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COMPARATIVE EFFICACY OF LOW-DOSE ATROPINE VERSUS MULTIFOCAL SPECTACLES IN SLOWING MYOPIA PROGRESSION IN CHILDREN

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CONFLICT OF INTEREST
None declared.

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None declared.

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ABSTRACT

BACKGROUND: Globally, children's myopia is increasing; it often develops rapidly and causes long-term visual problems. Early intervention strategies, such as medication therapy and optical correction, are essential to slowing this process and reducing the chance of future eye disorders.

OBJECTIVE: To evaluate how well multifocal glasses and low-dose atropine (0.01%) reduce axial length elongation and spherical equivalent progression in kids with myopia.

MATERIAL AND METHODS: Eighty children aged six to fifteen with mild to severe myopia participated in this six-month randomized controlled trial at the Social Security Teaching Hospital on Multan Road in Lahore. Either low dose atropine eye drops (0.01%) or multifocal glasses were randomly assigned to the participants. Measurements of the participants' axial length and spherical equivalent were made at baseline and follow-up.

RESULTS: The average age of the 74 participants in the study was 10.68 ± 2.75 years, 10.38 ± 2.69 in the atropine group, and 10.97 ± 2.81 in the multifocal group. Of these, 37.8% were female and 62.2% were male. The study found a significant increase in axial length in the multifocal groups at the second follow-up (25.36 ± 1.30 mm vs. 24.56 ± 1.50 mm, $p = 0.020$), but no significant differences in other parameters between groups. Intragroup analysis showed that the multifocal group had significant changes in axial length ($p < 0.001$) and refractive error ($p = 0.035$) over time, but the atropine group did not.

CONCLUSION: The study discovered that, while both low-dose atropine and multifocal spectacles reduced myopia in children, atropine was more efficient at limiting axial elongation. Both treatments had comparable results for visual acuity and refractive error, with good overall tolerance.

KEYWORDS Myopia, Atropine, Eye glasses.

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INTRODUCTION

Myopia, also known as shortsightedness, is the main kind of refractive error, where the retinal image is concentrated in front of the retina. [1] First, a common eye condition that is causing an increasing number of cases of visual impairment globally is myopia. Over the past few decades, myopia has become more common, especially in East Asia, and is predicted to become even more over the next fifty years. [2] An estimated one billion myopes globally may be at risk for myopia-related problems by 2050. The prevalence and progression of myopia are known to be influenced by several factors, such as age, myopia onset age, myopia severity, country, and ethnicity. Previous studies found that the average annual development of myopia in youngsters was slightly higher for Asians (-0.82D) and nearly half a diopter for Europeans (-0.55D). [3]

Myopia is a major health concern on a global scale. The World Health Organization (WHO) predicts that half of the world's population will be myopic by 2050. Other estimates predict that by 2050, there will be 5 billion people diagnosed with myopia and over 1 billion people with myopia higher than 5 diopters (D). [4] Over the past 50 years, the prevalence of myopia has significantly increased worldwide. High myopia can significantly impact a person's physical, social, and financial aspects of life, leading to a measurable reduction in quality of life. [5]

Myopia usually develops in childhood, peaking in prevalence between the ages of 8 and 10. The prevalence of myopia in children varies significantly depending on the ethnic origin. Numerous studies have looked into how myopia develops, and they have discovered that a younger age at which myopia begins or a longer time span for myopia advancement are strong predictors of high myopia. [6]

Myopia can be classified as either syndromic, which is associated with hereditary conditions such as Marfan syndrome, or no syndromic, which is associated with gene polymorphisms but has a recognized genetic foundation. Numerous methods, including anticholinergic drugs, refractive correction, multifocal lenses, orthokeratology, and refractive surgery, have been attempted to treat myopia and prevent further deteriorations in visual acuity. [7] Slowing the course of myopia requires an understanding of the risk factors and mechanisms, such as hyperopic defocus, which results in excessive axial growth.

However, myopic defocus can impede its expansion. Multifocal lenses, which provide a centre distance zone and a peripheral zone with myopic defocus, were developed using periphery focus technology to decrease axial elongation. [8] Soft bifocal and multifocal contact lenses, ortho-keratology, and low concentration (0.01%) atropine eye drops are some of the most widely used techniques for slowing the progression of myopia. [9] By pharmacologically blocking the parasympathetic acetylcholine muscarinic receptors on the sphincter pupillae muscle, the anticholinergic medication atropine causes mydriasis and cycloplegia. [10]

Although high-dose (1%) atropine eye drops are quite efficient, they have undesirable side effects like impaired vision and photophobia. Lower dosages of atropine (0.01%) have less side effects while yet producing similar therapeutic efficacy. [11] Atropine eye drops are an effective way to manage children's myopia. Even though higher dosages produce more results, they might also have unfavorable side effects include rebound symptoms after quitting the medicine, photophobia, and obscured near vision. Low atropine concentrations (e.g., 0.01%) offer reasonable efficacy with fewer adverse effects, easy use, and little rebound effects following therapy discontinuation. [12]

The Defocus Incorporated Multiple Segments lens is designed to help children with their myopia. It features a centre zone for distance correction and a number of tiny circular segments with +3.50D power spread out in a honeycomb pattern around the mid-periphery. This design offers clear vision at all distances while providing myopic defocus. [13] Two methods to lessen myopia include topical drugs and optical treatments like bifocal and multifocal lenses that cause peripheral myopic defocus. These approaches do, however, have drawbacks in terms of application, affordability, safety, and effectiveness. [14]

Atropine has been shown to be an effective inhibitor of myopia progression. The optimal dosage of atropine for this purpose has been studied in the past. [15] Current strategies for managing myopia include topical timolol, antimuscarinic drugs like pirenzepine and atropine, under corrected and multifocal spectacles, new lens designs, and different contact lens therapies (such bifocal or multifocal contact lenses and orthokeratology). [16]

Low-dose atropine has demonstrated consistent efficacy among the pharmacological treatments available to delay the progression of myopia, making it one of the recommended techniques based on numerous research. Its effect on kids with premyopia is still unknown, though.[17]. Low-dose atropine eye drops have been increasingly popular worldwide in recent years as a treatment for children's progressive myopia, and many doctors now acknowledge it as a top therapeutic option. [18].

METHODOLOGY

This study employed a randomized controlled trial design conducted at Social Security Teaching Hospital, Lahore, over a period of six months following BASR approval. A total of 80 children aged 6–15 years with myopia ranging from

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INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION
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−0.50 D to −6.00 D and best-corrected visual acuity of 20/40 or better were enrolled using a non-probability convenient sampling technique. Sample size was calculated using an independent t-test with 95% confidence, 80% power, and an effect size of 0.5, with an additional 10% included to compensate for potential dropouts. Ethical approval was obtained, informed consent was secured from parents or guardians (with assent from children where appropriate), confidentiality was ensured, and participation remained voluntary throughout the study. Eligible participants were randomly allocated in a 1:1 ratio to either the low-dose atropine (0.01%) group or the multifocal spectacles group using a computer-generated randomization sequence managed by an independent researcher. The study followed a single-blind design in which outcome assessors were blinded to group allocation to minimize assessment bias. Baseline evaluation included best-corrected visual acuity, cycloplegic refraction for spherical equivalent, and axial length measurement using optical biometry. Children in the atropine group were instructed to instil eye drops once nightly, while those in the spectacle group were advised to wear multifocal glasses throughout the day except during sleep and bathing. Follow-up assessments were conducted at three months and at the end of six months. At each visit, axial length, spherical equivalent progression, and visual acuity were reassessed using standardized protocols. Treatment adherence was monitored through parental reports and treatment diaries, and any adverse effects were documented using structured forms. All clinical and follow-up data were recorded in a computerized database and later analyzed statistically to compare the effectiveness of low-dose atropine and multifocal spectacles in controlling myopia progression.

RESULTS

In this study, a total of 74 participants were enrolled, of whom 28(37.8%) were females and 46(62.2%) were males, as shown in Figure No. 1. Overall average age in this study was 10.68±2.75 years, ranging from 06-15 years. In the atropine group, 10.38±2.69 years, and in the multifocal group, it was 10.97±2.81 years. The normality of the data was assessed through the Shapiro-Wilk test. Results indicated that data were not normally distributed (P <0.05).

Figure No. 1: Gender Distribution Among Study Participants

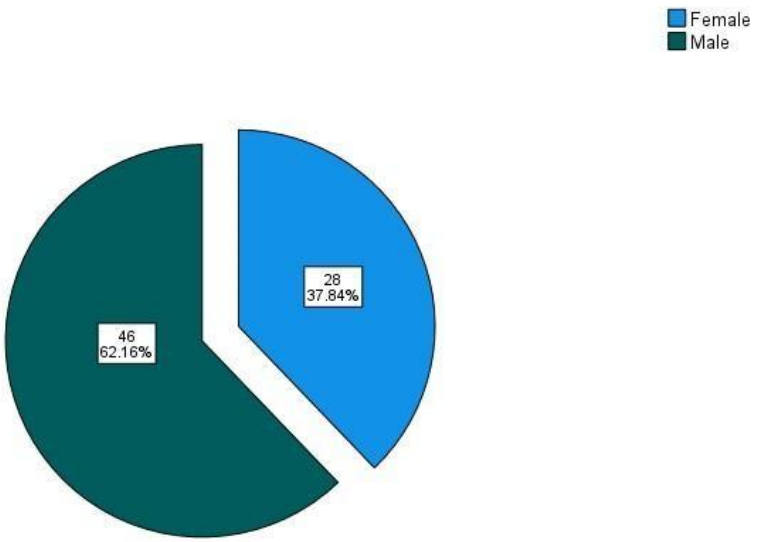

Table No. 1: Impact of Multifocal Spectacles and Atropine on Myopia Control Parameters in the Right Eye

	Multifocal	Atropine	P-value
	OD	OD	
Axial Length Baseline	23.73±1.22	23.70±1.12	0.987
Axial Length 1st Follow-up	24.84±1.26	24.60±1.47	0.534
Axial Length 2nd Follow-up	25.36±1.30	24.56±1.50	0.020*
Uncorrected VA baseline	0.62±0.22	0.63±0.22	0.825

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INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION
ORIGINAL RESEARCH
Volume 4 | Issue 2 | 2026
ISSN: 3007-2948

Uncorrected VA 1st Follow-up	0.59±0.27	0.59±0.22	0.897
Uncorrected VA 2nd Follow-up	0.62±0.22	0.56±0.23	0.214
Refractive Error Baseline	-2.76±1.23	-2.94±1.18	0.548
Refractive Error 1st Follow-up	-2.70±1.29	-2.75±1.38	0.884
Refractive Error 2nd Follow-up	-3.36±1.42	-2.88±1.20	0.177
BCVA Baseline	0.11±0.05	0.09±0.05	0.332
BCVA 1st Follow-up	0.10±0.06	0.09±0.06	0.481
BCVA 2nd Follow-up	0.10±0.06	0.10±0.07	0.957

The comparative analysis between the Multifocal Spectacles and Atropine groups in terms of axial length, uncorrected visual acuity, refractive error, and BCVA of the right eye revealed noteworthy findings. At baseline, both groups showed almost identical measurements for axial length, uncorrected VA, refractive error, and BCVA, with no statistically significant differences. This suggests that both groups were well-matched before the intervention.

During the first follow-up, there remained no significant differences between the groups across all parameters, indicating a comparable short-term effect of both treatments. However, by the 2nd follow-up, a significant difference was observed in axial length ($p = 0.020$), with the multifocal spectacle group showing a greater increase. This suggests that axial elongation progressed more in the multifocal group compared to the Atropine group over time. On the other hand, uncorrected visual acuity, refractive error, and BCVA showed no significant intergroup differences at any time point.

Table No. 2: Impact of Multifocal Spectacles and Atropine on Myopia Control Parameters in the Left Eye

	Multifocal	Atropine	P-value
	OS	OS	
Axial Length Baseline	24.02±1.11	24.06±1.19	0.910
Axial Length 1st Follow-up	-2.95±1.51	24.54±1.45	0.556
Axial Length 2nd Follow-up	24.54±1.46	24.60±1.37	0.948
Uncorrected VA baseline	0.52±0.24	0.62±0.24	0.087
Uncorrected VA 1st Follow-up	0.59±0.25	0.64±0.24	0.361
Uncorrected VA 2nd Follow-up	0.54±0.22	0.57±0.20	0.456
Refractive Error Baseline	-2.39±1.22	-2.44±1.28	0.812
Refractive Error 1st Follow-up	-2.95±1.51	-2.99±1.41	0.931
Refractive Error 2nd Follow-up	-2.95±1.66	-3.13±1.61	0.615
BCVA Baseline	0.11±0.06	0.10±0.06	0.637
BCVA 1st Follow-up	0.11±.06	0.10±0.06	0.426
BCVA 2nd Follow-up	0.10±0.06	0.11±0.05	0.803

For the left eye, the findings indicate no statistically significant intergroup differences in axial length progression, refractive error change, or visual acuity outcomes. Both multifocal spectacles and low-dose atropine appeared equally effective in maintaining visual and refractive stability in the left eye over the study period.

Table No. 3: Friedman Test Results for Right Eye Intragroup Comparison Over Time

Parameters	Groups	Chi-Square	P-value
Refractive Error	Multifocal Spectacles	6.703	0.035*
	Atropine	0.216	0.898
Axial Length	Multifocal Spectacles	20.486	<0.001*
	Atropine	5.892	0.053*
Uncorrected Visual	Multifocal Spectacles	0.286	0.867

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ORIGINAL RESEARCH
Volume 4 | Issue 2 | 2026
ISSN: 3007-2948

Acuity			
	Atropine	1.810	0.405
BCVA	Multifocal Spectacles	1.121	0.571
	Atropine	1.556	0.459

*Shows significant p-value

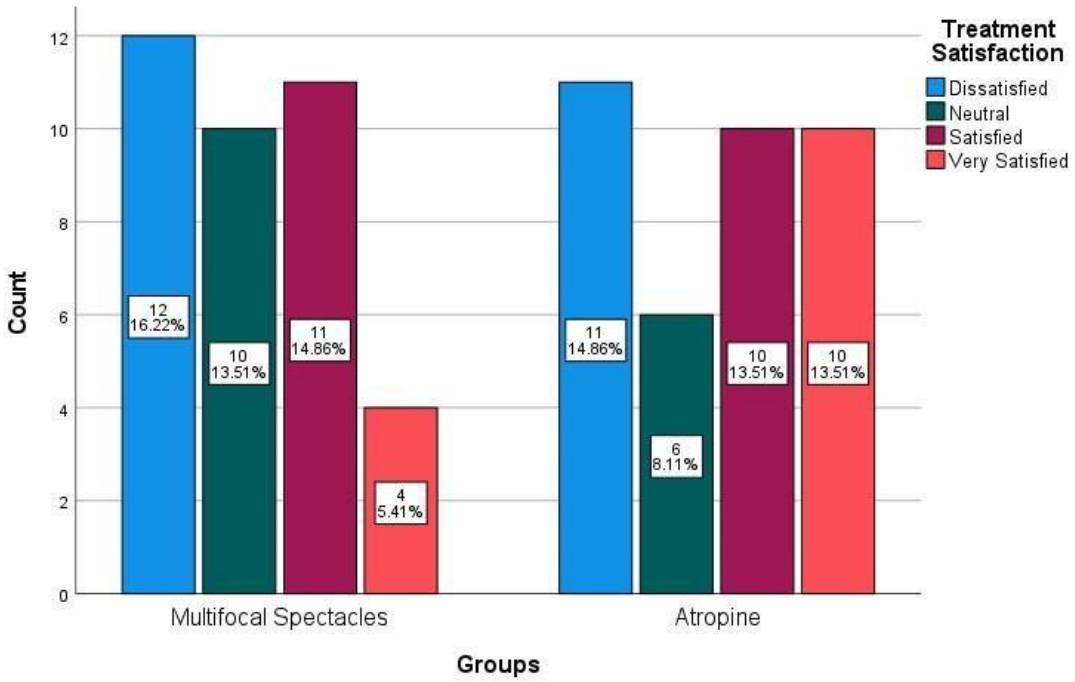
The Friedman test was conducted separately within each treatment group (Multifocal Spectacles and Atropine) to assess changes over three time points (Baseline, 1stFollow-up, and 2nd Follow-up) for refractive error, axial length, uncorrected visual acuity, and best-corrected visual acuity. Statistically significant change over time was observed in refractive error ($p = 0.035$) and axial length ($p = <0.001$) in the Multifocal Spectacles group. No significant change in these parameters in the Atropine group, though axial length showed borderline significance ($p = 0.053$).

Table No. 4: Friedman Test Results for Left Eye Intragroup Comparison Over Time

Parameters	Groups	Chi-Square	P-value
Refractive Error	Multifocal Spectacles	0.703	0.704
	Atropine	4.919	0.085
Axial Length	Multifocal Spectacles	4.541	0.103
	Atropine	1.676	0.433
Uncorrected Visual Acuity	Multifocal Spectacles	0.122	0.941
	Atropine	1.075	0.584
BCVA	Multifocal Spectacles	0.681	0.712
	Atropine	0.043	0.979

No significant change over time was observed in refractive error, axial length, VA UC, or BCVA for either group.

Figure No. 2: Comparison of Treatment Satisfaction Between Groups



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ORIGINAL RESEARCH
Volume 4 | Issue 2 | 2026
ISSN: 3007-2948

Figure No. 3: Comparison of Reported Side Effects in Multifocal Spectacles and LowDose Atropine Groups

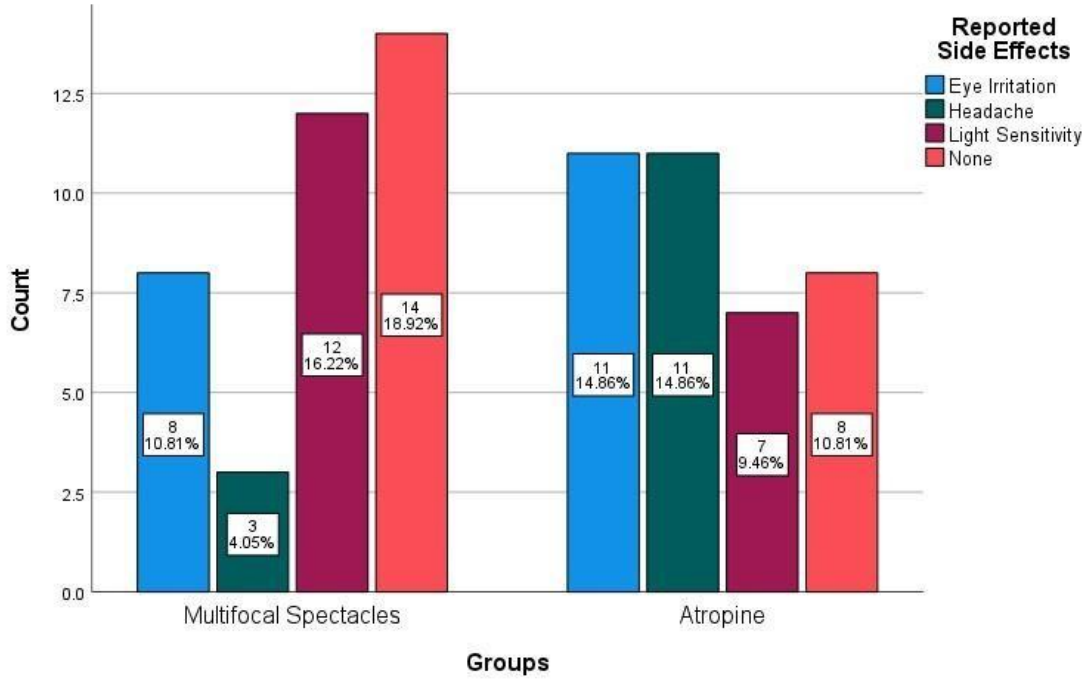
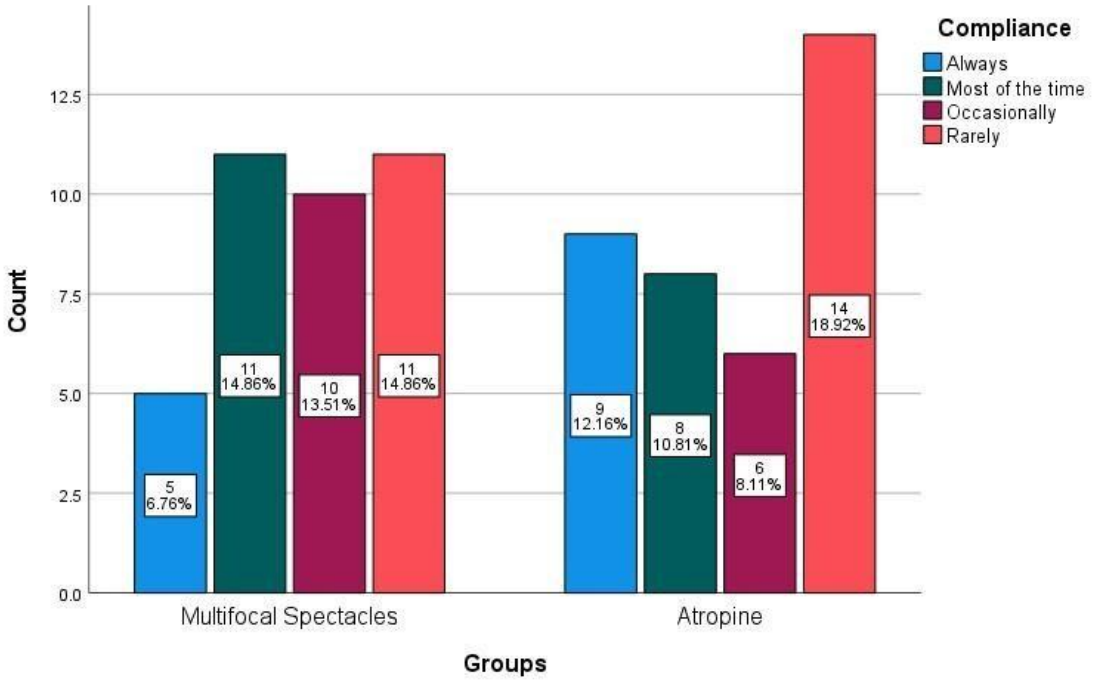


Figure No. 4: Comparison of Treatment Compliance



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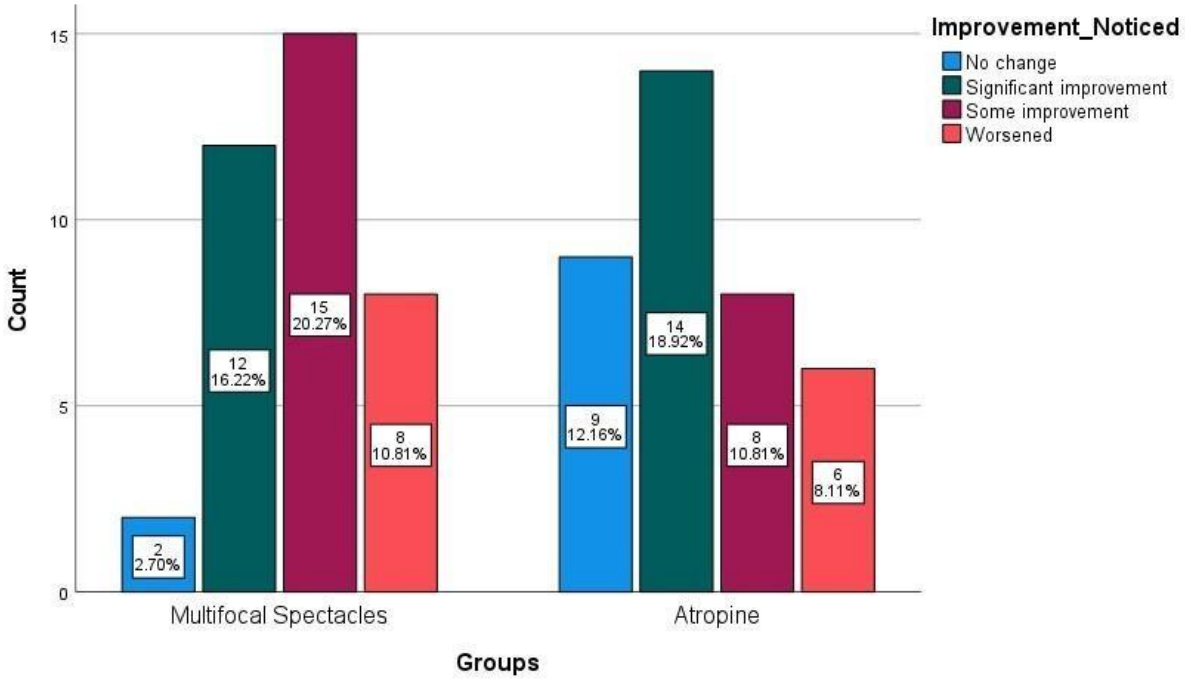
ORIGINAL RESEARCH
Volume 4 | Issue 2 | 2026
ISSN: 3007-2948

Figure No. 5: Comparative Analysis of Treatment Outcomes



DISCUSSION

The findings of this study are useful to understand the comparative effectiveness of the two main interventions for myopia control. In the present study, 74 patients were involved, and during the second follow-up, axial length growth in the multifocal spectacle group significantly exceeded that of the atropine group ($p = 0.020$). This observation is consistent with the totality of evidence that has indicated that atropine could be more effective in the management of axial elongation than optical treatment. In a randomized, double-masked, placebo-controlled trial of low-dose atropine in European children, the dose of 0.1 percent atropine loading dose reduced axial length by 0.13 mm (61%), and 0.01 percent atropine lowered axial length by 0.06 mm (29%) compared to placebo at six months [19]. This explains this concentration dependent effect in the current study because atropine managed better performance and control of axial elongation than multifocal spectacles. The results of the European study can be especially applied since the environment in which they were held exemplifies the fact that the effectiveness of atropine is not limited to Asian populations [19].

A landmark 3-year phase 3 randomized clinical trial, namely, CHAMP, compared 0.01% and 0.02% atropine with placebo in North American and European subjects [20]. Although 0.02 % atropine failed to show the primary endpoint, a significant effect on slowing the progression of myopia was achieved with 0.01 % atropine, with 28.5% of the respondents compared to 17.5% in the placebo group. The current study will be highly valuable to complete the existing body of research, since it will offer strong support to establish the applicability of atropine in treating patients of non-Asian origin in comparison with studies in Asian populations, whose effect sizes were considerably larger [20].

The article by Hou et al. (2023) was a thorough meta-analysis of various types of atropine concentration in terms of myopia control, with the analysis of 39 studies and 7,712 participants [15]. They performed a network meta-analysis in which they found that 0.05 percent atropine was best in slowing down refractive changes (0.62D per year), whereas 1 percent atropine was best in axial length control [38]. Nevertheless, it was determined that a concentration of 0.05% of atropine is the most suitable after taking into account efficacy and safety [15]. The finding indicates that the concentration of atropine in the present study might not have been perfectly chosen to give the best effect.

The efficacy of multifocal spectacles has been seen to be greatly exploited with mixed results. A randomized controlled trial study conducted by Lam et al. (2020) shows that Defocus Incorporated Multiple Segments (DIMS) spectacle lenses produced a significant 52% reduction in myopia progression and 62% in axial elongation than single vision lenses after 2 years. DIMS design has a series of segments with +3.50D power placed in a honeycomb pattern, generating simultaneous myopic defocus and also clearing vision [11].

A recent real-life study in the French Myopia Cohort assessed 2,542 children with DIMS spectacles or spectacles with Highly Aspherical Lenslet (HAL). It was concluded that the two types of myopia control spectacle designs showed rather high efficacy, as the mean progression was reduced by 0.59D, in contrast with single vision lenses. Interestingly,

INSIGHTS-IJHR
INSIGHTS-JOURNAL OF HEALTH AND REHABILITATION
ORIGINAL RESEARCH
Volume 4 | Issue 2 | 2026
ISSN: 3007-2948

children using HAL spectacles on average performed a little bit better than the ones using DIMS lenses, but the margin was small and it might not reach clinical significance [21].

Long-term efficacy of DIMS lenses was demonstrated in follow-up studies over a prolonged period. Lengthening scores were lower in children who continuously wore DIMS lenses than in wearing contact lenses as an intervention: Those who continuously wore DIMS lenses had myopia progress of -0.15D/year and axial elongation of 0.10mm/year at 6-year follow-up (Yam et al., 2023. These observations indicate that the multifocal spectacle group in this study could have produced other results on follow-ups of a longer period or a different spectacle design [22].

The 8-year follow-up study of the use of DIMS spectacle lens released at the ARVO 2025 confirms the long-term effects of this intervention. Out of 63 children who were monitored over the entire tracking period, myopia progression and axial elongation were on a much lower level in children wearing DIMS lenses than in age matched norms. Surprisingly, the overall progression of myopia was 0.5D, and the overall axial elongation was estimated at 0.5mm in 11 kids who received DIMS lenses for more than 8 years [23].

The literature on contact lenses presents a large evidence of myopia control efficacy. In a 3-year landmark randomized clinical trial (BLINK), the high-add (+2.50D) multifocal contact lenses reduced the progression of myopia by 43 percent and axial elongation by 36 percent relative to single vision lenses. The investigation focused on the significance of adding power, because lenses of medium power additions (+1.50D) did not reveal better results [24].

CONCLUSION

This Comparative study has shown that low doses of atropine and multifocal spectacles could delay the development of myopia among children, but the former was more effective in inhibiting axial elongation of the right eye throughout the observation duration. The groups did not show any significant differences in their refractive error or visual acuity, and both treatments were well-tolerated. These results should be confirmed, and the strategies of myopia management should be optimized due to further research with bigger samples and with longer follow-ups.

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