Original Article

Real-World Comparison of the Effectiveness of Defocus Incorporated Multiple Segments and Myopi-X Spectacle Lenses for Myopia Control in Turkish Children: A Retrospective Study

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Abstract

Objectives: This study compared the 12-month real-world effectiveness of defocus incorporated multiple segments (DIMS) spectacle lenses, Myopi-X progressive addition lenses, and single-vision (SV) lenses in slowing myopia progression in children.

Materials and Methods: This retrospective observational study included 385 eyes using one of the three spectacle types. Baseline age, spherical equivalent refraction (SER), and axial length (AL) were recorded. Twelve-month changes in SER and AL were analyzed using the Kruskal-Wallis test with Bonferroni-adjusted pairwise comparisons. Generalized estimating equations (GEE) were used to assess the effects of treatment group, age group, sex, and baseline AL group on SER and AL changes.

Results: The study population consisted of 118 Myopi-X eyes (32.4%), 107 SV eyes (29.4%), and 139 DIMS eyes (38.2%). Baseline demographic and ocular characteristics (including age, sex, SER, AL, age group, and baseline AL group) were comparable among the groups (all $p>0.05$). After 12 months, mean SER progression was -0.35±0.34 diopters (D) in the Myopi-X group, -0.46±0.37 D in the SV group, and -0.24±0.33 D in the DIMS group ($p<0.001$). Mean AL elongation was 0.21±0.12 mm, 0.24±0.17 mm, and 0.17±0.16 mm, respectively ($p=0.004$). GEE analyses demonstrated a significant treatment effect for both SER and AL change ($p<0.001$ for both). The least progression occurred in the DIMS group, followed by Myopi-X, while the SV group showed the highest progression. Baseline AL group was the only significant predictor of AL elongation ($\beta=0.210$, 95% confidence interval: 0.189-0.231, $p<0.001$), with greater elongation in eyes with high baseline AL. Age group and sex did not significantly influence SER or AL outcomes.

Conclusion: DIMS spectacle lenses were more effective than Myopi-X and SV lenses in reducing both refractive progression and axial elongation over 12 months. Baseline AL was a key determinant of axial growth, supporting the use of individualized risk assessment in pediatric myopia management.

Keywords: Myopia, spectacle lenses, axial length, refractive errors, child

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Introduction

The global prevalence of myopia continues to increase at an alarming rate; projections suggest that nearly half of the world's population may be affected by 2050.[1,2] This is a major public health concern, especially due to the rising incidence of high myopia, which is strongly associated with complications such as glaucoma, retinal detachment, myopic maculopathy, and choroidal neovascularization.[3] Greater axial length (AL) and higher degrees of myopia are recognized as major risk factors for these sight-threatening outcomes.[4,5] The prevalence of myopia is rising not only in East Asian countries but also across Europe, with younger populations exhibiting the most marked increases.[6,7,8]

Myopia management in children generally involves three main strategies: pharmacological therapy, advanced optical designs, and behavioral or lifestyle modifications.[9,10] Among pharmacological options, low-dose atropine has consistently been demonstrated to slow myopia progression

while limiting the adverse effects typically associated with higher concentrations.[11] However, practical challenges such as monthly compounding, long-term compliance, and mild side effects may restrict its routine use. As alternatives, novel optical treatments, including defocus incorporated multiple segments (DIMS) lenses, highly aspherical lenslets (HALs), and orthokeratology, induce peripheral myopic defocus while preserving central visual clarity, thereby reducing axial elongation and slowing progression.[12,13] Evidence from clinical trials has confirmed that these lenses are more effective than single-vision (SV) lenses in controlling myopia progression.

Despite the increasing use of Myopi-X and DIMS lenses in Türkiye, real-world evidence comparing their effectiveness with that of conventional SV lenses is limited. Moreover, the influence of baseline parameters such as age, sex, and AL on treatment response remains inadequately explored, although previous studies suggest that these may act as significant predictors.[14,15,16] This retrospective study aimed to evaluate the 1-year effectiveness of Myopi-X and DIMS lenses compared with SV lenses in slowing myopia progression in a Turkish pediatric cohort. Subgroup analyses were conducted to assess the effects of baseline AL (moderate vs. high), age (<10 vs. ≥10 years), and sex on treatment outcomes.

Materials and Methods

Study Design

This retrospective observational study was conducted between May 2023 and May 2024 in the Department of Ophthalmology of Acıbadem Hospital in Ankara, Türkiye. The study adhered to the tenets of the Declaration of Helsinki and was approved by the Acıbadem University Institutional Ethics Committee (date: 08.05.2025; decision no: 2025-07/295). Written informed consent was obtained from the parents or legal guardians of all participants.

Inclusion and Exclusion Criteria

Eligible participants were children aged 6-16 years diagnosed with myopia, defined as cycloplegic spherical equivalent refraction (SER) ≤-0.50 diopters (D). Additional inclusion criteria were anisometropia <1.50 D and astigmatism <2.00 D. The exclusion criteria were a history of ocular pathologies such as glaucoma, cataract, keratopathy, amblyopia, or strabismus, as well as systemic or ocular conditions that could interfere with measurement accuracy or adherence to treatment.

Intervention Protocols

The participants were divided into three groups: Myopi-X progressive addition spectacle lenses, DIMS spectacle lenses, and SV spectacle lenses (control). All lenses were prescribed for full-time wear, excluding sleep and bathing. Both eyes of each patient were included in the analysis. However, eyes not meeting the inclusion criteria were excluded from the study.

Cycloplegic autorefraction was performed 30 min after administering two drops of 1% tropicamide (Tropamid, Bilim İlaç, İstanbul, Türkiye) at 5-min intervals. This agent was selected due to its rapid onset, shorter recovery time, and proven cycloplegic efficacy in non-strabismic pediatric populations.[17] Measurements were taken using a Topcon CKR-8900 autorefractometer (Topcon Corp., Tokyo, Japan). Cycloplegic refraction was repeated until three consecutive readings demonstrated a standard deviation <0.05 D. AL was measured with the Zeiss IOL Master 700 (Carl Zeiss Meditec AG, Jena, Germany) until the standard deviation was <0.05 mm. These procedures followed published recommendations for measurement feasibility and repeatability in ophthalmology.[18]

Outcome Measures

The primary outcomes were changes in SER and AL after 12 months of follow-up.

Subgroup Classifications

The participants were stratified by sex (male or female), age (<10 years and ≥10 years), and baseline AL.

Baseline AL was categorized as moderate or high using age-specific normative percentile curves, based on the reference values reported by Tideman et al.[19] For age, 10 years was selected as the cut-off because children initiating spectacle wear before this age have been shown to demonstrate faster myopia progression and a greater likelihood of developing high myopia in adulthood.[20]

Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, version 29.0 (IBM Corp., NY, USA). Descriptive statistics were reported as mean ± standard deviation for continuous variables and as frequency (percentage) for categorical variables. The Shapiro-Wilk test was applied to assess normality. Group differences at baseline were evaluated using the Kruskal-Wallis test for continuous variables and the chi-square test for categorical variables.

For the primary outcomes (12-month SER and AL changes), generalized estimating equations (GEEs) were applied to account for within-participant correlations, as both eyes of each patient were included. Treatment group, sex, age group, and baseline AL group were entered as predictors. Regression coefficients (β) with 95% confidence

intervals (CI) and Wald χ^2 statistics were reported. Statistical significance was set at a two-sided $p<0.05$.

Power Analysis

Because of the retrospective design, the sample size was determined by the available eligible records. However, a priori sample size estimation was performed using G*Power (Version 3.1.9.7; Universität Düsseldorf, Düsseldorf, Germany) with a two-tailed alpha level of 0.05 and a statistical power of 80%.[21] Effect sizes were derived from our previously published study evaluating the 1-year effectiveness of DIMS spectacle lenses in a Turkish pediatric cohort.[22] Based on these effect sizes, the minimum required sample size was estimated to be 159 eyes (approximately 53 per group) for SER change and 260-270 eyes (approximately 85-90 per group) for AL change. The present study included 364 eyes (107-139 per group), exceeding the estimated sample size requirements.

Results

Baseline Characteristics

A total of 385 eyes were included in the analysis: 118 eyes (32.4%) in the Myopi-X group, 107 eyes (29.4%) in the SV group, and 139 eyes (38.2%) in the DIMS group. Baseline demographic and ocular characteristics are presented in Table 1 for continuous variables and Table 2 for categorical variables.

At baseline, there were no statistically significant differences among the groups in mean age, SER, or AL ($p>0.05$) based on the Kruskal-Wallis test (Table 1). Although pairwise comparisons suggested a trend toward older age and longer baseline AL in the SV group, these differences did not remain significant after Bonferroni correction.

Sex distribution was similar across the three treatment groups ($p=0.682$). Overall, 164 eyes (45.1%) belonged to children aged <10 years and 200 eyes (54.9%) to those aged ≥10 years. In total, 179 eyes (49.2%) were classified

Table 1. Baseline demographic and ocular characteristics

Variable	Myopi-X (n=118)	SV (n=107)	DIMS (n=139)	p value
Age (years)	9.07±2.15 (5-13)	9.57±1.77 (5-12)	9.19±2.53 (4-15)	0.061
SER (D)	-2.47±1.62 (-10.62 to -0.12)	-2.46±1.80 (-7.63 to +0.25)	-2.65±1.25 (-5.50 to -0.25)	0.073
AL (mm)	24.39±0.87 (22.95-26.58)	24.54±1.05 (22.26-27.60)	24.27±1.04 (22.48-26.90)	0.066

Values are presented as mean ± standard deviation (range). P values are based on the Kruskal-Wallis test
SV: Single-vision, DIMS: Defocus incorporated multiple segments, SER: Spherical equivalent refraction, expressed in diopters (D); AL, axial length, expressed in millimeters (mm)

Table 2. Baseline categorical characteristics

Variable	Myopi-X (n=118)	SV (n=107)	DIMS (n=139)	p value
Sex Female Male	 50 (42.4%) 68 (57.6%)	 49 (45.8%) 58 (54.2%)	 74 (53.2%) 65 (46.8%)	0.682
Age group <10 years ≥10 years	 65 (55.1%) 53 (44.9%)	 25 (23.4%) 82 (76.6%)	 74 (53.2%) 65 (46.8%)	0.415
Baseline AL group Moderate High	 56 (47.5%) 62 (52.5%)	 45 (42.1%) 62 (57.9%)	 78 (56.1%) 61 (43.9%)	0.732

Values are shown as n (%). Percentages are calculated per column based on the number of eyes in each treatment group. Between-group comparisons were performed using the chi-square test
SV: Single-vision, DIMS: Defocus incorporated multiple segments, AL: Axial length

as having moderate baseline AL and 185 eyes (50.8%) as having high baseline AL. Distributions of age and baseline AL category were also comparable among the treatment groups (both p>0.05).

SER and AL Changes After 12 Months

The mean change in SER after 12 months was -0.35±0.34 D in the Myopi-X group, -0.46±0.37 D in the SV group, and -0.24±0.33 D in the DIMS group. The Kruskal-Wallis test revealed a significant difference among the three groups (p<0.001). The distribution of SER changes by treatment group is illustrated in Figure 1.

Similarly, the mean AL elongation was 0.21±0.12 mm in the Myopi-X group, 0.24±0.17 mm in the SV group, and 0.17±0.16 mm in the DIMS group, with overall differences reaching statistical significance (p=0.004). Group differences stratified by baseline AL subgroups are presented in Figure 2, whereas further subgroup comparisons are illustrated in Figure 3. Detailed group comparisons are summarized in Table 3.

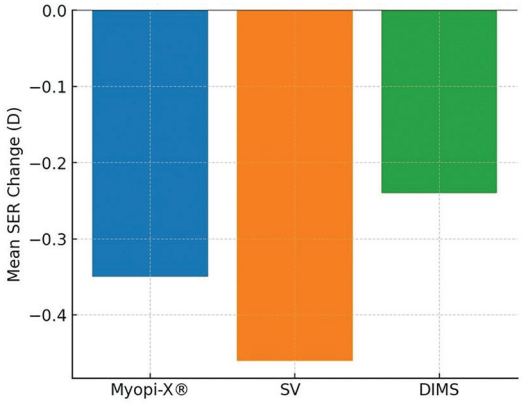

Figure 1. Twelve-month change in spherical equivalent refraction (SER) among the treatment groups. The bar chart illustrates the mean change in 12 months in the Myopi-X, single-vision (SV), and defocus incorporated multiple segments (DIMS) lens groups

GEE Analysis

The GEE analysis for 12-month SER change showed that the treatment group had a statistically significant effect (Wald χ^2=24.692, p<0.001). The least myopia progression was observed in the DIMS group (reference), followed by the Myopi-X group (β=-0.116, 95% CI: -0.197 to -0.034, p=0.005), with the highest progression in the SV group (β=-0.224, 95% CI: -0.314 to -0.135, p<0.001). SER change was not significantly associated with age group, baseline AL group, or sex (all p>0.05).

For AL change, treatment group also showed a statistically significant effect (Wald χ^2=407.742, p<0.001). The lowest elongation occurred in the DIMS group, followed by the Myopi-X group, whereas the SV group had the highest elongation (all p<0.001). The baseline AL group was a significant predictor (Wald χ^2=377.974, p<0.001), with eyes in the high baseline AL group showing greater elongation (β=0.210, 95% CI: 0.189-0.231, p<0.001). In contrast, age group and sex had no significant effect on AL change.

The predictors of SER and AL changes are summarized in Table 4. The GEE analysis showed that among the categorical variables (sex, age group, baseline SER group, and baseline AL group), only the baseline AL group was a significant predictor of 12-month AL change (p<0.001). As this variable comprised two categories (moderate vs. high), no further pairwise analyses were necessary.

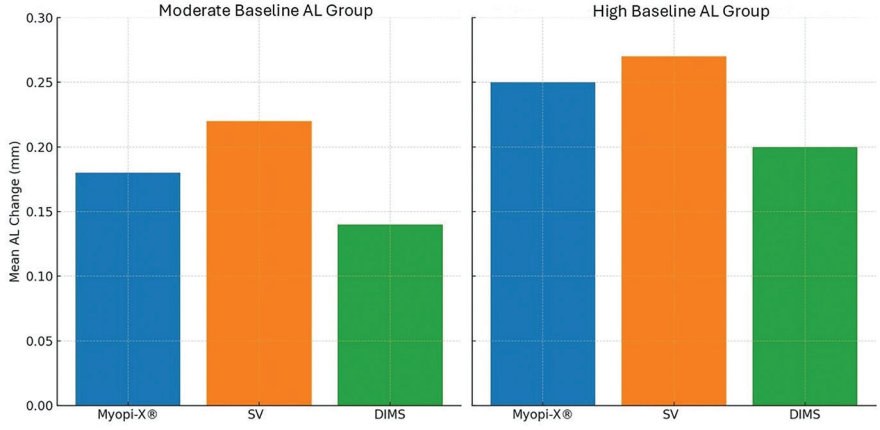

Figure 2. Twelve-month axial length (AL) changes according to baseline AL group. The bar charts illustrate the mean AL change in 12 months stratified by baseline AL group (moderate vs. high). Comparisons are shown for the Myopi-X, single-vision (SV), and defocus incorporated multiple segments (DIMS) lens groups

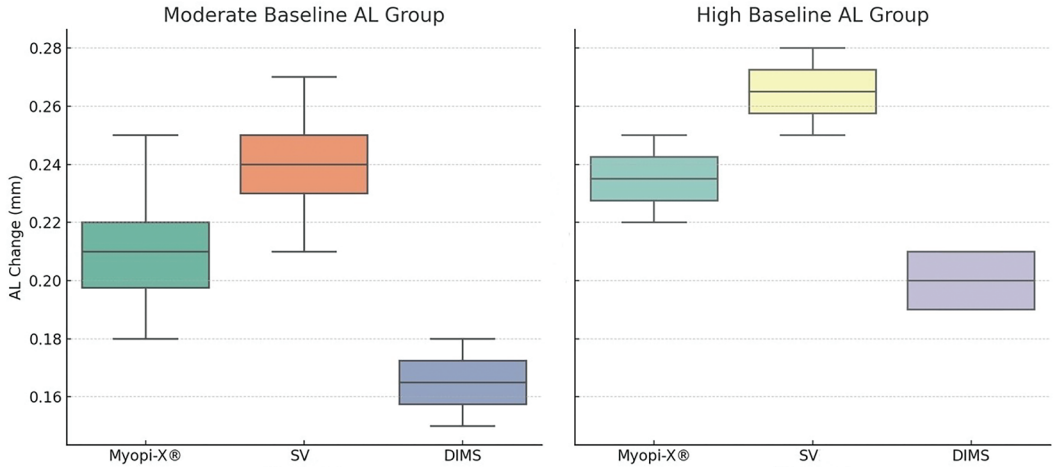

Figure 3. Twelve-month axial length (AL) change stratified by baseline AL group. The boxplots show the distribution of AL change in 12 months in the moderate and high baseline AL groups. Comparisons are presented for the Myopi-X, single-vision (SV), and defocus incorporated multiple segments (DIMS) lens groups. Boxes represent interquartile ranges; the horizontal line inside the box indicates the median, and whiskers denote the minimum and maximum values

Table 3. Twelve-month changes in spherical equivalent refraction (SER) and axial length (AL)

Variable	Myopi-X (n=118)	SV (n=107)	DIMS (n=139)	p values
SER change (D)	-0.35±0.34	-0.46±0.37	-0.24±0.33	Overall: <0.001
				DIMS vs. Myopi-X: 0.005
				DIMS vs. SV: <0.001
				Myopi-X vs. SV: 0.214
AL change (mm)	0.21±0.12	0.24±0.17	0.17±0.16	Overall: 0.004
				DIMS vs. Myopi-X: <0.001
				DIMS vs. SV: <0.001
				Myopi-X vs. SV: 0.326

Values are presented as mean ± standard deviation. Overall group differences were assessed using the Kruskal-Wallis test. Pairwise comparisons were performed with generalized estimating equations to account for the inclusion of both eyes
SV: Single-vision, DIMS: Defocus incorporated multiple segments

Table 4. Predictors of spherical equivalent refraction (SER) and axial length (AL) changes in 12 months (GEE analysis)

Outcome	Treatment group	Age group (<10 vs. ≥10 years)	Baseline AL group (moderate vs. high)	Sex (female vs. male)
SER change	<0.001	0.694	0.460	0.865
AL change	<0.001	0.950	<0.001	0.077

P values are derived from generalized estimating equation (GEE) models including both eyes

Discussion

This retrospective study including 364 eyes demonstrated that DIMS spectacle lenses were more effective in slowing myopia progression compared with both Myopi-X progressive addition lenses and conventional SV lenses. Eyes in the DIMS group showed the least SER progression (-0.24±0.33 D) and axial elongation (0.17±0.16 mm), whereas the SV group exhibited the highest progression (-0.46±0.37 D and 0.24±0.17 mm, respectively) after 12 months. Subgroup analyses identified higher baseline AL as a significant predictor of greater axial elongation, while age and sex did not significantly influence SER progression or axial elongation, highlighting baseline AL as a key determinant of treatment response.

Our findings are consistent with pivotal randomized controlled trials by Lam et al.[23,24,25] In their 2-year study,[23] children wearing DIMS lenses showed a 52% reduction in myopia progression and a 62% reduction in axial elongation compared with SV lenses, with sustained effects confirmed in 3- and 6-year follow-up studies.[24,25] Compared with these Asian cohorts, our real-world study in Turkish children demonstrated similar benefits, indicating that the effectiveness of DIMS lenses may extend beyond East Asian populations to other clinical settings.

Nucci et al.[26] reported comparable outcomes in Italian children wearing DIMS lenses, with significantly lower SER progression and axial elongation than with SV lenses at 12 months. While they adjusted for baseline age, SER, and AL, these variables were not identified as independent predictors. In contrast, our analyses demonstrated baseline AL as a significant predictor of axial elongation, with no association observed for age or sex.

Neller et al.[27] evaluated DIMS treatment response using age-specific physiological growth curves and reported greater axial elongation and lower treatment success in children with high baseline AL, as well as faster ocular growth in younger children. In line with these observations, our study confirmed baseline AL as a key predictor of axial elongation, although age did not reach statistical significance.

Our previously published study represents one of the few investigations of Myopi-X lenses.[28] In that analysis, Myopi-X lenses significantly reduced myopia progression and axial elongation compared with SV lenses but remained less effective than DIMS lenses. The present findings are consistent, confirming that Myopi-X lenses provide measurable control benefits, although DIMS lenses remain superior. These results emphasize the importance of evaluating locally available optical interventions in specific populations.

Earlier spectacle-based approaches, including bifocals and progressive addition lenses, demonstrated limited or modest efficacy in slowing myopia progression.[29,30] Subsequent designs such as MyoVision, Myopilux, Perifocal, and the experimental Apollo lens yielded only modest treatment effects.[31] Unlike these experimental prototypes, our real-world data showed that Myopi-X lenses achieved significantly lower SER progression and axial elongation than SV lenses, although their effect remained less pronounced than that of DIMS lenses.

Increasing attention has focused on baseline predictors of response to myopia control. Nucci et al.[26] confirmed the robustness of DIMS treatment effects after adjusting for baseline factors, whereas Neller et al.[27] highlighted the influence of baseline AL and age. Tideman et al.[19] introduced age-specific AL growth curves to support individualized treatment evaluation, and Brennan et al.[32] emphasized age and AL as major determinants of myopia progression. Consistent with this framework, baseline AL emerged as the strongest predictor of axial elongation in our cohort.

Retrospective orthokeratology studies have shown that baseline age and refractive error significantly influence treatment efficacy.[33] Zhong et al.[34] reported slower progression in older children, with additional effects of lens design and optical aberrations, whereas Sarkar et al.[35] demonstrated the influence of baseline age, SER, and AL on treatment outcomes. These differences likely reflect distinct mechanisms of action: orthokeratology induces corneal reshaping influenced by corneal biomechanics and age-related ocular growth, whereas DIMS and Myopi-X lenses act through peripheral myopic defocus without structural corneal changes, potentially explaining the lack of age dependence in our cohort.

Weise et al.[36] and Lee et al.[37] reported greater progression in younger children and those with higher baseline myopia. Lu et al.[38] observed slower elongation in eyes with higher baseline AL, whereas our study demonstrated greater elongation in such eyes, possibly due to differences in ethnicity, treatment modality, and baseline ocular characteristics. European cohorts comparing DIMS lenses and HALs reported inconsistent associations between age, sex, and axial elongation.[39,40] Overall, our findings align with European data, suggesting that baseline AL may exert a stronger influence on ocular growth dynamics than chronological age.

Strengths and Limitations

This study benefited from a relatively large sample size, inclusion of both eyes with appropriate statistical adjustment, and a real-world clinical setting. Subgroup and predictor analyses further strengthened the evaluation of treatment response.

Limitations include the retrospective design, 1-year follow-up duration, and lack of randomization. In addition, Myopi-X lenses are primarily prescribed in Türkiye, which may limit generalizability.

Conclusion

DIMS lenses were superior to Myopi-X and SV lenses in limiting both refractive progression and axial elongation. Myopi-X lenses, while not widely adopted internationally, are commonly prescribed in Türkiye and provide measurable benefits compared with SV lenses, although their effect remains less pronounced than that of DIMS lenses. Among all evaluated factors, baseline AL was

the only consistent predictor of axial elongation, whereas age and sex showed no significant influence.

Ethics

Ethics Committee Approval: Acıbadem University Institutional Ethics Committee (date: 08.05.2025; decision no: 2025-07/295).

Informed Consent: Written informed consent was obtained from the parents or legal guardians of all participants.

Declarations

Authorship Contributions

Surgical and Medical Practices: N.A., U.E.A., Concept: N.A., U.E.A., Design: N.A., Data Collection or Processing: N.A., Analysis or Interpretation: N.A., U.E.A., Literature Search: N.A., Writing: N.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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