"DEFOCUS INCORPORATED MULTIPLE SEGMENTS (DIMS) LENSES: A NOVEL PERSPECTIVE IN MYOPIA PROGRESSION MANAGEMENT IN A TERTIARY EYE CARE CENTER, ASSAM"

Rimpi Borpatragohain, Kishor Kumar Choudhury, Dr. Damaris Magdalene, Garima Kalita

Abstract

Aim:
To evaluate the effectiveness of Defocus Incorporated Multiple Segments (DIMS) spectacle lenses compared with conventional single-vision lenses in controlling myopia progression over a 12-month period, using changes in spherical equivalent refraction (SER) and axial length as outcome measures.

Methods:
This prospective, randomized, hospital-based comparative study included 50 myopic patients who met the inclusion criteria. Participants were randomly allocated into two groups: a control group fitted with single-vision spectacle lenses (n = 25) and an intervention group fitted with DIMS spectacle lenses (n = 25). Baseline evaluations included demographic data, cycloplegic SER, and axial length measurements. There were no statistically significant differences between groups at baseline ($p > 0.05$). Follow-up assessments of SER and axial length were conducted after 12 months. Intragroup changes were analyzed using paired statistical tests, while intergroup comparisons were performed using independent statistical analyses. Results were expressed as mean changes with 95% confidence intervals (CI), and statistical significance was set at $p < 0.05$.

Results:
After 12 months, the single-vision lens group demonstrated significant myopia progression, with mean SER worsening from −4.40 D at baseline to −5.11 D, representing a mean myopic shift of −0.71 D (95% CI: −0.62 to −0.80; $p < 0.001$). Axial length in this group increased from 24.60 mm to 25.40 mm, with a mean elongation of 0.80 mm (95% CI: 0.72 to 0.88; $p < 0.001$).
In contrast, the DIMS lens group exhibited significantly slower progression. Mean SER changed from −4.32 D to −4.90 D over 12 months, corresponding to a mean shift of −0.58 D (95% CI: −0.50 to −0.66; $p < 0.001$). Mean axial length increased marginally from 24.95 mm to 25.08 mm, with a mean elongation of 0.13 mm (95% CI: 0.08 to 0.18; $p < 0.001$).
Intergroup comparisons revealed that both the myopic shift in SER and axial elongation were significantly lower in the DIMS group compared with the single-vision group (SER difference: 0.13 D, $p = 0.02$; axial length difference: 0.67 mm, $p < 0.001$).

Conclusion:
DIMS spectacle lenses were significantly more effective than single-vision lenses in slowing both refractive progression and axial elongation over a 12-month period. The statistically and clinically meaningful reduction in axial growth supports the role of DIMS lenses as a safe, non-invasive, and effective optical intervention for myopia management in routine clinical practice.

Keywords: Myopia control; Defocus Incorporated Multiple Segments; DIMS lenses; Axial length; Spherical equivalent refraction; Spectacle lenses; Myopia progression

1. Introduction:

Myopia is a common refractive error in which parallel rays of light are focused anterior to the retinal plane when accommodation is relaxed, resulting in blurred distance vision. Although traditionally considered a benign and easily correctable condition, myopia has emerged as a significant global public health concern due to its rapidly increasing prevalence and associated long-term ocular complications. Recent epidemiological projections indicate that approximately 50% of the world's population may be myopic by the year 2050, with a substantial proportion developing high myopia. This dramatic rise is particularly evident among children and adolescents, highlighting the urgent need for effective strategies to control myopia progression.

The clinical importance of myopia extends far beyond reduced visual acuity. Progressive myopia is primarily driven by excessive axial elongation of the eyeball, leading to permanent structural changes within the eye. Increased axial length is strongly associated with a higher risk of sight-threatening complications such as retinal detachment, myopic maculopathy, choroidal neovascularization, glaucoma, and early-onset cataract. These pathological changes may result in irreversible visual impairment and impose a significant socioeconomic burden. Consequently, contemporary myopia management focuses not only on optical correction but also on slowing axial growth to reduce the risk of future ocular morbidity.

The development and progression of myopia are influenced by a complex interaction of genetic, environmental, and behavioral factors. Increased near work activities, prolonged digital screen exposure, reduced outdoor time, and intensive educational demands have all been implicated in accelerating myopic progression, particularly in pediatric populations. Experimental studies suggest that reduced exposure to bright outdoor light may alter retinal dopamine signaling, a mechanism thought to play a critical role in regulating eye growth. These findings reinforce the concept that myopia is a multifactorial condition requiring proactive and evidence-based intervention.

Conventional single-vision spectacle lenses remain the most widely prescribed modality for myopia correction. While they effectively restore central visual clarity, they do not address the biological mechanisms underlying myopia progression. Furthermore, single-vision lenses may induce relative peripheral hyperopic defocus, which has been proposed as a stimulus for axial elongation. As a result, there has been growing interest in optical designs that modify peripheral retinal image quality to influence ocular growth patterns.

Defocus Incorporated Multiple Segments (DIMS) spectacle lenses represent a novel optical approach to myopia control. These lenses are designed with a central optical zone that provides clear distance vision, surrounded by multiple lens segments with added plus power. This configuration produces simultaneous myopic defocus on the peripheral retina while maintaining optimal central visual acuity. Animal models and human clinical studies suggest that sustained peripheral myopic defocus can inhibit excessive axial elongation, thereby slowing myopia progression.

Compared with pharmacological and contact lens–based interventions, DIMS spectacle lenses offer several advantages, including non-invasiveness, ease of use, high patient acceptance, and minimal risk of adverse effects. These characteristics make them particularly suitable for long-term use in children and adolescents. However, despite encouraging results from earlier studies, there remains a need for additional clinical evidence across different populations and real-world clinical settings to support their widespread adoption.

Therefore, the present study was undertaken to evaluate and compare the effectiveness of Defocus Incorporated Multiple Segments spectacle lenses and conventional single-vision lenses in controlling myopia progression over a 12-month period. Changes in spherical equivalent refraction and axial length were used as objective outcome measures to assess both refractive and structural aspects of myopia progression. The findings of this study aim to contribute to the growing body of evidence supporting optical strategies for myopia management and to inform clinical practice in contemporary optometry.

2. Materials and Methods

Study Design

This study was designed as a prospective, randomized, hospital-based comparative clinical study conducted over a period of 12 months. The primary objective was to evaluate and compare the effectiveness of Defocus Incorporated Multiple Segments (DIMS) spectacle lenses and conventional single-vision spectacle lenses in controlling myopia progression. The study focused on changes in spherical equivalent refraction (SER) and axial length as primary outcome measures.

Study Setting and Ethical Approval

The study was carried out in the outpatient department of a tertiary eye care hospital. Ethical approval was obtained from the Institutional Ethics Committee prior to the initiation of the study. All procedures followed the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants or from parents/guardians in the case of minors after explaining the nature and purpose of the study.

Study Population and Sample Size

A total of 50 myopic patients who met the eligibility criteria were enrolled in the study. Participants were recruited consecutively from the outpatient clinic. The sample size was selected to allow meaningful comparison between the intervention and control groups within the available study period and clinical resources.

Inclusion Criteria

Participants were included in the study if they met the following criteria:

- Presence of myopia as determined by cycloplegic refraction
- Clear ocular media with no evidence of active ocular disease
- Normal binocular vision and ocular motility
- No prior history of myopia control treatment
- Willingness to wear spectacles full time and attend follow-up visits

Exclusion Criteria

Participants were excluded if they had:

- Any ocular pathology such as amblyopia, strabismus, retinal disease, or glaucoma
- History of ocular surgery or trauma
- Systemic diseases known to affect ocular growth or refraction
- Use of pharmacological agents for myopia control
- Anticipated poor compliance with spectacle wear

Randomization and Group Allocation

After baseline assessment, eligible participants were randomly allocated into two equal groups using a simple randomization method.

Control group (n = 25): Prescribed conventional single-vision spectacle lenses

Intervention group (n = 25): Prescribed Defocus Incorporated Multiple Segments (DIMS) spectacle lenses

Both groups were advised to wear their spectacles during all waking hours throughout the study period.

Clinical Examination Protocol

All participants underwent a comprehensive ophthalmic examination at baseline and at the 12-month follow-up visit. Examinations were performed by the same examiner to minimize inter-observer variability.

The examination protocol included:

- Measurement of uncorrected and best-corrected visual acuity
- Detailed anterior and posterior segment evaluation
- Cycloplegic refraction
- Axial length measurement

Refraction Assessment

Cycloplegic refraction was performed to ensure accurate measurement of refractive error and to eliminate the effect of accommodation. Spherical equivalent refraction (SER) was calculated by adding half of the cylindrical power to the spherical power. SER values were used for statistical analysis.

Axial Length Measurement

Axial length was measured using a standardized and calibrated ocular biometry device. Multiple readings were taken for each eye, and the average value was recorded to improve measurement reliability. Axial length was selected as a key outcome measure due to its strong association with myopia progression and long-term ocular complications.

Outcome Measures

- The primary outcome measures were:
- Change in spherical equivalent refraction (SER) over 12 months
- Change in axial length over 12 months

Follow-up

Participants were reviewed after 12 months using the same clinical examination protocol and instruments as used at baseline. Compliance with spectacle wear was reinforced during routine visits.

Statistical Analysis

Data were entered into statistical software for analysis. Descriptive statistics were used to summarize baseline demographic and clinical characteristics. Intragroup comparisons between baseline and follow-up measurements were performed using paired statistical tests. Intergroup comparisons were conducted using independent statistical tests. Results were expressed as mean values with corresponding 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant.

3. Results

Study Population and Baseline Characteristics

The present prospective study was conducted at Sri Sankaradeva Nethralaya, Guwahati, Assam, between November 2024 and November 2025. A total of 65 myopic children were initially screened for eligibility. Seven participants were excluded based on predefined exclusion criteria (two due to lack of parental consent, three due to co-existing ocular pathology, and two due to binocular vision abnormalities). Of the remaining

58 eligible participants, eight were lost to follow-up at the 12-month visit and were considered dropouts. Consequently, 50 participants completed the 12-month follow-up and were included in the final analysis, with 25 participants each in the control (single-vision lens) group and the treatment (DIMS lens) group.

Baseline demographic and clinical characteristics are summarized in Table 1. The mean age of participants was 10.36 ± SD years in the control group and 10.48 ± SD years in the DIMS group. Age-wise distribution of participants in the control and treatment groups is illustrated in Figures 3 and 4, respectively. Gender distribution showed a predominance of male participants in both groups, as depicted in Figures 5 and 6.

At baseline, there were no statistically significant differences between the two groups with respect to age, spherical equivalent refraction (SER), or axial length (all $p > 0.05$), confirming that the groups were well matched prior to intervention.

Changes in Spherical Equivalent Refraction

Changes in spherical equivalent refraction over the 12-month study period are presented in Table 2. In the single-vision lens group, mean SER progressed from −4.40 ± 0.72 D at baseline to −5.11 ± 0.81 D at 12 months, corresponding to a mean myopic shift of −0.71 ± 0.19 D (95% CI: −0.62 to −0.80; $p < 0.001$).

In contrast, the DIMS lens group demonstrated a slower rate of refractive progression. Mean SER changed from −4.32 ± 0.69 D at baseline to −4.90 ± 0.75 D at 12 months, representing a mean shift of −0.58 ± 0.16 D (95% CI: −0.50 to −0.66; $p < 0.001$).

Intergroup comparison revealed that the magnitude of myopic progression was significantly lower in the DIMS group than in the single-vision group ($p = 0.02$). Distribution of baseline SER in the control and treatment groups is illustrated in Figures 7 and 8, while the comparative change in SER between groups is shown in Figure 1.

Percentage analysis demonstrated an approximate 16% increase in myopia in the control group, compared with approximately 13% in the DIMS group, indicating a clinically meaningful reduction in refractive progression with DIMS lenses.

Age-wise Analysis of Spherical Equivalent Refraction

One-way ANOVA revealed statistically significant age-related differences in SER progression within both groups. In the control group, SER at baseline (SER1) and at 12 months (SER2) showed significant variation across age subgroups (SER1: $F = 2.466$, $p = 0.030$; SER2: $F = 3.378$, $p = 0.050$), as detailed in Table 3.

Similarly, in the DIMS group, significant differences across age groups were observed for both baseline and 12-month SER measurements (SER1: $F = 2.056$, $p = 0.030$; SER2: $F = 1.683$, $p = 0.020$), as shown in Table 4.

Changes in Axial Length

Axial length progression over the 12-month period is summarized in Table 5. In the single-vision lens group, mean axial length increased from 24.60 ± 0.54 mm at baseline to 25.40 ± 0.61 mm at 12 months, resulting in a mean axial elongation of 0.80 ± 0.18 mm (95% CI: 0.72 to 0.88; $p < 0.001$), corresponding to an approximate 3.3% increase from baseline.

In contrast, the DIMS lens group exhibited significantly reduced axial growth. Mean axial length increased from 24.95 ± 0.57 mm to 25.08 ± 0.60 mm, representing a mean elongation of only 0.13 ± 0.07 mm (95% CI: 0.08 to 0.18; $p < 0.001$), equivalent to an approximate 0.5% increase from baseline.

Intergroup analysis demonstrated a highly significant difference in axial elongation between the two groups ($p < 0.001$), indicating superior control of ocular growth with DIMS lenses. Distribution and cumulative percentage of axial length change in the control and treatment groups are illustrated in Figures 9 and 10, respectively, while the comparative difference between groups is shown in Figure 2.

Age-wise Analysis of Axial Length

Age-stratified one-way ANOVA revealed statistically significant differences in axial length progression within both groups. In the control group, significant differences were observed for axial length at baseline (AL1: $F = 7.175$, $p = 0.041$) and at 12 months (AL2: $F = 6.338$, $p = 0.050$), as shown in Table 6.

In the DIMS group, axial length also varied significantly across age groups for both baseline and 12-month measurements (AL1: $F = 1.731$, $p < 0.001$; AL2: $F = 1.277$, $p < 0.001$), as presented in Table 7.

Changes in Spherical and Cylindrical Refraction

Changes in spherical and cylindrical refractive components over the 12-month period are summarized in Table 8. The control group showed a greater negative shift in spherical refraction, indicating progressive myopia, with minimal change in cylindrical error. In contrast, the DIMS group demonstrated a smaller myopic shift in spherical power, with cylindrical values remaining largely stable, further supporting the refractive control effect of DIMS lenses.

Overall Outcome

Overall, participants wearing DIMS spectacle lenses exhibited significantly reduced myopia progression and markedly slower axial elongation compared with those wearing conventional single-vision lenses over the 12-month follow-up period. The treatment effect was more pronounced for axial length than for refractive change, underscoring the strong influence of DIMS lenses on limiting structural ocular growth.

Discussion

The present study demonstrates that Defocus Incorporated Multiple Segments (DIMS) spectacle lenses are significantly more effective than conventional single-vision spectacle lenses in slowing myopia progression over a 12-month period. Both primary outcome measures spherical equivalent refraction and axial length showed significantly reduced progression in the DIMS group, with the most pronounced effect observed in axial elongation. Given that axial length is a key structural determinant of myopia-related ocular pathology, this finding has important clinical implications.

The greater axial elongation observed in the single-vision lens group supports existing evidence that conventional spectacles, while effective for optical correction, do not address the biological drivers of myopia progression. Peripheral hyperopic defocus associated with single-vision lens wear has been proposed as a stimulus for continued axial growth. In contrast, DIMS lenses are specifically designed to impose constant peripheral myopic defocus, which is believed to generate inhibitory signals that regulate ocular growth. The markedly reduced axial elongation seen in the DIMS group in the present study is consistent with this proposed mechanism.

The reduction in refractive progression observed with DIMS lenses further supports their role as an effective myopia control intervention. Although both groups demonstrated statistically significant intragroup progression over 12 months, the magnitude of myopic shift was significantly lower in the DIMS group. This suggests that while myopia progression may not be completely halted, DIMS lenses can meaningfully slow its rate, particularly when used during periods of active ocular growth.

Spectacle-based myopia control strategies offer several practical advantages over pharmacological and contact lens–based interventions. Unlike low-dose atropine, DIMS lenses are not associated with adverse

effects such as photophobia, reduced accommodation, or rebound progression following treatment cessation. Additionally, compared with contact lens modalities, spectacle lenses carry no risk of contact lens–related infection and are easier to use in younger children. These factors contribute to improved safety, acceptance, and long-term compliance in routine clinical practice.

The findings of this study are in agreement with previously published clinical trials evaluating DIMS lenses, which have reported significant reductions in myopia progression and axial elongation compared with single-vision lenses. However, the present study adds value by providing real-world clinical evidence from a hospital-based setting, supporting the generalizability of DIMS lens efficacy across different patient populations and clinical environments.

From a clinical perspective, early intervention is critical in myopia management, as axial elongation occurring during childhood and adolescence is largely irreversible. By effectively reducing axial growth, DIMS lenses may lower the long-term risk of myopia-associated complications such as retinal detachment and myopic maculopathy. Therefore, incorporating DIMS lenses into routine myopia management protocols may contribute to improved long-term visual outcomes.

4. Limitations

Despite the clinically relevant findings of the present study, several limitations should be acknowledged while interpreting the results.

1. Sample Size and Study Setting

The study was conducted with a relatively modest sample size comprising 50 paediatric patients (100 eyes). This limited number may reduce the statistical power of the analysis and restrict the ability to identify smaller yet clinically meaningful differences between groups. Furthermore, as this was a single-centre, hospital-based investigation carried out in a tertiary eye care institution in Assam, the study population may not be representative of the broader paediatric population. Variations in ethnicity, socioeconomic status, lifestyle, and access to eye care across different regions may limit the external validity and generalisability of the findings to community-based or multicentric settings.

2. Study Design and Duration of Follow-up

The follow-up period was restricted to 12 months, which allows assessment of short-term myopia control efficacy but does not provide insight into the long-term sustainability of treatment effects or the occurrence of delayed adverse outcomes. In addition, the allocation of participants into intervention and control groups within the same clinical setting may introduce potential selection and performance biases, particularly if complete masking of participants and examiners was not consistently maintained.

3. Outcome Measures and Confounding Variables

Myopia progression in this study was primarily evaluated using spherical equivalent refraction (SER) and axial length measurements. Although these are widely accepted outcome parameters, other ocular structural markers such as choroidal thickness, peripheral retinal defocus, and higher-order aberrations were not routinely assessed. The absence of these additional measures limits deeper mechanistic understanding of the myopia control effect observed. Moreover, several known confounding factors including duration of outdoor activity, near-work exposure, parental history of myopia, and adherence to spectacle wear were not comprehensively quantified or controlled, which may have influenced the treatment outcomes.

4. Intervention-Related Considerations

The study evaluated only a single DIMS lens design with a fixed addition power. Consequently, the findings cannot be extrapolated to other myopia control lens designs, varying add powers, or combination treatment

strategies such as concurrent low-dose atropine therapy. Additionally, factors influencing real-world applicability such as adaptation-related symptoms (e.g., peripheral blur or asthenopia), patient comfort, economic burden, and availability of the lenses were not systematically assessed. These aspects are important for determining long-term compliance, acceptability, and cost-effectiveness in routine clinical practice.

5. Conclusion

The findings of this prospective comparative study demonstrate that Defocus Incorporated Multiple Segments (DIMS) spectacle lenses are significantly more effective than conventional single-vision spectacle lenses in controlling myopia progression over a 12-month period. Participants wearing DIMS lenses exhibited a smaller myopic shift in spherical equivalent refraction and, more importantly, a markedly reduced rate of axial elongation compared with those wearing single-vision lenses.

The pronounced reduction in axial length progression observed with DIMS lenses is of particular clinical significance, as axial elongation is the primary structural factor associated with the development of myopia-related ocular complications. By effectively limiting excessive ocular growth, DIMS lenses have the potential to reduce the long-term risk of sight-threatening conditions such as myopic maculopathy, retinal detachment, and glaucoma.

As a spectacle-based intervention, DIMS lenses offer several advantages, including non-invasiveness, ease of use, and high patient acceptability, making them especially suitable for pediatric and adolescent populations. The results of this study support the integration of DIMS spectacle lenses into routine clinical practice as an effective strategy for myopia management.

Further longitudinal studies with larger sample sizes and extended follow-up periods are recommended to evaluate the long-term sustainability of treatment effects and to establish comprehensive clinical guidelines. Nevertheless, the present study adds meaningful evidence to the growing body of literature supporting optical defocus–based approaches for myopia control.

6. Acknowledgement

I am deeply grateful to the Almighty for His blessings and guidance throughout this journey. My heartfelt thanks to my thesis guide, Dr. Damaris Magdalene, and co-guide, Mr. Kishor Kumar Choudhury, for their invaluable mentorship, encouragement, and support. I sincerely thank Dr. Harsha Bhattacharjee for permitting this study and my teachers Dr. Sumita Sarma Borthakur, Mrs. Mitalee Choudhury, Mr. Tridip Puzari, Mrs. Surabhi Suman Kalita, Ms. Ibtesam Zaman, and Ankur Kalita for their guidance and inspiration. Special thanks to Garima Kalita for statistical assistance. I am forever grateful to my patients, their parents, and my family especially my mother, Niruma Chetia Borpatragohain, and sister, Rekha Borpatragohain for their love, patience, and unwavering support.

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Expected vision	Myopia
6/6(20/20)	<-0.50
6/9(20/30)	-0.50
6/12(20/40)	-0.75
6/18(20/60)	-1.00
6/24(20/80)	-1.50
6/36(20/120)	-2.00
6/60(20/200)	-2.00 to -3.00

Table 1: Visual acuity and magnitude of myopia

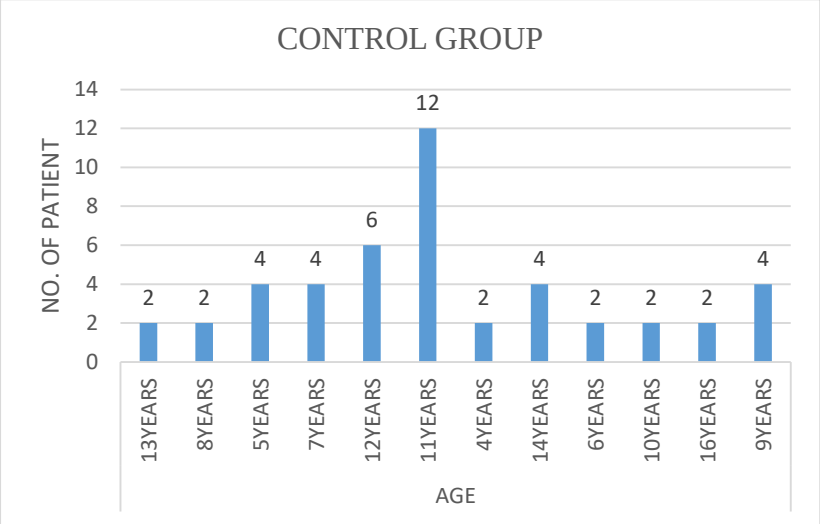

Figure 3: Age-wise Distribution of Patients in the Control Group

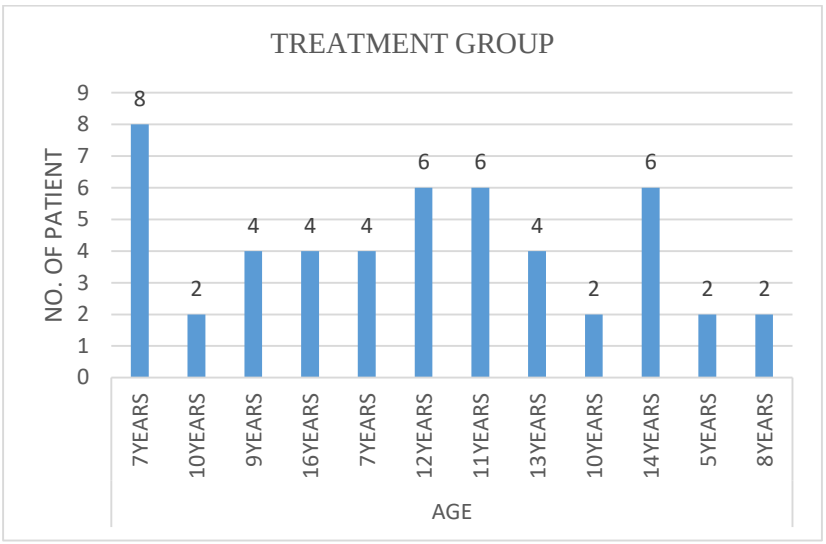

Figure 4: Age-wise Distribution of Patients in the Treatment Group

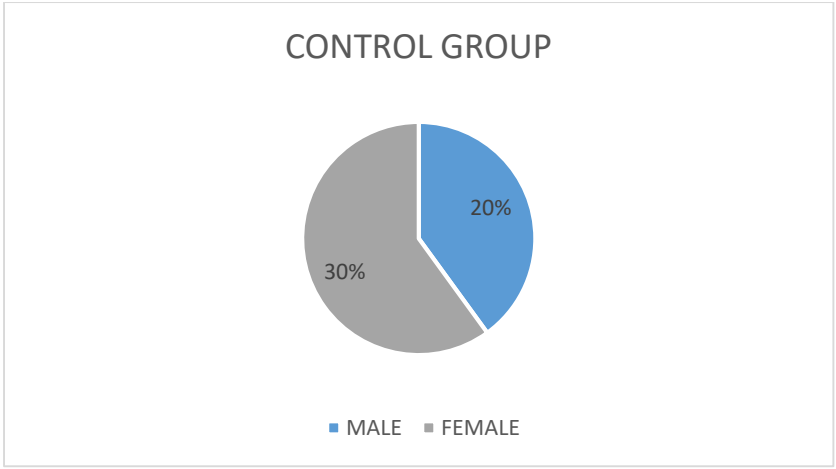

Figure 5: Gender Distribution of Patients in the Control Group

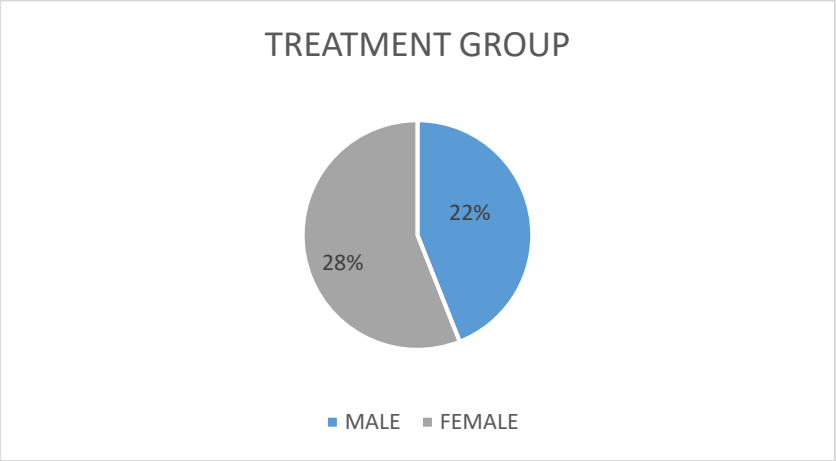

Figure 6: Gender Distribution of Patients in the Treatment Group

Group	**Time point**	**Mean SER (D)**	**Change over 1 year (D)**
Control group	Baseline	−4.40	
	Post 1 year	−5.11	−0.71 (more myopic)
Treatment (DIMS)	Baseline	−4.32	
	Post 1 year	−4.90	−0.57 (more myopic)

Table 2: Comparison of Mean SER Changes Over 1 Year in Control and DIMS Treatment Groups

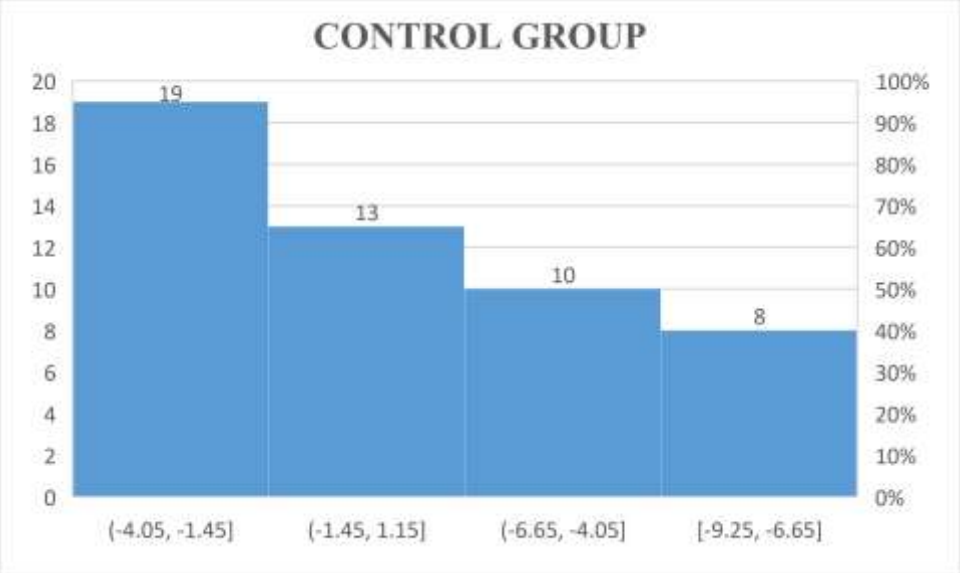

Figure 7: Distribution of Baseline SER in the Control Group

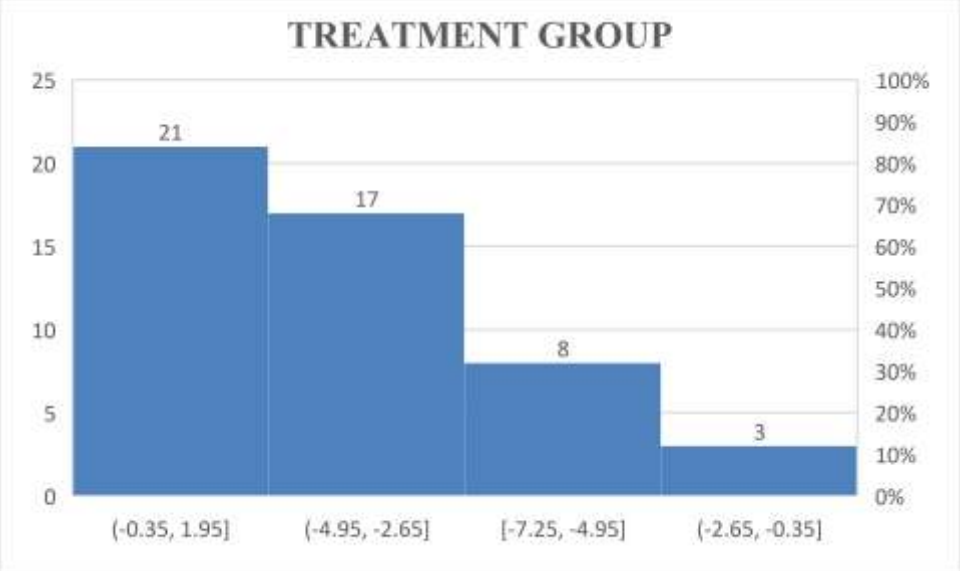

Figure 8: Distribution of Baseline SER in the Treatment Group

	Source	Sum of Squares	df	Mean Square	F	Sig.
SER1	Between Groups	44.769	10	4.477	2.056	0.030
	Within Groups	91.440	42	2.177		
	Total	136.209	52			
SER2	Between Groups	39.308	10	3.931	1.683	0.020
	Within Groups	98.110	42	2.336		
	Total	137.418	52			

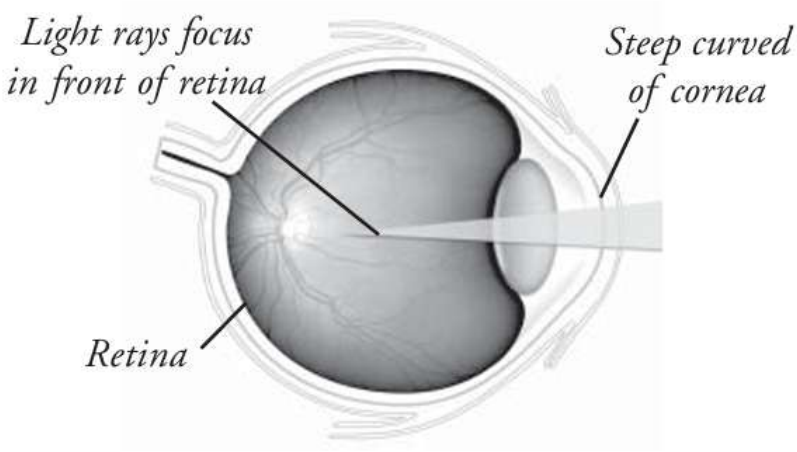

Figure 1: Light rays focusing in front of the retina[2]

	Source	Sum of Squares	df	Mean Square	F	Sig.
SER1	Between Groups	128.032	13	9.849	2.466	0.030
	Within Groups	155.755	39	3.994		
	Total	283.787	52			
SER2	Between Groups	145.457	13	11.189	3.378	0.050
	Within Groups	129.167	39	3.312		
	Total	274.624	52			

Table 3: One-way ANOVA for SER at Baseline and After 1 Year in Control Group

Table 4: One-way ANOVA for SER at Baseline and After 1 Year in Treatment Group

Group	Time point	Mean AL (mm)	Absolute change (mm)	% change vs baseline*
Control group	Baseline	24.60		
	Post 1 year	25.40	+0.80	≈ 3.3% increase
Treatment group	Baseline	24.95		
	Post 1 year	25.08	+0.13	≈ 0.5% increase

Table 5: Mean Axial Length Change Over 1 Year

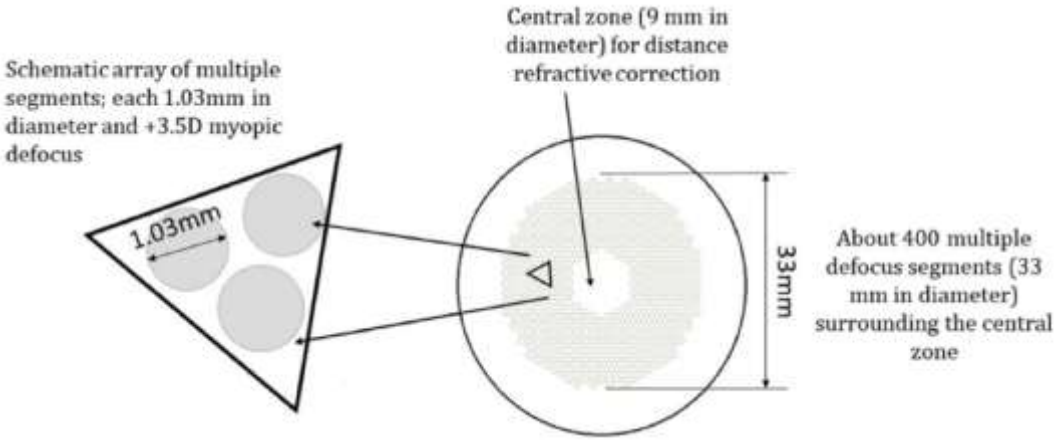

Figure 2: Design of defocus incorporate multiple segments[37]

Variable	Source	Sum of Squares	df	Mean Square	F	Sig.
AL1	Between Groups	50.296	13	3.869	7.175	0.041
	Within Groups	21.031	39	0.539		
	Total	71.327	52			
AL2	Between Groups	64.773	13	4.983	6.338	0.050
	Within Groups	30.658	39	0.786		
	Total	95.431	52			

Table 6: One-way ANOVA for Axial Length at Baseline and After 1 Year in Control group

	Source	Sum of Squares	df	Mean Square	F	Sig.
AL1	Between Groups	11.923	10	1.192	1.731	0.000
	Within Groups	28.937	42	0.689		
	Total	40.860	52			
AL2	Between Groups	9.770	10	0.977	1.277	0.000
	Within Groups	32.146	42	0.765		
	Total	41.916	52			

Table 7: One-way ANOVA for Axial Length at Baseline and After 1 Year in Treatment group

Table 8: Changes in Spherical and Cylindrical Refraction Over 1 Year in Control and DIMS Groups

Group	**Time point**	**Mean sphere (D)**	**Mean cylinder (D)**	**Interpretation**
Control (SV lenses)	Baseline	More negative (myopic) values; around −3 to −6 D on average	Cyl up to −4.50 D	Moderate–high myopia at start.
Control (SV lenses)	12 months	Shifted further negative	Similar or slightly more negative cyl	Myopia progressed over 1 year.
DIMS treatment group	Baseline	Moderate–high myopia, similar range to control	Cyl up to about −3.50 D	Groups broadly comparable at baseline.
DIMS treatment group	12 months	Less negative shift than control; some eyes stable	Cyl broadly similar	Myopia progression reduced compared with control.