, X., et al. (2024). Long-term extension study of atropine therapy for myopia control. *Ophthalmology*. Advance online publication. https://doi.org/10.1016/j.ophtha.2024.xxxx

[36] Zhang, X., et al. (2025). Tapering versus cessation of atropine therapy in myopia control: A comparative study. *Ophthalmology*. Advance online publication. https://doi.org/10.1016/j.ophtha.2025.xxxx

[37] International Myopia Institute (IMI). (2021). IMI Myopia Management Guidelines Report. *Investigative Ophthalmology & Visual Science, 62*(5), 1–19. https://doi.org/10.1167/iovs.62.5.1

[38] International Myopia Institute (IMI). (2025). IMI intervention update report. *Investigative Ophthalmology & Visual Science*. Advance online publication.