

## Efficacy of 0.01% Atropine for Myopia Progression in Children Aged 5 Years to 16 Years

Navin Yadav,<sup>1</sup> Anu Malik,<sup>2</sup> Ram Chandra Gupta,<sup>1</sup> Alka Gupta,<sup>1</sup> Lokesh Kumar Singh,<sup>1</sup> Jaishree Dwivedi<sup>1</sup>

<sup>1</sup>Upgraded Department of Ophthalmology, Lala Lajpat Rai Memorial Medical College, Meerut, Uttar Pradesh, India

<sup>2</sup>Department of Cornea and Refractive Surgery Services, Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences (AIIMS), Ansari Nagar, New Delhi, India

### ABSTRACT

**Introduction:** Myopia is an increasingly prevalent global public health concern, particularly among children, with potential long-term visual complications. Low-dose atropine has emerged as promising pharmacological intervention for controlling myopia progression.

**Objective:** To evaluate the efficacy and safety of 0.01% atropine eye drops in controlling myopia progression in children over one year.

**Methodology:** A placebo-controlled, interventional study was conducted for one year in ophthalmology department of a tertiary care centre. A total of 189 eyes (95 participants) were included in treatment group and 150 eyes (75 participants) in control group. Baseline and follow-up assessments at four, eight, and 12 months included axial length, spherical equivalent, distance uncorrected visual acuity, amplitude of accommodation, intraocular pressure, pupil diameter, and fundus examination. Statistical analysis was performed using Epi Info software, and a p-value <0.05 was considered statistically significant.

**Result:** At 12 months, treatment group demonstrated significantly reduced myopia progression compared with control group. Mean spherical equivalent was  $2.61 \pm 0.30$  dioptres in treatment group and  $2.83 \pm 0.36$  dioptres in control group ( $p < 0.001$ ). True myopia progression was  $0.53 \pm 0.22$  dioptres in treatment group compared with  $0.84 \pm 0.48$  dioptres in control group ( $p < 0.001$ ). Axial length elongation was significantly lower in treatment group ( $0.19 \pm 0.08$  millimetres) compared with control group ( $0.36 \pm 0.24$  millimetres) ( $p < 0.001$ ). The control group demonstrated consistently poorer uncorrected visual acuity ( $p < 0.001$ ). Statistically significant differences were also observed in photopic pupil diameter and amplitude of accommodation ( $p < 0.05$ ). Intraocular pressure was slightly lower in treatment group but remained within physiological limits ( $p < 0.05$ ).

**Conclusion:** Topical 0.01% atropine effectively reduced myopia progression and axial elongation in children over one year, with a favourable safety profile and minimal clinically significant effects on accommodation, intraocular pressure, and pupil diameter.

**Key words:** Atropine; axial length; child; myopia; refractive errors.

Financial Interest : Nil

Received : 16.12.2024

Conflict of Interest : Nil

Accepted : 27.11.2025

#### Corresponding Author

Dr. Anu Malik  
Assistant Professor,  
Department of Cornea and Refractive Surgery Services,  
Dr. Rajendra Prasad Centre for Ophthalmic Sciences,  
AIIMS, Ansari Nagar, New Delhi, India.  
E-mail: docanu.20@gmail.com



Access this article online

Website: [www.nepjol.info/index.php/NEPJO](http://www.nepjol.info/index.php/NEPJO)

DOI: <https://doi.org/10.3126/nepjoph.v17i34.72617>

Copyright © 2025 Nepal Ophthalmic Society

ISSN: 2072-6805, E-ISSN: 2091-0320



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND).



## INTRODUCTION

Myopia, or nearsightedness, is the most prevalent refractive error globally, affecting an estimated 1.5 billion individuals (22% of the world's population) (Foster, 2014). Its prevalence has reached epidemic proportions in certain Asian countries, ranging from 70–90% (Fredrick, 2002). Among children aged 5-17 years, substantial ethnic and geographic variability exists, with the highest prevalence reported in Asians (18.5%), followed by Hispanics (13.2%), African Americans (6.6%), and Caucasians (4.4%) (Kleinstei et al., 2003). Notably, in Taiwan, myopia prevalence has escalated to 84% among high school students, underscoring the magnitude of this public health concern (Vitale et al., 2009) (Cyphers et al., 2022).

Axial myopia is primarily attributed to excessive elongation of the ocular axial length (Cline et al., 1997). High myopia significantly increases the risk of vision-threatening complications, including retinal detachment, primary open-angle glaucoma, and vitreous floaters (Messmer, 1992). According to the National Institutes of Health, no definitive preventive strategy exists, and conventional optical correction with spectacles or contact lenses does not alter disease progression unless overcorrection occurs (National Institutes of Health, 2010).

Pharmacological intervention, particularly with atropine, has gained widespread acceptance, with approximately 75% of North American specialists and over 80% in Australia favouring this modality. Increased outdoor activity has also been associated with a reduced risk of myopia onset and progression (Ramamurthy et al., 2015).

The therapeutic effects of atropine are believed

to involve muscarinic receptor pathways at multiple ocular sites. Retinal muscarinic receptors within the retinal pigment epithelium may influence scleral remodelling through choroidal signalling (Lind et al., 1998; Tanaka et al., 1997). Atropine may also enhance dopamine release, thereby modulating ocular growth (Schwahn et al., 2000). Additionally, it increases choroidal thickness and inhibits scleral glycosaminoglycan synthesis, ultimately limiting axial elongation (Sander et al., 2014; Zhang et al., 2016; Lind et al., 1998).

## METHODOLOGY

This single-masked, randomised, single-centre, placebo-controlled interventional study was conducted in the upgraded Outpatient Department of Ophthalmology at LLRM Medical College, Meerut, a tertiary care centre, over a period of one year from 1 September 2022 to 31 August 2023. The study aimed to evaluate the efficacy of 0.01% atropine eye drops in controlling myopia progression. Participants who attended the outpatient department during the study period, fulfilled the predefined inclusion criteria, and provided informed consent were enrolled. A total of eligible children within the specified age group were recruited using a convenience sampling method from those presenting to the department during the study period. Children with myopia within the defined refractive range and age criteria were included, whereas those with ocular pathology, previous ocular surgery, hypersensitivity to study medications, systemic conditions affecting refraction, or poor anticipated compliance were excluded.

After enrolment, a detailed baseline history including name, age, sex, and address was recorded. Participants were randomised into two groups: the treatment group received

prepackaged monodose 0.01% atropine eye drops instilled once daily at bedtime, and the control group received unlabelled 0.5% carboxymethylcellulose eye drops once daily. Both participants and outcome assessors were masked to treatment allocation. All children were followed for 12 months with evaluations at baseline, four months, eight months, and twelve months. Axial length was measured using a non-contact A-scan biometer (Biomedix Echorule 2; Optotechnik and Devices Ltd.), recording the mean of three consecutive readings with a standard deviation (SD) of 0.00. Cycloplegic refraction was performed using a streak retinoscope in a semi-dark room after pharmacological dilation with homatropine 2% (5–8 years) or cyclopentolate 1% (8–16 years), and spherical equivalent was calculated as sphere + 0.5 × cylinder. Additional assessments included logMAR-converted uncorrected visual acuity, amplitude of accommodation by dynamic retinoscopy, intraocular pressure measured with a CT-1P Topcon non-contact tonometer (mean of five readings adjusted for central corneal thickness), photopic pupil diameter, and detailed fundus examination. Compliance and adverse events were systematically documented.

The study was conducted following approval from the Institutional Ethical Committee (Reference number: SC-1/2024/5419; dated 16.07.2024), and written informed consent was obtained from parents or guardians before participation. There was no financial or competitive conflict of interest. Data were entered into Microsoft Excel and analysed using Epi Info software. Qualitative variables were expressed as percentages, and quantitative variables were analysed using descriptive statistics. Pearson's Chi-square test was applied to assess associations between categorical variables. For intergroup comparisons, the

unpaired Student's t-test was used, and paired t-test was applied to compare baseline and 12-month outcomes. A p-value <0.05 was considered statistically significant.

## RESULT

Of the total 170 participants in the study, 87 (51.17%) were boys, and 83 (48.82%) were girls. Among the total 87 boys, 20 (22.9%) were found to be in the 5-9 years age group, 53 were found to be in the >9-15 years age group and 14 were found to be in the >14-16 years of age group. Among the total of 83 Girls, 19 (22.89% of total girls) were found to be in the 5-9 years age group, 50 (60.25% of total girls) were in the >9-14 years age group, and 14 (16.86% of total girls) were in >14-16 years age group.

The key observations were that the largest age group for both genders was >9-14 years, representing about 60% approximately of each gender group. The mean age Group among the Boys and Girls was found to be  $11.7 \pm 2.22$  years and  $11.9 \pm 2.18$  years, respectively.

The baseline demographic and ocular parameters recorded at study initiation, including spherical equivalent (D), axial length (mm), visual acuity (logMAR units), accommodation amplitude (mm), photopic pupil diameter (mm), intraocular pressure (mmHg), and fundus examination findings have been tabulated (Table1).

Regarding the efficacy profile of 0.01% atropine, at the 12-month follow-up, the mean Spherical Equivalent of the control group was found to be  $2.83 \pm 0.36$ , and of the treatment group was found to be  $2.61 \pm 0.30$ . The difference is found to be statistically significant, with a p-value less than 0.001 (Figure 1).

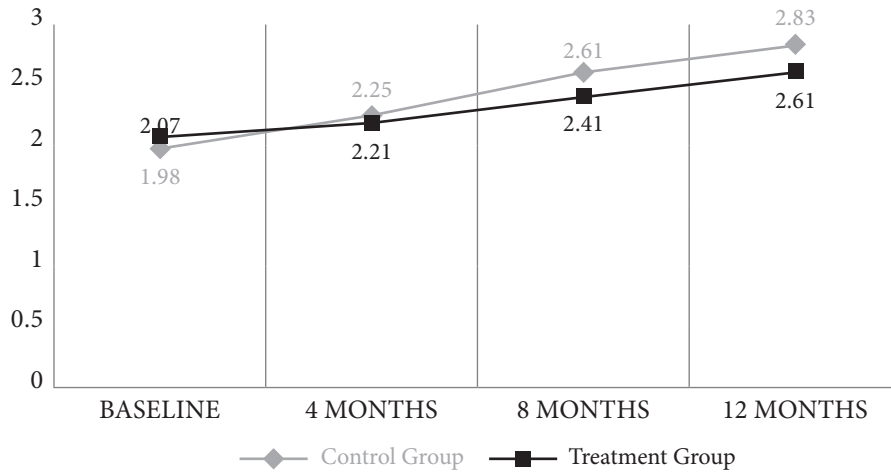
True Myopia progression (TMP) in terms of spherical equivalent was calculated with the

**Table 1: Baseline demographic and ocular parameters.**

Baseline Parameters	Control Group Mean ± SD (Range)	Treatment Group Mean ± SD (Range)	p-value
No of eyes studied	150	189	
Mean age (years)	12.44 ± 2.13	12.77 ± 2.36	
	(5-16)	(8-16)	
Spherical Equivalent (Diopter)	- 1.98 ± 0.37	- 2.07 ± 0.35	0.027
	(1.25-2.50)	(0.75-2.50)	
Axial length (mm)	24.61 ± 0.22	24.63 ± 0.15	0.234
	(24.10-25.20)	(24.32-24.83)	
Visual acuity (Log Mar)	0.78 ± 0.20	0.91 ± 0.41	0.001
	(0.50-1.08)	(0.3-1.08)	
Accommodation amplitude (mm)	16.05 ± 0.14	16.14 ± 0.18	<0.001
	(15.79-16.33)	(15.50-16.50)	
Photopic pupil diameter (mm)	2.70 ± 0.028	2.69 ± 0.031	<0.001
	(2.63-2.76)	(2.62-2.74)	
IOP (mmHg)	16.50 ± 0.27	16.24 ± 0.35	<0.001
	(15.78-17.17)	(15.60-16.70)	
Fundus examination	Findings were within normal limits		

**Table 2: Clinical and biometric parameters assessed at the final follow-up visit.**

Parameters studied	Control Group Mean ± SD	Treatment Group Mean ± SD	p-value
Spherical equivalent (D)	-2.83 ± 0.36	-2.6 ± 0.30	<0.001
TMP (Diopter)	0.84 ± 0.48	0.53 ± 0.22	<0.001
%TRMP	63.08 ± 45.83 %		
Axial length (mm)	24.97 ± 0.10	24.82 ± 0.07	<0.001
TALE (mm)	0.36 ± 0.24	0.19 ± 0.08	<0.001
%TRMP	52.77 ± 33.33 %		
Visual acuity Log Mar	1.10 ± 0.08	1.06 ± 0.11	<0.001
Accommodation amplitude (D)	17.24 ± 0.68	17.01 ± 0.63	<0.001
Intraocular pressure (mmHg)	15.85 ± 0.67	15.27 ± 0.49	<0.001
Photopic pupil diameter (mm)	2.67 ± 0.77	2.93 ± 0.14	<0.001



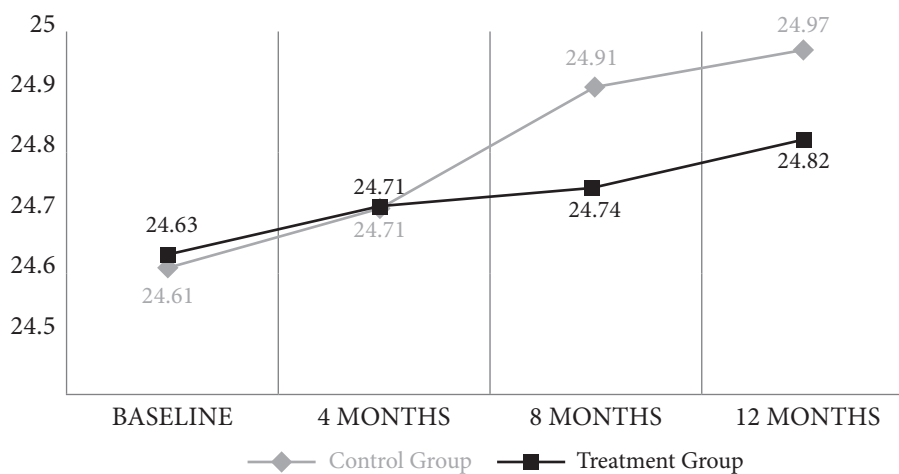
**Figure 1: Comparison of mean spherical equivalent at 12 months between control (2.83 ± 0.36 D) and treatment (2.61 ± 0.30 D) groups, showing a statistically significant difference (p <0.001).**

difference found in spherical equivalent at the last follow-up from spherical equivalent at baseline at the end of one year; the change was found to be 0.53 ± 0.22 D in the treatment group and 0.84 ± 0.48 D in the control group at the end of the study. When the true reduction in myopia progression of both groups was compared, the data were statistically significant with a p-value <0.001 (Table 2).

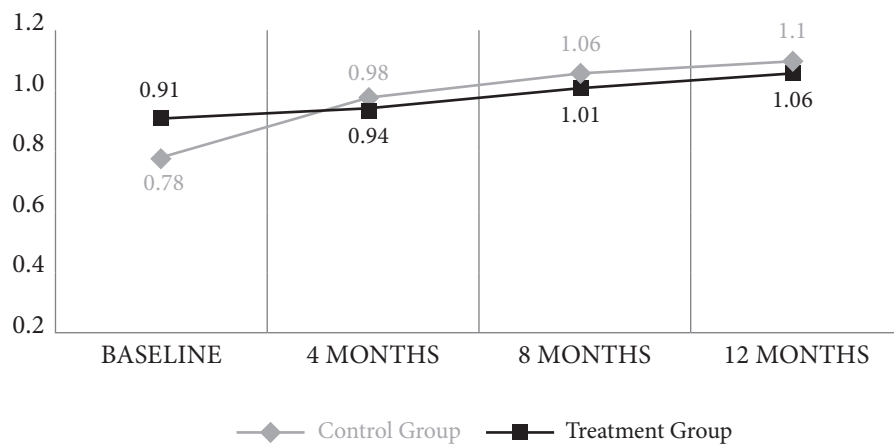
The percentage true reduction in Myopia Progression in the treatment group compared

to the control group { $\%TRMPD = \frac{TMP (treatment\ group)}{MP (control\ group)} \times 100$ } was calculated and found to be 63.08 ± 45.83 %, suggesting the myopia progression in the treatment group was only 63.08 ± 45.83 % of the myopia progression found in the control group.

At 12 months, the difference between the mean Axial length among the control group and the treatment group was found to be statistically significant (p <0.001). (Figure 2)



**Figure 2: Comparison of mean axial length at 12 months between the control and treatment groups, demonstrating a statistically significant difference (p <0.001).**



**Figure 3. Trend in mean visual acuity (logMAR) in the treatment and control groups over the study period.**

True axial length elongation (TRALE) was calculated (Axial length at last follow-up – axial length at baseline) at the end of 1 year, and the change was found to be  $0.19 \pm 0.08$  mm in the treatment group, which was lesser as compared to change found  $0.36 \pm 0.24$  mm in the control group, when compared among each other found to be statistically significant with p value  $< 0.001$ . The percentage true reduction in Axial Length Elongation in the treatment group compared to the control group  $\{\%TRALE = TRALE (\text{treatment group}) \times 100 / ALE (\text{control group})\}$  eyes was calculated and found to be  $52.77 \pm 33.33$  %, suggesting that axial length elongation in the treatment group was only  $52.77 \pm 33.33$  % of the axial length elongation found in the control group (Table 2).

About the safety profile of 0.01% atropine, in the mean accommodation amplitude, the control group showed a general increase in values over time, starting at  $16.05 \pm 0.18$  D at baseline and rising to  $17.24 \pm 0.68$  D at 12 months. The treatment group, however, exhibited a more stable trend, beginning at  $16.14 \pm 0.18$  D and ending at  $17.01 \pm 0.63$  D after 12 months. Notably, the treatment group's values remained

lower than the control group's at all time points after baseline. The comparison between the control and treatment groups was found to be statistically significantly different throughout the study period ( $p < 0.001$ ).

Mean intra-ocular pressure: The changes in IOP of both the control group show a slight change during the study when compared from baseline ( $16.50 \pm 0.27$  mmHg) to 12 months ( $15.85 \pm 0.67$  mmHg), and the treatment group shows  $16.24 \pm 0.35$  mmHg at baseline to  $15.27 \pm 0.49$  mmHg at 12 months. The treatment group's values are consistently lower than the control group's after the baseline. The p-value for each time point is reported as  $< 0.001$ .

Mean photopic pupil diameter: The control group, at baseline, was  $2.70 \pm 0.02$  mm and  $2.68 \pm 0.08$  mm at 12 months. In contrast, the treatment group demonstrates a noticeable increase from  $2.69 \pm 0.03$  mm at baseline to  $2.90 \pm 0.08$  mm at 12 months. The p-value for each time point is reported as  $< 0.001$ , suggesting statistically significant differences between the groups throughout the study period. The change in photopic pupil diameter compared to baseline

was  $-0.02 \pm 0.07$  mm and  $0.21 \pm 0.11$  mm in control and treatment groups, respectively and found to be statistically significant with p value 0.001.

Fundus examination of the participants from both groups was found to be within normal limits during and at the end of the study.

Also, no participants from either group complained of any allergic symptoms, blurring of vision, foreign body sensation, redness, fever or any other systemic side effects during and at the end of the study.

## DISCUSSION

There was a statistically significant difference between the control group spherical equivalent ( $2.83 \pm 0.36$  D) and the treatment group spherical equivalent ( $2.61 \pm 0.30$  D) at 12-month follow-up (p-value <0.001). True Myopia progression (TMP) was found to be  $-0.53 \pm 0.22$  D in the treatment group and  $-0.84 \pm 0.48$  D in the control group and was compared and found to be a statistically significant difference (p-value < 0.001). True axial length elongation was calculated (Axial length at last follow-up – axial length at baseline) and found to be  $0.19 \pm 0.08$  mm in treatment and  $0.36 \pm 0.24$  mm in the control group, and compared with each other, found to be a statistically significant difference (p-value <0.001).

The percentage True Reduction in Axial Length Elongation (%TRALE) in the treatment group compared to the control group was calculated as  $\text{TRALE (treatment group)} \times 100 / \text{ALE (control group)}$ , yielding a result of  $52.77 \pm 33.33\%$ . This finding is consistent with the results from a study by Shweta Chaurasia and colleagues (Chaurasia et al., 2022), which evaluated the efficacy and safety of 0.01% low-

dose atropine. In their groundbreaking study, the primary outcomes assessed were annual myopia progression (MP) and axial length elongation (ALE) in both treatment and control eyes. After one year of intervention, the study demonstrated a significant reduction of 63.89% in MP and 44.44% in ALE, highlighting the effectiveness of 0.01% atropine in slowing myopia progression.

When compared to the study by Clark and Clark (2015), which involved 60 school children treated with low-concentration atropine, the present study's findings align closely. TY and Clark (TY Clark et al. 2015) reported a slower rate of myopia progression in eyes treated with 0.01% atropine ( $-0.1 \pm 0.6$ D per year) compared to control eyes ( $-0.6 \pm 0.4$ D per year,  $p = 0.001$ ). These results are consistent with the outcomes observed in the current study. In the Lamp study Phase 2 (Yam et al., 2020), over the 2 years, the mean SE progression and mean AL elongation of 0.01% atropine group were found to be  $1.12 \pm 0.85$  D and  $0.59 \pm 0.38$  mm, respectively.

At baseline, there is a significant difference between the groups ( $p = 0.001$ ), with the treatment group starting higher (0.91) than the control group (0.78). By four months, both groups show increases, with the control group (0.98) surpassing the treatment group (0.94); this difference remains statistically significant ( $p = 0.009$ ). At eight months, both groups continue to improve, with the control group (1.06) maintaining a higher value than the treatment group (1.01). At 12 months, both groups show further increases, with the control group (1.10) still higher than the treatment group (1.06). The differences at both eight and 12 months are highly significant ( $p < 0.001$ ). We did not find any relevant studies describing the effect of 0.01% atropine eye drops on distance visual

acuity (LogMAR) in children with myopia.

The control group shows a general increase in values over time, starting at  $16.05 \pm 0.18$  D at baseline and rising to  $17.24 \pm 0.68$  D at 12 months. The treatment group, however, exhibits a more stable trend, beginning at  $16.14 \pm 0.18$  D and ending at  $17.01 \pm 0.63$  D after 12 months. Notably, the treatment group's values remain lower than the control group's at all time points after baseline. The comparison between the control and treatment group was found to be statistically significant different throughout the study period ( $p < 0.001$ ), which suggests that 0.01% atropine does not affect accommodation amplitude. The distance BCVA and near BCVA in both groups was not affected. Also, neither group complained of any asthenopia symptoms during and at the end of the study.

The changes in IOP in mmHg of both, the control group showed a slight change during the study when compared from baseline ( $16.50 \pm 0.27$  mmHg) to 12 months ( $15.85 \pm 0.67$  mmHg), and the treatment group shows  $16.24 \pm 0.35$  mmHg at baseline to  $15.27 \pm 0.49$  mmHg at 12 months. The treatment group's values are consistently lower than the control group's after the baseline. The p-value for each time point is reported as  $< 0.001$ , indicating statistically significant differences between the groups throughout the study period, but found to be within normal limits throughout the study. Hence, it suggests that 0.01% atropine does not affect intraocular pressure.

The change in photopic pupil diameter compared to baseline was  $-0.02 \pm 0.07$  mm and  $0.21 \pm 0.11$  mm in control and treatment groups, respectively, and found to be statistically significant with p value 0.001.

LAMP Phase 2 study (Yam et al., 2020) observed that over two years, the efficacy of 0.05% atropine was double that observed with 0.01% atropine, and it remained the optimal concentration among the studied atropine concentrations in slowing myopia progression. Photopic pupil size increased by 1.1 mm in 0.01% atropine group, and AA decreased by 2.4 D.

Also, in comparison to Cyphers and colleagues (Cyphers et al., 2022), who evaluated symptoms and ocular findings associated with the use of 0.01% atropine eye drops for one week in thirty-one participants of whom 81% were Caucasian, an increase in photopic pupil size by 0.2 mm and average intraocular pressure of the two eyes by 1.1 mmHg were found, but none of the changes were clinically meaningful. Neither vision nor accommodation or reading speed was affected using 0.01% atropine eye drops for one week.

A meta-analysis by Huy and colleagues (Tran et al., 2021) analysed the effect of various concentrations of atropine eye drops on PD and AA. Only 3 of the 13 studies provided data on PD, and 4 of the 13 were on AA. All these studies were conducted in Asian countries. The meta-analysis results showed that all the analysed concentrations (0.01%, 0.02%, 0.025%, 0.05%, 0.1%, 0.5% and 1.0%) resulted in a reduction in Accommodation Amplitude (mean change  $-4.67$  D, 95% CI,  $-7.44$  to  $-1.89$  D,  $p < 0.001$ ) and an increase in Pupil Diameter (mean increase 1.33 mm, 95% CI, 0.57 to 2.09 mm,  $p < 0.001$ ) except for 0.01% atropine. In concentrations lower than 0.1%, the slope of the curve between atropine and change in Pupil Diameter and Accommodation Amplitude was steep, but changes were smaller, whereas at concentrations higher than 0.01% the slope plateaued with greater changes in Accommodation Amplitude and Pupil Diameter.

Shweta Chaurasia and colleagues (Chaurasia et al., 2022) studied to evaluate the efficacy and safety of 0.01% low-dose atropine in the Indian paediatric population with progressive myopia. This single-centre, placebo-controlled interventional study involved 43 participants aged 6–16 years. The participants received 0.01% atropine in the right eyes (treatment) and a placebo in the left eyes (control) over one year. Photopic pupil size measured in treatment eyes and control eyes was  $3.86 \pm 0.47$  mm and  $3.18 \pm 0.37$  mm, respectively ( $p = 0.0001$ ). However, no patient complained of allergy to atropine drops, blurring of vision, photophobia, or glare.

The study findings present compelling evidence supporting the effectiveness of 0.01% atropine eye drops in slowing myopia progression, as demonstrated by significant differences observed between the treatment group and the control group in terms of key clinical measures—specifically, myopia progression, axial length elongation, and reduction in visual acuity. These results highlight the potential of low-dose atropine as a powerful tool in managing myopia, particularly in paediatric populations.

The present study adds novel evidence by providing placebo-controlled data demonstrating that 0.01% atropine significantly reduces both refractive progression and axial length elongation in children over one year within a real-world tertiary care setting. Unlike many prior reports that primarily focused on refractive outcomes alone, this study concurrently evaluated biometric, visual, and physiological parameters, thereby offering a comprehensive assessment of both efficacy and safety. The demonstration of nearly halved axial

elongation with minimal clinically significant impact on accommodation, intraocular pressure, and pupil diameter strengthens the translational relevance of low-dose atropine therapy and supports its practical integration into routine paediatric myopia management.

The limitations of the study include a relatively small sample size, which may restrict the generalisability of the findings to broader myopic populations. Additionally, the one-year follow-up period may not fully capture long-term trends in myopia progression and axial elongation. However, the study possesses notable strengths, including rigorous and structured follow-up with all participants examined at predefined intervals according to their enrolment schedule, ensuring consistency in data collection, behavioural monitoring, and detailed clinical evaluation. Importantly, there were no losses to follow-up, thereby eliminating attrition bias and strengthening the internal validity of the study findings.

## CONCLUSION

The present study reinforces the clinical efficacy of low dose atropine in slowing myopia progression in children. Its sustained use demonstrates meaningful potential in reducing axial elongation and thereby mitigating the long-term risk of developing high myopia and its associated pathological complications. Early initiation of low-dose atropine therapy may offer substantial benefits at both the individual and public health levels by decreasing the future burden of myopia-related visual morbidity.

## REFERENCES

- Chaurasia, S., Negi, S., Kumar, A., Raj, S., Kaushik, S., Optom, R.K.M., et al., (2022). Efficacy of 0.01% low dose atropine and its correlation with various factors in myopia control in the Indian population. *Scientific Reports*; 12(1): 7113. DOI: <https://doi.org/10.1038/s41598-022-10079-1> PMID: [35501349](https://pubmed.ncbi.nlm.nih.gov/35501349/)
- Clark, T.Y. and Clark, R.A., (2015). Atropine 0.01% eyedrops significantly reduce the progression of childhood myopia. *Journal of Ocular Pharmacology and Therapeutics*; 31(9): 541-545. DOI: [10.1089/jop.2015.0043](https://doi.org/10.1089/jop.2015.0043) PMID: [26218150](https://pubmed.ncbi.nlm.nih.gov/26218150/)
- Cline, D., Hofstetter, H.W. and Griffin, J.R., 1997. *Dictionary of Visual Science*. 4th ed. Boston: Butterworth-Heinemann.
- Cyphers, B., Huang, J., and Walline, J.J., (2022). Symptoms and ocular findings associated with administration of 0.01% atropine in young adults. *Clinical and Experimental Optometry*, 105(8), pp.873-883. DOI: [10.1080/08164622.2022.2033603](https://doi.org/10.1080/08164622.2022.2033603) PMID: [35188076](https://pubmed.ncbi.nlm.nih.gov/35188076/)
- Foster, P.J. and Jiang, Y., 2014. Epidemiology of myopia. *Eye*, 28(2), pp.202-208.
- Fredrick, D.R., 2002. Myopia. *BMJ*, 324(7347), pp.1195-1199.
- Kleinstei, R.N., Jones, L.A., Hullett, S., Kwon, S., Lee, R.J., Friedman, N.E. et al., 2003. Refractive error and ethnicity in children. *Archives of Ophthalmology*, 121(8), pp.1141-1147.
- Li, M., Tan, C.S., Foo, L.L., Sugianto, R., Toh, J.Y., Sun, C.H. et al., 2022. Dietary intake and associations with myopia in Singapore children. *Ophthalmic and Physiological Optics*, 42(2), pp.319-326.
- Lind, G.J., Chew, S.J., Marzani, D. and Wallman, J., 1998. Muscarinic acetylcholine receptor antagonists inhibit chick scleral chondrocytes. *Investigative Ophthalmology and Visual Science*, 39(12), pp.2217-2231.
- Messmer, D.E., 1992. [Retinal detachment]. *Schweizer Rundschau für Medizin Praxis*, 81(19), pp.622-625. (In German).
- National Eye Institute (NEI), 2010. *Facts About Refractive Errors*. [online] Available at: <URL> [Accessed 30 July 2016].
- National Institutes of Health (NIH), 2010. *Near-sightedness*. [online] Available at: <URL> [Accessed 10 May 2016].
- Ramamurthy, D., Lin Chua, S.Y. and Saw, S.M., 2015. A review of environmental risk factors for myopia during early life, childhood and adolescence. *Clinical and Experimental Optometry*, 98(6), pp.497-506.
- Sander, B.P., Collins, M.J. and Read, S.A., 2014. The effect of topical adrenergic and anticholinergic agents on the choroidal thickness of young, healthy adults. *Experimental Eye Research*, 128, pp.181-189.
- Schwahn, H.N., Kaymak, H., und Schaeffel, F., 2000. Effects of atropine on refractive development, dopamine release, and slow retinal potentials in the chick. *Visual Neuroscience*, 17(2), pp.165-176.
- Seko, Y., Tanaka, Y. and Tokoro, T., 1997. Apomorphine inhibits the growth-stimulating effect of retinal pigment epithelium on scleral cells in vitro. *Cell Biochemistry and Function*, 15(3), pp.191-196.
- Tran, H.D.M., Sankaridurg, P., Naduvilath, T., Ha, T.T.X., Tran, T.D., Jon, M. et al., 2021. Meta-analysis assessing change in pupillary diameter, accommodative amplitude, and efficacy of atropine for myopia control. *Asia-Pacific Journal of Ophthalmology*, 10(5), pp.450-460.
- Vitale, S., Sperduto, R.D. and Ferris, F.L. 3rd, 2009. Increased prevalence of myopia in the United States between 1971-1972 and 1999-2004. *Archives of Ophthalmology*, 127(12), pp.1632-1639.
- Yam, J.C., Li, F.F., Zhang, X., Tang, S.M., Yip, B.H.K., Kam, K.W. et al., 2020. Two-year clinical trial of the low-concentration atropine for myopia progression (LAMP) study: Phase 2 report. *Ophthalmology*, 127(7), pp.910-919.
- Zhang, Z., Zhou, Y., Xie, Z., Chen, T., Gu, Y., Lu, S. et al., 2016. The effect of topical atropine on the choroidal thickness of healthy children. *Scientific Reports*, 6, p.34936.