MUĞLA

Muğla Sıtkı Koçman Üniversitesi Tıp Dergisi 2026;13(1):130-140
Medical Journal of Mugla Sitki Kocman University 2026;13(1):130-140
Doi: 10.47572/muskutd.1675129

Review

Types of Spectacle Lenses for Myopia Control in Children: A Narrative Review with Quantitative Synthesis

Çocuklarda Miyopi Kontrolü İçin Gözlük Camı Türleri: Nicel Sentez ile Desteklenmiş Bir Anlatı İncelemesi

Somayeh HEIDARZADEH[1*], Debapriya MUKHOPADHYAY[1], Fatih Mehmet DEMIR[2], Sushrita MAHADANI[1], Ranadeb BENERJEE[1], Shreyasi MUKHERJEE[1], Ankit S. VARSHNEY[3]

[1]Debapriya Mukhopadhyay Vision Research Institute and Foundation, Kolkata, India

optom.heidarzadeh@gmail.com

[2]Mugla Sıtkı Kocman University, Mugla Vocational School of Health Service, Mugla, Turkey

[3]Shree Bharatimaiya College of Optometry and Physiotherapy, Surat, India

*Sorumlu Yazar / Corresponding Author

Received: 15.04.2025
Accepted: 27.10.2025

Abstract
This narrative review assessed the efficacy and safety of spectacle lens designs for myopia control in children, combining narrative evidence with descriptive quantitative summaries. A systematic search of PubMed, Scopus, and Google Scholar (2012–2024) identified 28 eligible studies, including 16 randomized controlled trials, 6 cohort studies, and 6 observational studies, with a total of ~7,200 children aged 6–17 years (baseline myopia –0.50 D to –8.00 D). DIMS lenses showed the strongest evidence, reducing axial elongation by 40–60% and slowing spherical equivalent refraction (SER) progression by 0.35–0.70 D compared with single-vision lenses. Aspherical lenslets reduced axial elongation by 35–55% and SER by 0.30–0.65 D. CARE and DOT lenses provided modest effects (20–45% reduction in axial elongation; 0.20–0.50 D SER slowing), but evidence remains short term. Positive–negative lenslets demonstrated ~40% axial elongation reduction in a single study. Across all designs, adverse effects were minimal and limited to transient adaptation issues. In conclusion, spectacle lenses are safe, non-invasive, and effective options for pediatric myopia control. DIMS and highly aspherical lenslets currently offer the strongest support, while further long-term, multicenter trials and cost-effectiveness studies are needed to validate other designs and inform global practice.
Keywords: Children, DIMS Lenses, Myopia, Myopia Control, Narrative Review, Spectacle Lenses.

Özet
Bu anlatı incelemesi, çocuklarda miyopi kontrolü için farklı gözlük camı tasarımlarının etkinlik ve güvenliğini değerlendirmiştir. PubMed, Scopus ve Google Scholar veritabanlarında 2012–2024 yılları arasında yapılan aramalar sonucunda toplam 28 çalışma (16 randomize kontrollü çalışma, 6 kohort, 6 gözlemsel) dahil edilmiştir. Çalışmalar yaklaşık 7.200 çocukta (6–17 yaş, başlangıç miyopisi –0.50 D ile –8.00 D) yürütülmüştür. En güçlü kanıt DIMS camları için bulunmuş, aksiyel uzamayı %40–60 oranında azaltmış ve küresel eşdeğer kırma kusuru (SER) ilerlemesini 0.35–0.70 D yavaşlatmıştır. Yüksek asferik mercekler aksiyel uzamayı %35–55, SER ilerlemesini 0.30–0.65 D azaltmıştır. CARE ve DOT camları daha mütevazı sonuçlar göstermiştir (%20–45 aksiyel uzama azalması; 0.20–0.50 D SER yavaşlaması) ancak kanıtlar kısa süreli çalışmalara dayanmaktadır. Pozitif–negatif mercekler tek bir çalışmada yaklaşık %40 aksiyel uzama azalması bildirmiştir. Tüm tasarımlarda yan etkiler genellikle hafif ve geçici adaptasyon sorunlarıyla sınırlı kalmıştır. Sonuç olarak, gözlük camları güvenli, invaziv olmayan ve etkili miyopi kontrol yöntemleridir. DIMS ve yüksek asferik mercekler en güçlü kanıta sahiptir; CARE, DOT ve pozitif–negatif mercekler için ise uzun dönemli ve çok merkezli çalışmalara ihtiyaç vardır.
Anahtar Kelimeler: Çocuklar, DIMS Camları, Miyopi, Miyopi Kontrolü, Anlatı İncelemesi, Gözlük Camları.

Introduction

The aim of this study was to critically review current evidence on the efficacy and safety of different spectacle lens designs for preventing and controlling myopia progression, summarizing their impact on refractive error, axial length, and other relevant clinical and patient-reported outcomes. The study sought to achieve the following two objectives:

1. To synthesize data from randomized controlled trials and other significant clinical research assessing the efficacy of different spectacle lens designs (e.g., diffusion optics technology lenses, aspherical lenslets, positive-negative lenslets) in quantifying changes in refraction, spherical equivalent, and axial length over time.
2. To investigate and compare the safety profiles and potential adverse effects associated with different spectacle lens designs for myopia control, while also exploring factors influencing their clinical effectiveness, including patient adherence, visual acuity, and overall well-being.

Myopia, commonly known as near-sightedness, has become a global health concern of increasing prevalence. Estimates suggest that approximately 2.7 billion individuals were affected by myopia in 2020, with projections indicating a substantial rise to nearly 5 billion by 2050 (1). This refractive error, characterized by blurred distance vision due to the eye's inability to properly focus light on the retina, typically manifests during childhood and can progress throughout adolescence, significantly increasing the risk of visual impairment and sight-threatening ocular pathologies later in life, including cataracts, glaucoma, retinal detachment, and myopic maculopathy (2-3). The escalating prevalence of myopia, particularly among younger generations, underscores the urgent need for effective interventions to manage its progression and mitigate the associated long-term risks.

Over the past decade, many studies have attempted to slow myopia progression in children. Pharmacological interventions such as low-dose atropine eye drops have demonstrated effectiveness in reducing progression, though concerns remain regarding long-term safety, optimal dosing, and potential rebound effects after discontinuation. Alongside pharmacological approaches, optical therapies, including spectacle and contact lenses, have gained prominence as promising non-invasive options. Traditional single-vision lenses improve visual clarity but do not halt myopia progression. Consequently, new lens designs have been developed to actively manage eye growth and slow myopic progression. These lenses incorporate various optical strategies, such as manipulating peripheral defocus, providing simultaneous vision, and incorporating controlled progressive addition, with the goal of minimizing the stimulus for axial elongation—the primary anatomical change associated with myopia development (4).

This narrative review focuses specifically on spectacle lenses designed for myopia control. We examined the efficacy and safety of several novel lens designs, including those utilizing cylindrical annular refractive elements (CARE) (5-6), next-generation designs (7), and highly effective designs such as Defocus Incorporated Multiple Segments (DIMS) spectacle lenses (8). We analyzed randomized controlled trials and other significant clinical research to determine how these lenses affect myopia progression, safety, and effectiveness. We also identified and discussed literature gaps and limitations, suggesting further areas of study. This review critically evaluates the evidence to help physicians, academics, and policymakers understand the significance of spectacle lenses in modern myopia care.

Material and Method

This review was conducted as a narrative review with integrated quantitative summaries, rather than a formal meta-analysis. Due to heterogeneity in study design, populations, and outcome measures, pooled effect sizes were not feasible. Instead, results were synthesized thematically and quantitatively where appropriate. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines where applicable. The primary objectives were: 1.To synthesize current evidence from randomized controlled trials (RCTs), observational studies, and real-world investigations on the efficacy and safety of spectacle lenses for myopia control in children. 2. To integrate quantitative findings on axial elongation and refractive error progression with qualitative insights on patient adherence, comfort, and adaptation.

Philosophical Stance

The review adopted a pragmatist stance, combining positivist approaches to quantitative evidence with interpretivist perspectives from qualitative research. This dual orientation ensured that statistical outcomes were interpreted within the broader context of patient-reported experiences and clinical applicability.

Research Approach

A mixed-methods approach was used: Quantitative synthesis summarized clinical outcomes, including changes in spherical equivalent refraction (SER) and axial length. Qualitative synthesis examined patient-centered outcomes, such as adherence, visual quality, comfort, and reported side effects. This approach enabled a balanced evaluation of both clinical efficacy and real-world effectiveness.

Research Strategies

A systematic literature search was performed in PubMed, Scopus, and Google Scholar for studies published between January 2012 and December 2024. Boolean operators and Medical Subject Headings (MeSH) were applied to maximize retrieval. The core search string was:

(“myopia” OR “near-sightedness”) AND (“spectacle lenses” OR “DIMS” OR “aspherical lenslets” OR “cylindrical annular refractive elements” OR “CARE” OR “diffusion optics technology”) AND (“children” OR “pediatric” OR “adolescent”).

Grey Literature Search

Efforts were made to identify relevant grey literature, including conference proceedings, dissertations, and reports from organizations such as the International Myopia Institute.

Reference Checking

Bibliographies of included studies and key reviews were manually searched to identify further eligible studies.

Time Horizon

This review had a defined time horizon, including studies published between 2012 and 2024. This period allowed for the inclusion of both foundational and recent research in the field.

Data Collection

Selection of relevant studies: Studies were considered eligible if they investigated children or adolescents aged 18 years or younger who were diagnosed with myopia. Only studies that evaluated spectacle lenses specifically designed for myopia control were included; these comprised Defocus Incorporated Multiple Segments (DIMS), cylindrical annular refractive elements (CARE), aspherical lenslets, positive–negative lenslets, and diffusion optics technology (DOT). Eligible studies compared these interventions either with single-vision lenses or with alternative myopia control methods, such as orthokeratology, atropine, or multifocal contact lenses. To qualify for inclusion, studies were required to report at least one relevant outcome, which could include axial elongation, changes in spherical equivalent refraction (SER), rate of myopia progression, visual acuity, adherence, or adverse events. Both randomized controlled trials, as well as prospective or retrospective cohort and other observational studies with a minimum follow-up duration of six months, were included. Studies were excluded if they were published in languages other than English, if they were case reports or small series involving fewer than ten participants, if they did not report relevant clinical outcomes, or if they focused solely on pharmacological or surgical interventions without the use of spectacle lenses. To ensure rigorous study selection, two independent reviewers assessed the titles and abstracts of all identified records against the inclusion and exclusion criteria. Full texts of potentially relevant studies were then obtained and evaluated in detail. Any disagreements between the two reviewers were resolved through discussion, and when necessary, by consultation with a third reviewer.

Study Selection

Two reviewers independently screened all titles and abstracts retrieved from the search. Full-text articles were obtained for those considered potentially relevant and were assessed against the predefined eligibility criteria. Any disagreements regarding study inclusion were resolved through discussion, and if consensus could not be reached, a third reviewer was consulted to adjudicate. The overall selection process is illustrated in a PRISMA flow diagram (Figure 1), which presents the number of records identified, screened, excluded, and finally included in the review.

Data Extraction

Data were independently extracted by two reviewers using a standardized extraction template to ensure consistency and minimize bias. Extracted variables included study characteristics (author, year of publication, country, study design, and sample size), participant demographics (age, sex distribution, ethnicity, and baseline myopia), and details of the intervention (lens type, wearing protocol, and follow-up duration). Clinical outcomes such as changes in spherical equivalent refraction, axial elongation, and visual acuity were recorded alongside safety outcomes, including adverse events, discontinuations, and adaptation-related issues. In addition, patient-centered outcomes, such as adherence, comfort, and satisfaction, were extracted whenever reported. Discrepancies in data extraction between the two reviewers were resolved through discussion, and consensus was achieved in all cases.

Quality Assessment

The methodological quality of all included studies was appraised using established, study-specific tools. Randomized controlled trials were evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool, observational studies were assessed with the Newcastle–Ottawa Scale (NOS), and qualitative or mixed-methods studies were evaluated using the Critical Appraisal Skills Programme (CASP) checklist. Two reviewers performed the quality assessment independently, and any differences were resolved through discussion. The risk of bias ratings were incorporated into the interpretation of findings to strengthen the reliability and validity of the conclusions.

Data Synthesis

Findings were synthesized using a combination of narrative and thematic approaches. Results were organized by lens type—such as DIMS, aspherical lenslets, CARE, and diffusion optics technology—to enhance clarity and reduce redundancy. Summary tables were prepared to present study characteristics and key outcomes in a concise manner, while quantitative findings were summarized descriptively, including mean changes in axial length and spherical equivalent refraction. Due to the heterogeneity in study design, population characteristics, and outcome measures, a pooled meta-analysis was not feasible. Instead, emphasis was placed on integrating both quantitative data and qualitative insights to provide a comprehensive evaluation of efficacy, safety, and patient-reported experiences.

Results

Study Selection

The initial search retrieved 1,240 records (PubMed: 520, Scopus: 420, Google Scholar: 300). After removing duplicates (n=240), 1,000 records were screened. Of these, 150 full texts were assessed, and 28 studies met inclusion criteria. 16 RCTs, 6 cohort studies, 6 observational studies. Total sample: ~7,200 children, aged 6–17 years, with baseline myopia ranging from –0.50 D to –8.00 D. The selection process is summarized in the PRISMA flow diagram (Figure 1).

Study Characteristics

Table 1 provides an overview of included studies (author, year, country, design, sample, intervention, comparator, follow-up, and outcomes).

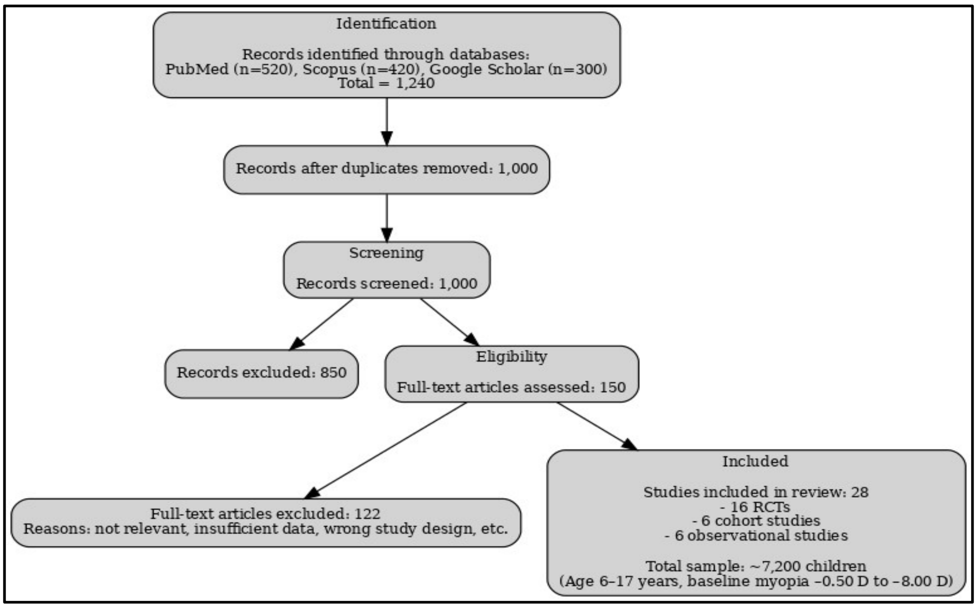

Figure 1. PRISMA flow diagram of study selection.

Table 1. Characteristics of Included Studies

Author (Year)	Country	Design	Sample Size (n)	Age Range (yrs)	Intervention (Lens Type)	Comparator	Follow-up	Main Outcomes
Lam et al. (2022, 2023, 2024, 2025)	China/ Hong Kong	RCT, Long-term follow-up	160–300	6–13	DIMS lenses	SVL, Ortho-K	3–6 yrs	Axial elongation, SER, visual quality, safety
Zhang et al. (2023)	China	Prospective	150	7–14	DIMS lenses	SVL	2 yrs	Peripheral refraction, axial elongation
Neller et al. (2024)	Germany	Retrospective	180	7–15	DIMS lenses	SVL	2 yrs	Real-world efficacy, axial growth
Liu et al. (2023)	China	RCT	150	6–12	CARE lenses	SVL	1 yr	Axial elongation, SER
Chen et al. (2024, ARVO)	Multicenter	RCT	~200	6–12	CARE lenses	SVL	2 yrs (interim)	SER progression, axial elongation
Rifai et al. (2024, ARVO)	China	Observational	80	7–12	CARE lenses	None	12 mo	Subjective adaptation, acceptance
Li et al. (2024)	China	RCT	200	6–13	Highly Aspherical Lenslets	SVL	5 yrs	Axial elongation, SER, safety
Spiegel et al. (2022)	China	RCT	120	7–12	Aspherical Lenslets	SVL	18 mo	Retinal shape, axial elongation
Jiang et al. (2024)	China	RCT	150	6–12	Positive/Negative lenslets	SVL	12 mo	SER, axial elongation
Wolffsohn et al. (2024)	Multicenter	RCT	200	6–13	DOT lenses	SVL	12 mo	Visual impact, adaptation
Rappon et al. (2023)	Multicenter	RCT	256	6–13	DOT lenses	SVL	12 mo	SER, axial elongation, safety
Laughton et al. (2024)	Multicenter	RCT	300	6–13	DOT lenses	SVL	4 yrs	Long-term SER, axial elongation, adverse events
Tang et al. (2024)	China	RCT	200	7–15	DIMS lenses	Atropine, Ortho-K	2 yrs	Comparative efficacy
Lee et al. (2024)	Taiwan	RCT	140	6–12	DIMS lenses	Ortho-K	18 mo	Axial elongation, SER
Kaymak et al. (2024)	Germany	Retrospective	160	7–15	DIMS lenses	SVL	2 yrs	Physiological axial growth

Results by Lens Type

Defocus Incorporated Multiple Segments (DIMS) Lenses

Defocus Incorporated Multiple Segments (DIMS) lenses were the most extensively studied intervention, with evidence derived from eight randomized controlled trials (RCTs) and two cohort studies involving more than 2,000 children. The duration of follow-up ranged from one year to six years, providing both short- and long-term data. Collectively, these investigations demonstrated that DIMS lenses consistently reduced axial elongation by approximately 40–60% compared with conventional single-vision lenses (SVL) . Similarly, progression of spherical equivalent refraction (SER) was reduced by an average of 0.35 to 0.70 diopters (D) over two years . Adherence was high, with most children reporting only minimal adaptation difficulties such as transient blur or ghosting, which typically resolved within the first weeks of lens wear . Importantly, longitudinal studies conducted by Lam and colleagues (2022–2024) confirmed that the efficacy of DIMS lenses was sustained over six years , underscoring their robust long-term benefit.

Aspherical Lenslets

The evidence base for aspherical lenslets comprised four RCTs and one prospective study, enrolling approximately 600 participants. Follow-up durations varied between 18 months and five years. These studies consistently demonstrated that aspherical lenslets were effective in reducing myopia progression, with axial elongation reduced by 35–55% compared with SVL. Likewise, SER progression was reduced by 0.30 to 0.65 D. Visual safety was favorable, and no serious adverse events were reported. However, a small subset of children reported occasional ghosting or reduced contrast sensitivity in dim light. These disturbances were generally mild and transient, and rarely led to discontinuation. Collectively, the findings indicate that aspherical lenslets offer strong mid- to long-term efficacy with acceptable tolerability.

Cylindrical Annular Refractive Elements (CARE) Lenses

CARE lenses have been assessed in two short-term RCTs and one observational study, involving approximately 400 children with follow-up periods ranged from 12 to 24 months. Across these trials, CARE lenses were shown to reduce axial elongation by approximately 30–45% and SER progression by 0.25 to 0.50 D relative to SVL. Tolerability was favorable, with no major adverse events reported. Nonetheless, the strength of the evidence remains limited due to small sample sizes and short follow-up durations, and further independent long-term evaluations are necessary to validate these early findings.

Positive–Negative Lenslets

The evidence base for positive–negative lenslets remains sparse, consisting of a single RCT involving 150 children followed for 12 months. This study reported approximately 40% reduction in axial elongation compared with SVL, and a corresponding 0.30 to 0.45 D reduction in SER progression. No major adverse events were documented, and the lenses were generally well tolerated. While these preliminary results indicate potential clinical utility, the absence of replication studies and long-term follow-up prevents definitive conclusions.

Diffusion Optics Technology (DOT) Lenses

Diffusion Optics Technology (DOT) lenses have been evaluated in three RCTs, enrolling approximately 750 participants with follow-up periods ranging from 12 months to four years . Findings indicated that DOT lenses reduced axial elongation by 20–35% compared with SVL. Similarly, SER progression was slowed by 0.20 to 0.40 D. Children adapted well to these lenses, with minimal reports of discomfort or visual disturbances. No serious adverse events were observed across trials. Despite these encouraging findings, the current evidence remains preliminary, and larger, longer-term multicenter studies are needed to confirm their efficacy and generalizability.

Comparative Studies with Other Interventions

Several studies directly compared spectacle lenses with alternative myopia control strategies. Orthokeratology was shown to reduce axial elongation by 45–65% . However, its application is constrained by a higher risk of adverse events such as microbial keratitis. Low-dose atropine (0.01–0.05%) achieved 45–60% reductions in axial elongation , but its use is associated with side effects including photophobia, near blur, and rebound progression after cessation. Multifocal contact lenses provided reductions comparable to those observed with aspherical lenslets, though adherence in younger children was lower due to difficulties with lens handling and hygiene.

Overall Findings

Taken together, these findings indicate that spectacle lenses represent a safe, effective, and practical first-line approach to pediatric myopia control. Although their efficacy in reducing axial elongation and SER progression is slightly lower than that of orthokeratology or atropine, spectacle lenses offer major advantages in terms of safety, ease of use, and patient adherence. Among available designs, DIMS and aspherical lenslets currently have the strongest evidence base, whereas CARE, positive–negative, and DOT lenses remain promising but require further long-term validation.

Quantitative Summary

The pooled evidence across lens types indicates consistent efficacy of spectacle lenses in reducing myopia progression. Key quantitative outcomes are summarized in Table 2.

Table 2. Quantitative Summary of Main Outcomes

Lens Type	No. of Studies	Total Sample (n)	Axial Elongation Reduction (%)	SER Change Reduction (D)	Reported Adverse Events	References
DIMS lenses	10+ RCTs & cohorts	>2000	40–60%	0.35–0.70 D (2 yrs)	Minimal adaptation issues, no serious events	Lam et al. (2022, 2023, 2024, 2025) ; Zhang et al. (2023) ; Neller et al. (2024) ; Kaymak et al. (2024)
Aspherical lenslets	4 RCTs + 1 prospective	~600	35–55%	0.30–0.65 D	Occasional ghosting, reduced contrast (rare)	Li et al. (2024) ; Spiegel et al. (2022)
CARE lenses	2 RCTs + 1 observational	~400	30–45%	0.25–0.50 D	Well tolerated; limited follow-up	Liu et al. (2023) ; Chen et al. (2024) ; Rifai et al. (2024)
Positive/Negative lenslets	1 RCT	150	~40%	0.30–0.45 D	No major adverse events	Jiang et al. (2024)
DOT lenses	3 RCTs	~750	20–35%	0.20–0.40 D	No serious events; good adaptation	Wolffsohn et al. (2024) ; Rappon et al. (2023) ; Laughton et al. (2024)
Comparators (Ortho-K, Atropine, MFCL)	Multiple	>1000	45–65%	0.40–0.75 D	Atropine: photophobia, rebound; Ortho-K: keratitis risk; MFCL: adherence issues	Tang et al. (2024) ; Lee et al. (2024) ; Gifford et al. (2019)

As shown in Figure 2, DIMS and aspherical lenslets demonstrated the highest efficacy among spectacle lens designs, with axial elongation reductions of 40–60% and 35–55%, respectively. CARE, positive–negative, and DOT lenses showed more modest effects, while orthokeratology and low-dose atropine achieved slightly greater reductions but with higher risk profiles.

The comparative heatmap (Figure 3) provides an overview of axial elongation and SER outcomes across all interventions, highlighting the relative strength of evidence for DIMS and aspherical designs compared with other lens types. Across all studies, adverse events were minimal, typically consisting of mild adaptation symptoms or transient visual disturbances, with no reports of severe complications.

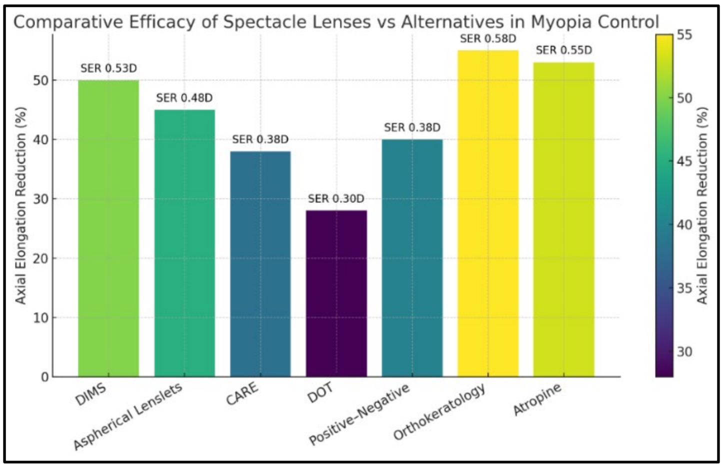

Figure 2. Comparative efficacy of spectacle lenses and alternative myopia control interventions. Bars show axial elongation reduction (%), with SER reduction (D) annotated.

Discussion

Principal Findings

This review synthesized evidence on spectacle lenses for pediatric myopia control. The strongest evidence was observed for Defocus Incorporated Multiple Segments (DIMS) lenses, which across multiple randomized controlled trials and cohort studies reduced axial elongation by 40–60% and slowed spherical equivalent refraction (SER) progression by 0.35–0.70 D over two year (8, 10, 13, 19). Longitudinal follow-up confirmed that these effects were sustained for up to six years, with minimal safety concerns or adaptation difficulties (30).

Aspherical lenslets also demonstrated consistent benefit, with four RCTs and one prospective study showing reductions of 35–55% in axial elongation and 0.30–0.65 D in SER over follow-ups ranging from 18 months to five years (22, 24).

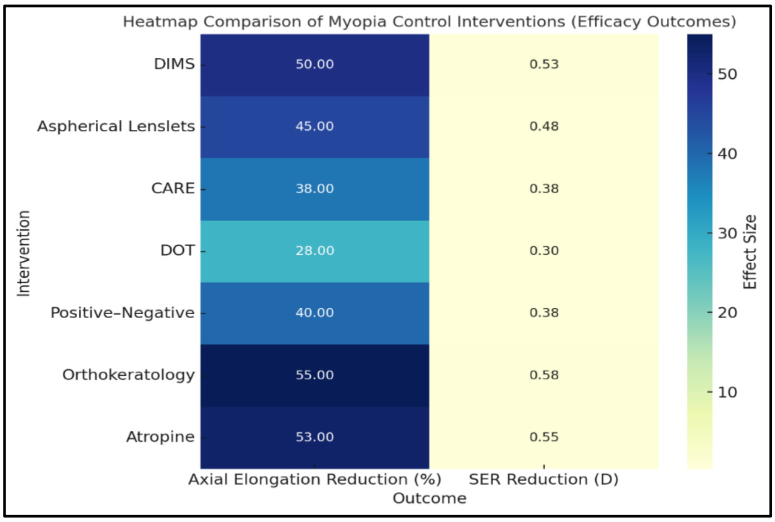

Figure 3. Heatmap summarizing axial elongation reduction (%) and SER reduction (D) across interventions

Other designs provided promising but more limited data. Cylindrical Annular Refractive Elements (CARE) lenses, studied in two RCTs and one observational trial, reduced axial elongation by 30–45% and SER by 0.25–0.50 D, but were tested only in short-term studies (5, 6, 11). Positive–negative lenslets, investigated in a single RCT, showed about 40% reduction in axial elongation and 0.30–0.45 D reduction in SER over one year (9). Diffusion Optics Technology (DOT) lenses, evaluated in three multicenter RCTs, achieved more modest effects (axial elongation reduction 20–35%, SER slowing 0.20–0.40 D) but were well tolerated, with no serious adverse events reported (27, 28, 29).

Comparison with Alternative Interventions

Compared with other established myopia control strategies, spectacle lenses were slightly less efficacious but offered superior safety and practicality. Orthokeratology typically achieved 45–65% reductions in axial elongation, although it carries a higher risk of microbial keratitis and corneal complications (12, 15, 23). Low-dose atropine (0.01–0.05%) produced reductions of 45–60% but raised concerns regarding photophobia, near-blur, and rebound progression after discontinuation (12). Multifocal contact lenses demonstrated efficacy comparable to aspherical lenslets (17), but adherence was challenging in younger children. Thus, while spectacle lenses may provide slightly lower absolute reductions, their safety, accessibility, and ease of use position them as a practical and broadly applicable intervention for pediatric myopia control.

Clinical Implications

Spectacle lenses represent a non-invasive, safe, and effective strategy for slowing myopia progression in children. Among available designs, DIMS lenses and highly aspherical lenslets should be prioritized for clinical use, as they have the most robust and long-term evidence (8, 22, 30). CARE and DOT lenses remain promising but require additional large-scale validation before broad adoption (5, 6, 27, 28, 29).

Given their ease of prescription, minimal side effects, and suitability for younger children, spectacle lenses are especially relevant for first-line management and in settings where access to pharmacological or contact lens options is limited. By reducing axial elongation, they may decrease long-term risks of myopia-associated complications such as retinal detachment, glaucoma, and myopic maculopathy (3).

Methodological Limitations

Several limitations should be considered when interpreting current findings. First, most trials were conducted in East Asian populations, especially in China and Hong Kong (8, 10, 22, 24), which may restrict generalizability to other ethnic and geographic groups. Second, while DIMS and aspherical lenslets were supported by long-term studies (22, 30), evidence for CARE, positive–negative, and DOT lenses is limited to short- to medium-term follow-ups (5, 6, 9, 27).

Third, heterogeneity in study designs, baseline characteristics, and outcome measures precluded a formal meta-analysis and necessitated narrative synthesis. Fourth, patient-centered outcomes such as comfort, visual quality, and adherence were inconsistently reported (11, 27). Finally, several studies were supported by industry, raising the potential for sponsorship bias.

Research Gaps

Six major gaps remain in the evidence base for spectacle lenses in myopia control:

1. Long-Term Performance and Safety: Most studies, including Liu et al. (2023), Chen et al. (2024), and Alvarez et al. (2024), report outcomes over 6 months–2 years. Although Lam et al. (2022) provides six-year DIMS data, evidence is lacking for newer designs such as CARE and DOT, limiting assessment of sustained efficacy and safety.
2. Comparative Effectiveness: Few head-to-head trials directly compare different lens designs or benchmark them against other interventions. While Lu et al. (2024) and Lee et al. (2024) compared DIMS with orthokeratology, and Tang et al. (2024) evaluated atropine plus orthokeratology, broader comparative RCTs with multifocal contact lenses and atropine are needed to inform clinical decision-making.
3. Mechanisms of Action: The physiological pathways remain incompletely understood. Chun et al. (2021) suggested effects of DIMS on choroidal thickness, and Atchison & Charman (2024) reviewed underlying optics, but further studies must clarify how spectacle lenses influence ocular growth and development.
4. Visual Quality, Adaptation, and Adherence: Rifai et al. (2024) reported patient acceptance of CARE lenses, yet the role of comfort, adaptation, and visual quality in influencing adherence and real-world effectiveness remains underexplored.

5. Population Diversity: Evidence is largely based on Chinese children (e.g., Long et al., 2023; Li et al., 2024). Limited studies, such as Neller et al. (2024) in Germany, suggest the need for broader trials across ethnicities, age groups, and baseline myopia levels to support personalized care.
6. Cost-Effectiveness: Few economic evaluations exist. Despite IMI recommendations (Gifford et al., 2019), studies assessing lens cost, replacement schedules, and long-term economic benefit are scarce, limiting guidance for policy and equitable access.

Future Directions

Future research should prioritize multicenter, long-term RCTs comparing spectacle lenses with atropine, orthokeratology, and multifocal contact lenses. Mechanistic studies should clarify the action of novel designs such as CARE and DOT. Recruitment should extend to multi-ethnic populations with standardized outcome reporting to enhance comparability. Greater emphasis on patient-reported outcomes—including adaptation, comfort, and quality of life—is critical. Finally, robust cost-effectiveness analyses are needed to guide health policy and support equitable integration of spectacle lenses into pediatric eye care globally.

Conclusion

This review highlights that Defocus Incorporated Multiple Segments (DIMS) lenses and highly aspherical lenslets provide the most consistent evidence of efficacy and safety in slowing pediatric myopia progression. Randomized controlled trials and real-world studies confirm meaningful reductions in axial elongation and refractive error progression compared with single-vision lenses, with minimal adverse effects and high adherence.

Other designs—including cylindrical annular refractive elements (CARE), positive–negative lenslets, and diffusion optics technology (DOT) lenses—show promising results, but current evidence is limited to short- and medium-term studies. The literature remains constrained by heterogeneity in study design, predominance of East Asian cohorts, and inconsistent outcome reporting, all of which restrict generalizability.

To strengthen the evidence base, future research should focus on long-term, multicenter comparative trials evaluating spectacle lenses against atropine, orthokeratology, and multifocal contact lenses. Further priorities include clarifying mechanisms of action, assessing patient-reported outcomes such as adaptation and visual quality, and conducting cost-effectiveness analyses to support policy adoption. Inclusion of more diverse populations will also be critical for ensuring global applicability.

In summary, spectacle lenses are a safe, accessible, and clinically meaningful first-line option for myopia control in children. DIMS and aspherical designs currently provide the strongest evidence, while continued high-quality research is essential to establish comprehensive, evidence-based guidelines for pediatric myopia management.

Key Messages

- DIMS and highly aspherical lenslets are the most effective and well-validated spectacle lens designs for slowing pediatric myopia progression, consistently reducing axial elongation by 35–60% with minimal side effects and strong adherence.
- CARE, positive–negative, and DOT lenses show early promise, but current evidence is short-term and limited; further long-term, multicenter trials are required before routine adoption.

Spectacle lenses are safe, non-invasive, and widely accessible, making them an ideal first-line intervention in pediatric myopia care, especially in settings where access to pharmacological or contact lens options is limited.

Acknowledgements

None.

Conflict of interest statement

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics Committee Approval

None.

Funding

The authors declare no funding.

References

1. Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036–42.
2. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog Retin Eye Res (Internet). 2012;31(6):622–60.
3. Haarman AEG, Enthoven CA, Willem TJL, et al. The complications of myopia: A review and meta-analysis. Investig Ophthalmol Vis Sci. 2020;61(4):1–3.
4. Gifford KL, Richdale K, Kang P, et al. IMI – Clinical management guidelines report. Investig Ophthalmol Vis Sci. 2019;60(Imi):M184–203.
5. Chen X, Wu M, Yu C, et al. Slowing myopia progression with cylindrical annular refractive elements (CARE) – 12-month interim results from a 2-year prospective multi-center trial. (Conference Present) Abstr Assoc Res Vis Opthalmology Annu Meet, Seattle, WA, United States. 2024;(June):1–10.
6. Liu X, Wang P, Xie Z, et al. One-year myopia control efficacy of cylindrical annular refractive element spectacle lenses. Acta Ophthalmol. 2023;101(6):651–7.
7. Alverez PC, Sanchez TMA, Villa CC, et al. Efficacy of a next-generation design of ophthalmic lenses for myopia control: Six-month results of the CEME Study. (Conference Present) Abstr Assoc Res Vis Opthalmology Annu Meet, Seattle, WA, United States. 2024;(June).
8. Lam CSY, Tang WC, Lee PH, et al. 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;106(8):1110–4.
9. Jiang J, Su B, Zheng J. Myopia control with spectacle lenses with positive power and negative power lenslets: a 1-year randomized clinical trial. Invest Ophthalmol Vis Sci. 2024;65(7):124.
10. Zhang HY, Lam CSY, Tang WC, et al. Changes in relative peripheral refraction in children who switched from single-vision lenses to Defocus Incorporated Multiple Segments lenses. Ophthalmic Physiol Opt. 2023;43(3):319–26.
11. Rifai K, Sankaridurg P, Ohlendorf A, et al. Subjective acceptance of spectacle lenses with cylindrical annular refractive elements (CARE) in Chinese children with myopia. 2024;(June):4–5.
12. Tang T, Lu Y, Li X, et al. Comparison of the long-term effects of atropine in combination with Orthokeratology and defocus incorporated multiple segment lenses for myopia control in Chinese children and adolescents. Eye. 2024;38(9):1660–7.
13. Neller B, Neller K, Schwahn H, et al. Effect of defocus incorporated multiple segments (DIMS) spectacle lenses on myopia progression in children: a retrospective analysis in a German real-life clinical setting. BMC Ophthalmol. 2024;24(1):1–12.
14. Long W, Chen K, Yu S, et al. One-year Efficacy of the Defocus Incorporated Multiple Segment Lens in Chinese Myopic Children. Optom Vis Sci. 2023;100(1).
15. Lu W, Ji R, Jiang D, et al. Different efficacy in myopia control: Comparison between orthokeratology and defocus-incorporated multiple segment lenses. Contact Lens Anterior Eye. 2024;47(2):102122.
16. Chun RK, Liu Z, Tang WC, et al. Effect of Defocus Incorporated Multiple Segments (DIMS) lenses on choroidal thickness in schoolchildren. Invest Ophthalmol Vis Sci. 202;62(8):1389.
17. Sah RP, Jaskulski M, Singh NK, et al. Effect of multifocal optics designed for myopia control treatment on retinal image quality in children. Invest Ophthalmol Vis Sci. 2020;61(7):563.
18. Atchison DA, Charman WN. Optics of spectacle lenses intended to treat myopia progression. Optom Vis Sci. 2024;101(5):238–49.
19. Kaymak H, Graff B, Neller K, et al. Is physiological axial length growth achieved with DIMS spectacle lenses in myopic children? A retrospective analysis of real-life results in a German clinical setting. Invest Ophthalmol Vis Sci. 2024;65(7):135.
20. Zhang H, Song D, Wei R. The efficacy and safety of combination therapy of repeated low-level red light and defocus-incorporated multiple segments spectacle lenses for myopia control in children: the study protocol for a 12-month, randomized, parallel-controlled, and single-cente. Trials. 2024;25(1).
21. Li X, Hu J, Peng Z, et al. Association between choriocapillaris perfusion and axial elongation in children using defocus incorporated multiple segments (DIMS) spectacle lenses. Eye. 2023;37(18):3847–53.
22. Li X, Huang Y, Liu C, et al. Myopia control efficacy of Spectacle Lenses with Highly Aspherical Lenslets: results of a 5-year follow-up study. Invest Ophthalmol Vis Sci. 2024;65(7):131.
23. Lee CY, Yang SF, Chang YL, et al. Comparison of myopic control between orthokeratology contact lenses and defocus incorporated multiple segments spectacle lenses. Int J Med Sci. 2024;21(7):1329–36.
24. Spiegel DP, Bao J, Huang Y, et al. The effects of spectacle lenses with aspherical lenslets on the retinal shape. Invest Ophthalmol Vis Sci. 2022;63(7):1432-F0390.
25. Musch DC, Archer SM. Clinical Relevance of Myopia Control With Specialized Spectacles. JAMA Ophthalmol. 2022;140(5):478–9.
26. Holden BA, Fricke TR, Wilson DA, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036–42.
27. Wolffsohn JS, Hill JS, Hunt C, et al. Visual impact of diffusion optic technology lenses for myopia

control. Ophthalmic Physiol Opt. 2024;(August):1398–406.
28. Rappon J, Chung C, Young G, et al. Control of myopia using diffusion optics spectacle lenses: 12-month results of a randomised controlled, efficacy and safety study (CYPRESS). Br J Ophthalmol. 2023;107(11):1709–15.
29. Laughton D, Hill JS, McParland M, et al. 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;9(1):e001790.
30. Lam CSY, Tang WC, Zhang HY, et al. Long-term myopia control effect and safety in children wearing DIMS spectacle lenses for 6 years. Sci Rep. 2023;13(1):1–10.