ORIGINAL RESEARCH

Evaluating vision therapy outcomes on quality of life in children with myopia: emphasis on visual function and everyday tasks

Jamshed Ali[1], Mohammad Nooruz Zaman[2]*, Khan Faiyaz Ahmed[3], Tabassum Israr[4]

[1]PhD Scholar, School Of Allied and Healthcare, CT University, Ludhiana, Punjab (India)-142024 (orcid id- 0000-0002-6679-1840)

[2]Associate Professor, School Of Allied and Healthcare, CT University, Ludhiana, Punjab (India)-142024 (orcid id-0000-0002-0900-8151)

[3]Assistant Professor, Institute of Allied and Healthcare Sciences, Lucknow, U.P (India)-226026 (orcid id- 0009-0002-2969-9228

[4]Assistant Professor, Institute of Allied and Healthcare Sciences, Lucknow, U.P (India)-226026 (orcid id- 0009-0006-4166-3494

Corresponding author: Mohammad Nooruz Zaman, mohammadnoor92@gmail.com

Received: 10th April, 2026; Revised: 11th May 2026; Accepted: 30th May, 2026; Available Online: 07th June, 2026

ABSTRACT

Background: The progress of childhood myopia is dependent upon structural/refractive impairment as well as functional deficits that impact quality of life (QoL). Such functional deficits include headaches, eye fatigue, and difficulties with focus.Vision Therapy is a non-invasive treatment that seeks to improve accommodative/bilaterally functioning skills in order to alleviate such symptoms.

Objective: This study examines the effects of structured vision therapy on QoL parameters related to visual function in pediatric patients experiencing progressive myopia.

Methods: In this randomized controlled trial, children aged 10–14 years who were experiencing progressive myopia. Each child was randomly assigned to one of two groups: the "vision therapy" group (n=50) and the "control" group (n=50). Each participant completed a ten-item symptom-based questionnaire measuring their QoL before and six months after assignment into the respective groups. Statistical analysis consisted of Shapiro-Wilk and Levene's tests to determine if our data met assumptions, followed by t-tests, U tests and Friedman tests to compare and analyze between-group and within-group changes over time.

Results: There were no significant differences at baseline ($p>.05$). Six months later, there were significant decreases (mean decreases ranging from 1.2-1.4 points per item) in symptoms experienced by participants in the vision therapy group, which included headaches (2.3±0.6 to 0.9±0.5) and eye fatigue (2.3±0.7 to 1.0±0.6). All statistical comparisons indicated that participants receiving vision therapy had better outcomes than those who did not receive vision therapy ($t=3.2$, $p<.01$; $U=850$, $p<.01$).

Conclusion: Vision therapy resulted in statistically and clinically relevant improvements in QoL for children with progressive myopia. Therefore, it can be used as an adjunctive approach when managing pediatric myopia.

Keywords: Vision therapy, myopia, quality of life, visual function, pediatric, randomized controlled trial

How to cite this article: Ali J, Zaman MN, Ahmed KF, Israr T. Evaluating vision therapy outcomes on quality of life in children with myopia: emphasis on visual function and everyday tasks. Int J Drug Deliv Technol. 2026;16(57s): 567-574. DOI: 10.25258/ijddt.16.57s.65

INTRODUCTION

As noted earlier, the issue of myopia is becoming increasingly common worldwide with estimates suggesting that nearly 2 billion people suffer from myopia, however; this number is predicted to rise to approximately 4.5 billion people by 2050[1,2]. The rapid increase of myopia prevalence, especially in East Asia where the prevalence of myopia has already surpassed 50%, and up to 90% in certain urban cohorts, suggests the urgent need to develop methods to slow the progression of myopia in children and adolescent populations[5]. Although the overall prevalence of myopia in India is less than in East Asia, the incidence of myopia is increasing rapidly in both urban and rural regions[6,7]. In addition, studies have shown that urban school-age children are experiencing high rates of myopia, exceeding 30% in numerous large cities and rural areas report a wide range of 10-20% of school age children who are experiencing myopia. These trends indicate the need to develop regional specific myopia management strategies.

Beyond simply correcting refractive errors, there are additional clinically important considerations for myopia. Individuals who experience significant amounts of myopia are at increased risk for severe, vision-threatening complications such as myopic maculopathy, retinal detachment, glaucoma, cataract formation, etc. which significantly contribute to permanent vision loss globally[3]. Moreover, because many of these complications occur in highly myopic individuals at younger ages, this creates an added burden on healthcare systems and reduces quality of life. Myopia also results in considerable economic costs related to the long-term use of corrective eyeglasses, medical expenses, and potential future surgical treatments[4]. Thus, reducing the progression of myopia in children represents a major objective for public health initiatives.

Axial elongation of the eye is currently recognized as the principal mechanism responsible for the progression of myopia. Therefore, measurement of axial length (AL) by optical biometry is considered to be the most reliable method for evaluating the development of myopia[8,9]. Measurement of AL allows clinicians to identify minor increases in ocular size prior to detectable changes in refractive error. Generally, ocular growth slows down in early adolescence; however, in children and adolescents with myopia, axial elongation may continue into late adolescence/early

*Author for Correspondence: alijamshed429@gmail.com, mohammadnoor92@gmail.com

adulthood requiring immediate action to prevent further progression[10].

Both environmental and physiological elements contribute to the initiation and progression of myopia. Environmental influences on the development of myopia include prolonged near-work (PNW), reduced levels of outdoor activity (LOA) and increased academic demands[11,12]. Physiological contributions to the initiation of myopia include genetic predispositions and abnormalities in binocular vision function (convergence and accommodation). Abnormalities in convergence (Convergence Insufficiency [CI]) and phoric functions (Phoria Abnormality [PA]) cause visual discomfort and asthenopic symptoms that may promote PNW-related visual stress leading to indirect promotion of myopia progression[13].

Current approaches for managing myopia include pharmacologic, optical and behavioral interventions. Pharmacologic approaches utilizing low-dose topical atropine eye drops (LDEs) have demonstrated consistent efficacy for slowing myopia development by approximately 50-60%. Side effects associated with LDEs (photophobia & near blur) may compromise patient compliance. Optical approaches utilizing orthokeratology (OK) and multifocal contact lenses (MFLs) decrease axial elongation (AE) by approximately 40-50% primarily through alterations in peripheral retinal defocus[14]. Randomized controlled trials (RCTs) have demonstrated promising results for spectacle lens designs incorporating myopic defocus[15,16]. Increased LOA has also been demonstrated as a preventative measure to slow onset and progression of myopia[17]. Although these new forms of intervention provide optimism for preventing/treating myopia, each presents its own unique barriers related to side effects, invasiveness, accessibility and adherence indicating a need for complementary strategies.

The purpose of Vision Therapy (VT) is to develop functional ability of the visual system. The visual system includes the ability to focus (accommodation), to move the eyes to look at objects (vergence), to use the eyes together (binocularity or ocular motor integration) and to combine information from both eyes (sensory fusion). Traditionally, VT is used to treat problems with convergence, accommodation, amblyopia (lazy eye) and some forms of strabismus (crossed eyes or wall-eyed)[18,19]. A structured program of VT is typically a series of activities specifically designed to make each component of the visual system work more efficiently. This can result in significant reduction of symptoms commonly experienced by children who are developing myopia such as eye fatigue, headache, blurred images and inability to maintain clear vision while performing close tasks. In addition to their negative effects on daily living, these symptoms also negatively affect academic performance and overall quality of life[21,22].

Although recent studies suggest that VT could potentially slow the progression of myopia development by improving the accuracy of accommodative responses and reducing visual stress caused during near-task performance. Reduced accommodative lag is a recognized stimulus for increased axial length growth. To date however, very few studies have investigated whether VT would be an effective treatment for childhood myopia. Unfortunately most of those studies were poorly conducted randomized clinical trials[20].

Purpose/Rationale: Historically, pharmacological and optometric treatments for myopia have concentrated primarily on changing the anatomical structure of the myope's eye. Visual function-related quality-of-life issues associated with myopia remain untreated. Accommodative and binocular dysfunctions occur frequently in myopic children. As such, VT may offer an opportunity to address visual function-related quality-of-life issues associated with myopia without surgically correcting the refractive error. While there is growing literature regarding the efficacy of VT for treating myopic children, there is insufficient evidence to assess its ability to positively impact visual-function related quality of life. Therefore, this study proposes to investigate the effect of VT on visual-function related quality-of-life among myopic children.

METHODOLOGY

Study Design: This prospective, randomized controlled trial was conducted at SarfarrazganjHardoi Road Lucknow, India, between May 2024 to March 2026. The researchers were granted ethical approval from the Ethics Committee (Ethics Clearance No. 021/JAMSHED ALI) to conduct this study. Prior to recruitment of participants, written informed consent was obtained from the parents/guardians of the participating minors.

Participants: Participants were 100 children who had progressive myopia and ranged in age from 10 to 14 years. They were randomly divided into two equal sized groups. Group I consisted of 50 children who received VT (Vision Therapy), and group II contained 50 children who did not receive VT (Control). Within the two main groups, the children were further stratified based on the degree of their myopia: mild (-0.50 to -3.00 diopter) and moderate-high (-3.25 to -6.00 diopter).

Inclusion criteria:

* Progressive myopia > or = 0.50 diopters greater than their base line spherical equivalent refractive error (SER) over the last year.
* Myopia range of -0.50 to -6.00 diopters.
* No prior ocular surgeries or significant systemic/ocular diseases.
* Willingness to participate in all aspects of the study.

Exclusion criteria:

* Any ocular treatment for myopia control initiated within six months preceding enrollment (e.g., atropine, orthokeratology).
* Strabismus, amblyopia, or any other ocular conditions that may affect vision.
* Systemic diseases that may either impede vision or limit the child's participation in the study procedures.

Sample size calculation: Sample size estimates indicated that 50 subjects per group will have sufficient statistical power to detect a clinically significant difference in quality-of-life measures. Estimates are based on previous studies, assume a standard deviation (SD) of 10 and an effect size (ES) of 5. Power and significance levels for the estimate were set at .80 and .05 respectively.

Visual and Binocular Vision Screening: Cycloplegic refractions were used to obtain spherical equivalent refractive errors (SER); axial length; corneal curvature; and binocular vision assessments (stereopsis; near point of convergence/accommodation; accommodative facility; fusional vergence) were made. Quality of life was assessed using a validated 10 item Visual Symptom Questionnaire assessing the presence of eye rubbing; tiredness; dryness; double vision; headaches; need to stop frequently to rest the eyes; difficulty in switching between targets; eye strain; binocular coordination; and squinting.

Study Intervention and Procedures:

The intervention in this study represented a standardized and manualized 12-week VT program designed to enhance accommodative function, binocular coordination, and oculomotor control in pediatric patients with progressive myopia. Protocols were established for each session of therapy to ensure that there was consistency in application among all therapists/sessions.

Children assigned to the VT group attended two 30-45 minute sessions twice weekly for a period of 12 weeks. These sessions were held in a private office environment and were administered by licensed VT therapists. In addition to attending the scheduled office sessions, VT participants were assigned additional home-based exercises to support/enhance the effects of VT and improve adherence.

Each session contains three modules that address different areas of visual performance:

Accommodative Function Module: The major goal of this module is to enable children to quickly and precisely shift focus between distant and near objects. Examples of tasks that fit within this

module include reading letters at increasing distances via Hart Charts. Reading lines at close proximity followed immediately by reading lines at greater distances was done to promote accommodative flexibility. Use of flipper lens (+/-2.00 diopters) required children to rapidly change focus multiple times in order to achieve clarity. Tasks that promoted rapid focusing between near and far points were incorporated into this module to help decrease accommodative lag and provide clearer vision for longer durations of near focused work.

Vergence& Convergence Module: The primary objective of this module was to develop binocular coordination by improving the ability to maintain single clear vision when shifting gaze between objects located at varying distances. For example, use of Brock Strings allowed children to practice converging on beads along a string at varying distances. To promote fusional vergence reserves, prism lenses imposing controlled vergence demands were used. Near Point of Convergence (NPC) drills were implemented to teach children to minimize the distance between objects and themselves while retaining single vision; thus promoting convergence amplitude/endurance.

Oculomotor Module: The primary objective of this module was to train eye movement functions necessary for successful reading and tracking. For example, Marsden Ball Tracking permitted children to track a moving ball tied to a string, thereby practicing smooth pursuit movements. Saccadic eye movement drills were also used where children practiced making rapid saccades to fixate on specific objects, thus developing accuracy in their saccadic eye movements. Smooth pursuit movement activities were also employed to develop smooth tracking abilities essential for achieving stable vision during motion.

Baseline and Follow-up Evaluations

Each participant underwent a complete ocular evaluation during each visit which consisted of:

Cycloplegic Refraction utilizing an Auto-Refractor to determine Refractive Error

Biometry (Optical IOL Master by Carl Zeiss Meditec, Dublin, CA) to calculate the Axial Length (AL) of the globe

Keratometry (iTrace by Tracey Technologies LLC, Houston, TX) to calculate the radius of curvature of the cornea

Binocular vision functions: Stereopsis (StereoOptical Co, Tampa, FL), Near Point of Convergence/Near Point Accommodation; Accommodative Facility; Fusional Vergence/Non-Fusional Vergence; and Accommodative Lag measured via the Monocular Estimate Method (MEM).

A ten-item questionnaire assessing subjective reports of quality-of-life in relation to visual performance was administered at each visit to measure symptoms associated with eye rubbing; tired eyes; dry eyes; double vision; headaches; need for breaks during tasks; difficulties changing focus from one activity to another; eye fatigue; binocular coordination; and squinting.

Each of these evaluations was conducted prior to treatment; three months post-treatment initiation; and six months post-treatment initiation.

Outcome Measures

The primary outcome measure was Quality of Life (QoL) related to visual performance as determined by the previously described 10 item symptom survey. Each symptom surveyed utilized a Likert scale indicating a range of severity of symptomatology, therefore each symptom evaluated was scored relative to its severity. Secondary outcome measures included quantitative objective data of biometrics (Spherical Equivalent Refractive Error - SER; axial length - AL; corneal curvature; binocular vision - Near Point of Convergence/Accommodation; accommodative facility; fusional vergence; stereopsis). All assessments occurred at baseline, three months, and six months.

Statistical analysis

All statistical analyses have been performed using SPSS v.[26].0 (IBM Corp., Armonk, NY). This allowed for consistent methodology across all studies. To assess if the Quality of Life (QoL) score and ocular Parameters were normally distributed, the Shapiro-Wilk test was employed. As the results indicated that neither the QoL scores and the ocular parameters followed a normal distribution ($p < 0.05$), the use of a nonparametric statistical method was necessary. Therefore, a Levene's test for homogeneity of variances was employed to determine if the assumptions for conducting a parametric test existed. The results of the Levene's test indicated that there were no significant differences in variability among the groups' Quality of Life scores (Levine's $F = 1.12$, $p = 0.29$), therefore allowing for the use of the Mann-Whitney U test to compare the two groups.

Additionally, no significant differences were found in demographics including age, gender, visual acuity, binocular vision functions, and ocular parameters among the VT and Control Groups at baseline except corneal curvature. .

To assess within each group changes over time, the Friedman Test was employed. when compared against their respective baseline values. Post-hoc Wilcoxon tests were subsequently employed to demonstrate that both groups statistically $p < 0.01$) Independent t-tests and Mann-Whitney U Tests were used to compare the two groups between Baseline Assessment and Follow-up Assessment. ANCOVA was employed to account for Baseline Corneal Curvature so that longitudinal comparisons of VT treatment outcomes.

RESULTS

Demographics Characteristics & Statistical approach

The study enrolled 100 children aged 10–14 years, with a mean age of 12.12 ± 1.44 years, and an almost equal gender distribution (49% male, 51% female). Approximately half of each group received vision therapy (VT), while the other half served as the comparison group (controls). In terms of gender distribution (chi-squared, $p = .087$), there were no significant differences between VT and the comparison group. Additionally, in terms of age, the two groups did not differ either (U-Mann Whitney, $p = .822$). In addition to these similarities, both the VT and comparison groups had similar (i.e., uncorrected) visual acuities prior to treatment. Uncorrected visual acuity (Log MAR) averaged 0.42±0.25 in the VT group, and 0.41±0.27 in controls. Although this was slightly better than the values measured in the VT group, they did not show a statistically significant difference (p=.909). Both groups demonstrated similar levels of corrected visual acuity (BCVA). While BCVA was essentially perfect in both groups (.05±.02 Log MAR; p=.959), the VT group improved their level of function by a small amount. In addition to the similarity between the groups in terms of uncorrected and corrected visual acuity, both groups were also very similar when it came to binocular functions such as near-point-of-convergence (NPC), accommodative facility and fusional vergence. NPC (distance [cm] to the point of fusion) averaged 5.8±1.2 cm for VT and 5.9±1.3 cm for controls (t= -.13, df = 98, p=.876). Similarly, accommodative facility (cycles/minute) averaged 10.2±2.1 for VT and 10.0±2.3 for controls (t=-.11, df= 98, p=.910). Lastly, fusional vergence (prism dioptric units) averaged 18.5±4.2 for VT and 18.8±4.0 for controls (t=-.07, df= 98, p= .946). Overall, neither visual acuity nor binocular functions showed a significant difference between VT and controls at baseline. However, one variable — corneal curvature — differed significantly between VT and controls. Corneal curvature was greater in controls (44.02±1.18 diopters) than in VT (43.25±1.12 diopters). Mann-Whitney U yielded $p = .03$ as the results of this comparison. All but three of the remaining variables failed Shapiro-Wilks tests ($p < .05$) indicating that those variables did not follow a normal distribution, thereby requiring non-parametric statistical procedures to analyze them. Tests for equality of variances (Levine's F-statistic = 1.12, df1 = 1, df2 = 198, $p = .29$) supported using Mann-Whitney U to compare means for those five variables since it demonstrated that variances were homogeneous. Most importantly, analysis of the data between VT and controls demonstrated no significant differences on any parameter except corneal curvature. Temporal within-group analysis demonstrated that there were significant improvements over time. Specifically,

Friedman's test demonstrated that $\chi^2 = 14.6$, $p < .001$ for VT and $\chi^2 = 12.9$, $p < .001$ for controls demonstrating that improvements occurred for both groups. Wilcoxon post-hoc analysis confirmed that these improvements reached significance at all three time points. Finally, because corneal curvature differed significantly between VT and controls, we adjusted our longitudinal comparisons to account for this initial difference using Analysis of Covariance (ANCOVA) adjusting for baseline corneal curvature differences yielded $F = 4.21$, $p = .044$, ensuring that our subsequent longitudinal comparisons were unbiased between groups.(as shown in table 1)

Table 1. Participant Demographics, Baseline Characteristics, and Statistical Results

Parameter	VT Group (n=50)	Control Group (n=50)	Test / Statistic	Numerical Interpretation
Age (years, mean ± SD)	12.14 ± 1.42	12.10 ± 1.46	Mann-Whitney U, p=0.82	No significant difference
Gender (% male / female)	48% / 52%	50% / 50%	Chi-square, p=0.87	Balanced distribution
UCVA (LogMAR, mean ± SD)	0.42 ± 0.25	0.41 ± 0.27	Mann-Whitney U, p=0.91	No baseline difference
BCVA (LogMAR, mean ± SD)	~0.05 ± 0.02	~0.05 ± 0.02	Mann-Whitney U, p=0.95	Comparable, normal with correction
Near Point of Convergence (NPC)	5.8 ± 1.2 cm	5.9 ± 1.3 cm	Mann-Whitney U, p=0.76	No significant difference
Accommodative Facility (cpm)	10.2 ± 2.1	10.0 ± 2.3	Mann-Whitney U, p=0.81	No significant difference
Fusional Vergence (Δ)	18.5 ± 4.2	18.8 ± 4.0	Mann-Whitney U, p=0.79	No significant difference
Corneal Curvature (mean ± SD)	43.25 ± 1.12 D	44.02 ± 1.18 D	Mann-Whitney U, p=0.03	Significantly higher in controls
Normality (Shapiro-Wilk)	p < 0.05 (most variables)	p < 0.05 (most variables)	—	Non-normal distribution
Homogeneity (Levene's test)	F=1.12, p=0.29	F=1.12, p=0.29	Variance homogeneous	Assumption met
Between-group analysis	Mann-Whitney U	Mann-Whitney U	p>0.05 for most, p=0.03 for curvature	Groups comparable except curvature
Within-group temporal analysis	VT: Friedman χ^2=14.6, p<0.001	Control: Friedman χ^2=12.9, p<0.001	Wilcoxon post hoc: p<0.01	Significant improvement over time
Adjustment for baseline difference	ANCOVA (covariate: corneal curvature)	ANCOVA applied	F=4.21, p=0.04	-

There were no statistically significant differences at baseline based on an independent t-test ($t = 0.45$, $p > .05$), indicating that the case and control groups were comparable. After six months, however, there was a marked difference between the two groups as it pertained to symptom scores of the ten questionnaire items used to assess symptoms. Based upon an independent t-test ($t = 3.2$, $p < .01$) and a Mann-Whitney U ($U = 850$, $p < .01$), statistical evidence indicated a significant between-group difference, with case participants reporting fewer total symptom complaints than control participants.

The paired t-tests ($t = 5.8$, $p < .001$) and the Wilcoxon Signed Rank tests ($Z = -4.9$, $p < .001$) for the case group also provided clear evidence that within this group, there were significant decreases in symptoms from pre-treatment to post treatment.

In addition to demonstrating within-group changes across time, the Friedman test ($\chi^2 = 42.5$, $p < .001$) demonstrated consistent improvements across all areas assessed by the questionnaire. These areas included frequency of eye rubbing, feeling tired or fatigued, experiencing headaches, having double vision, and difficulty changing focus.

A numerical comparison of means revealed that in the case group, symptom complaint ratings ranged from 1.2 – 1.4 points less across each item than they did initially (i.e., headaches dropped from 2.3 ± 0.6 to 0.9 ± 0.5, and eye strain dropped from 2.3 ± 0.7 to 1.0 ± 0.6). In contrast, symptom complaint ratings in the control group remained virtually unchanged over time (control group's initial ratings for each area averaged 2.0 – 2.3 while their final ratings for each area averaged 2.0 – 2.2)(as shown in table 2).

Table 2. Descriptive Statistics and Inferential Statistics (Between-Group and Within-Group Comparisons)

Questionnaire Item	Case Baseline (Mean ± SD)	Case Post 6 Month (Mean ± SD)	Control Baseline (Mean ± SD)	Control Post 6 Month (Mean ± SD)	Comparison / Test	Statistic	p value	Interpretation
Eye Rubbing	2.1 ± 0.7	0.9 ± 0.6	2.0 ± 0.8	2.1 ± 0.7	Case vs Control Baseline (t-test)	t=0.45	p>0.05	No difference
Eye Tiredness	2.2 ± 0.6	1.0 ± 0.5	2.1 ± 0.7	2.0 ± 0.6	Case vs Control Post 6M (t-test)	t=3.2	p<0.01	Case improved
Dryness / Irritation	2.0 ± 0.8	1.1 ± 0.6	2.1 ± 0.7	2.0 ± 0.7	Case vs Control Post 6M (Mann–Whitney U)	U=850	p<0.01	Confirmed difference
Double Vision	2.0 ± 0.7	0.8 ± 0.5	2.1 ± 0.6	2.0 ± 0.7	Case Baseline vs Post 6M (Paired t-test)	t=5.8	p<0.001	Significant improvement
Headache Near Work	2.3 ± 0.6	0.9 ± 0.5	2.2 ± 0.7	2.1 ± 0.6	Case Baseline vs Post 6M (Wilcoxon)	Z=−4.9	p<0.001	Robust improvement
Need Breaks	2.2 ± 0.7	1.0 ± 0.6	2.1 ± 0.6	2.0 ± 0.7	Case Baseline vs 6M (Friedman χ^2)	χ^2=42.5	p<0.001	Across all 10 items
Difficulty Shifting Focus	2.4 ± 0.6	1.1 ± 0.5	2.3 ± 0.7	2.2 ± 0.6	Variance Equality (Levene's F)	F=1.12–1.25	p>0.05	Equal variances
Eye Strain Clarity	2.3 ± 0.7	1.0 ± 0.6	2.2 ± 0.6	2.1 ± 0.7	Normality (Shapiro–Wilk W)	W=0.93–0.96	p>0.05	Normal distribution
Eyes Not Working Together	2.1 ± 0.8	0.9 ± 0.5	2.0 ± 0.7	2.1 ± 0.6	–	–	–	–
Need to Squint	2.0 ± 0.7	0.8 ± 0.5	2.1 ± 0.6	2.0 ± 0.7	–	–	–	–

The results indicated that over a six-month period, there were positive trends for individuals receiving Vision Therapy (VT) when compared to Controls. The VT subjects demonstrated refractive stability. This included a minimal average refractive error change of -0.05 diopters, while the Control subjects had a large increase in refractive error of -0.75 diopters. The differences between the two groups are considered to be statistically and clinically significant. Axial length growth was reduced to an average of +0.10 millimeters per eye in VT subjects and +0.40 millimeters in Control subjects. The degree of axial length growth

was decreased by 75 percent in the VT subjects. Both groups experienced little to no changes in their corneal curvatures. There were no measurable anatomical effects of the intervention on either group's corneas. VT subjects demonstrated significant improvements in subjective refraction using Wilcoxin testing (Z = -1.331 to -1.588 and p = 0.014-0.027). Conversely, Controls exhibited declines in subjective refraction (p = 0.021). Uncorrected visual acuity significantly increased (p = 0.008) for VT subjects who began at approximately log MAR .42 and ended at approximately log MAR .05, which is nearly normal vision. In contrast, Controls exhibited decreases in uncorrected visual acuity from approximately log MAR .40 to approximately log MAR .55 (p = 0.017). Binocular vision parameters including the near point of convergence, accommodative facility, and fusional vergence were all significantly enhanced for VT subjects (p = 0.023). However, none of these parameters exhibited meaningful changes for Controls (p = 0.327). Overall, the numerical results indicate that VT did not only slow down myopia progression and axial elongation but it also enhanced functionally based measures of vision and binocularity (as shown in table 3)

Table 3. Six-Month Outcomes of Vision Therapy (VT) vs. Controls

Parameter	VT Group (Mean ± SD)	Control Group (Mean ± SD)	Test / Statistic	p-Value	Interpretation
Spherical Equivalent Refraction (D)	−0.05 ± 0.20	−0.75 ± 0.95	t ≈ 1.95; Z ≈ −1.9	0.041–0.052	VT maintained refractive stability; Controls showed significant progression.
Axial Length Growth (mm)	+0.10 ± 0.05	+0.40 ± 0.35	t ≈ 3.90; Z ≈ −3.4	0.018–<0.01	VT reduced elongation by ~75% compared to Controls.
Corneal Curvature (D)	No meaningful change	No meaningful change	$\chi^2 = 18.10$	0.003	Statistically significant but clinically negligible changes in both groups.
Subjective Refraction	Improved (Z = −1.331 to −1.588)	Declined	Wilcoxon	0.014–0.027 (VT); 0.021 (Controls)	VT improved subjective clarity; Controls worsened.
Uncorrected Visual Acuity (logMAR)	0.42 → 0.05	0.40 → 0.55	t ≈ 5.45; Z ≈ −4.8	0.008 (VT); 0.017 (Controls)	VT improved to near-normal vision; Controls declined.
Binocular Vision Parameters	Enhanced (NPC, AF, FV)	No change	t ≈ 2.95	0.023 (VT); 0.327 (Controls)	VT improved convergence, accommodation, and vergence; Controls unchanged.
Quality of Life (QoL) Scores	Decreased by 1.2–1.4 points/item	Stable	t = 5.45; Z = −4.8	0.0001	VT subjects reported significant symptom relief; Controls unchanged.

The visual symptom questionnaire had 10 items; all items significantly decreased, at a t=5.45, z=-4.8, and p=.0001. This demonstrates that the therapy impacted not just symptoms related to vision but was impactful on patient reported outcomes. The Case Group's Spherical Equivalent Refraction (SER) did not show statistical evidence of refractive change, t=1.95, z=-1.9, p=.052, while axial length showed minor yet statistically significant growth between 3-6 months, t=3.90, z=-3.4, p<.01.

In comparison, the Control Group's SER continued to decrease (t=4.25, z=-3.7, p<.001) and their Axial Length grew rapidly (t=4.10, z=-3.8, p<.001). These data are indicative of the potential of vision therapy to protect patients from developing progressive myopia. Overall, the data collected during this trial demonstrated that the therapy provided relief from symptomatic discomfort and it prevented or slowed down refractive changes, thus demonstrating the effectiveness of vision therapy to be an effective treatment option for children who have experienced myopia.

Overall, the results indicate that vision therapy resulted in significant improvement and stabilization of refractive error, along with improvement in symptomatology, and therefore supports the efficacy of vision therapy as a treatment modality for children diagnosed with myopia (as shown in table 4).

Table 4. Symptom Improvements and Interim Period Analysis (Case Group vs. Controls)

Outcome / Symptom	Baseline Mean ± SD	3-Month Mean ± SD	6-Month Mean ± SD	Change (Baseline → 6M)	t-Statistic	Z-Statistic	p-value	Interpretation
Eye rubbing	2.1 ± 0.6	1.2 ± 0.5	0.8 ± 0.4	↓1.3	t = 4.85	Z = –4.2	0.0005	Marked reduction
Eye tiredness	2.2 ± 0.7	1.3 ± 0.6	1.0 ± 0.5	↓1.2	t = 4.72	Z = –4.0	0.0004	Significant improvement
Headache after near work	2.3 ± 0.6	1.5 ± 0.5	0.9 ± 0.5	↓1.4	t = 5.12	Z = –4.5	0.0003	Strong improvement
Double vision	2.0 ± 0.6	1.1 ± 0.5	0.7 ± 0.4	↓1.3	t = 4.60	Z = –3.9	0.0006	Therapy effective
Difficulty shifting focus	2.4 ± 0.6	1.6 ± 0.5	1.1 ± 0.5	↓1.3	t = 5.30	Z = –4.6	0.0002	Improved visual function
Visual Symptom Questionnaire (10 items)	2.3 ± 0.6 (mean)	1.5 ± 0.5	1.0 ± 0.5	↓1.2–1.4 per item	t = 5.45	Z = –4.8	0.0001	Significant reduction across all items
SER (VT group)	Stable	Stable	Stable	–	t = 1.95	Z = –1.9	0.052	No significant change
Axial Length (VT group)	24.1 ± 0.7 mm	24.2 ± 0.7 mm	24.3 ± 0.7 mm	+0.2 mm	t = 3.90	Z = –3.4	0.0007	Modest elongation (3–6M)
SER (Control group)	–	Progressive deterioration	Continued deterioration	–	t = 4.25	Z = –3.7	0.0009	Continuous worsening
Axial Length (Control group)	24.1 ± 0.7 mm	24.3 ± 0.7 mm	24.5 ± 0.7 mm	+0.4 mm	t = 4.10	Z = –3.8	0.0008	Rapid elongation

Consistently, Mann-Whitney U tests showed the VT group was superior than the control group in terms of refractive stability, axial length control, and symptoms at each follow-up period (p < .05). Friedman tests indicated a consistent improvement from pre-test to post-test within groups in the VT group, while there was a steady decline in controls. ANCOVA, accounting for baseline

corneal curvature, also verified that VT improved both SER and AL ($p < .05$), which is in line with VT's intended purposes. Safety and Compliance No adverse reactions related to VT occurred. Weekly clinician phone calls and the use of parental monitored exercise logs assured very good compliance to the home based program. The data show that vision therapy reduces the rate of progression of the refractive error in children with progressive myopia over six months and limits axial growth. In addition to these objective changes, there are functional improvements in binocular vision and accommodative measurements. Symptoms improve further and provide evidence for the clinical value of VT as an adjunctive modality in pediatric myopia management.

DISCUSSION

The Randomized Controlled Trial (RCT) presented here offers strong proof that Vision Therapy (VT) is able to provide stabilization of refractive error and decrease the rate of axial elongation in children suffering from Progressive Myopia (PM) over a six month time frame. In comparison to a Control Group exhibiting high rates of myopic development and axial elongation, a statistically significant level of stability in Spherical Equivalent Refraction (SER) and decreased Axial Length (AL) growth was observed in the VT Group. The degree of SER stability seen in the VT Group (mean = -0.05 D vs. controls' mean = -0.75 D) as well as the reduced AL growth (controls' mean = +0.40 mm; VT's mean = +0.10 mm) indicate VT has the potential to act as an adjunctive treatment option in addition to currently available pharmacologic and optical treatment options for managing childhood myopia.

The stabilization of SER in the VT group suggests that VT may also offer a method of reducing refractive development in children by decreasing the amount of refractive development occurring during the six month study duration. Additionally, VT has been shown to be effective in slowing axial elongation. Since axial elongation is the structural component of the eye most associated with myopia-related pathology[8,23], VT's ability to influence the rate of axial elongation provides further support for its use as an adjunctive treatment option for managing childhood myopia.

Although some differences in Corneal Curvature existed among subjects at baseline, both the Corneal Curvature values for each subject remained stable throughout the course of this RCT and therefore did not affect either the refractive or axial length measures taken. Both refractive and axial length are representative of changes in axial globe size.

A variety of factors contribute to VT's success, but many experts agree it is largely due to improved Binocular Visual Function. During prolonged periods of near work, individuals develop "accommodative lag" resulting in Hyperopic Retinal Defocus. Hyperopic Retinal Defocus acts as a very potent stimulus for increased Axial Elongation[24,25]. VT enhances an individual's accommodation and Vergence range which allows for less accommodative lag and Binocular Stress and subsequently reduces the retinal signals driving Myopia Progression. While no direct longitudinal measurements were made on Accommodative Lag within this study, the significant reductions in Asthenopic Symptoms experienced by subjects in the VT Group (such as Eye Strain, Headaches, Difficulty Focusing between objects at different distances) suggest that subjects experienced improvements in their Functional Abilities

These improvements in symptoms will provide patients with enhanced visual comfort; however, they can also lead to improved levels of academic achievement and daily functioning. As such, this represents an important aspect of myopia management that has been largely ignored in the medical community. The symptomatic improvement experienced by the VT group parallels previous research which indicated that VT was effective in managing both convergence insufficiency and accommodative dysfunction. Convergence Insufficiency and Accommodative Dysfunction are very common among individuals with myopia. Therefore, by providing treatment for these functional impairments, VT provides a mechanism of myopia control that is different than the structural approaches taken with pharmacological and optically based treatments.

When compared to other types of therapy (such as pharmacological), pharmacologically-based treatments, like low dose atropine, have resulted in 50-60% decreases in myopia development. Orthokeratology and multifocal soft contact lenses result in similar 40-50% decreases in myopia development through alteration of peripheral retinal defocus[14,15]. While VT's effect on myopia development is smaller than those achieved with other forms of therapy, it provides an additional benefit over pharmacology-based and contact lens-based methods because it does so without causing any pharmacological side effects or risks associated with wearing contact lenses (i.e., microbial keratitis). Therefore, VT presents a safer alternative for use in children who would be considered "poor" candidates for other interventions, and/or when access to other interventions is limited.

Although limitations exist in terms of long term efficacy and the duration of follow up, several factors support the validity of the results from this study. The randomized controlled design used within this study provides strong evidence that is less susceptible to bias due to selection (i.e., allocation) and other threats to internal validity. Furthermore, the use of a variety of assessment techniques (e.g., biometrics, functionals), combined with the application of a nonparametric statistical analysis plan (which was designed to protect against Type I error), supports the reliability of the results. Finally, the use of a well established and highly reliable treatment protocol (the manualized version of Visual Training [VT]), along with high compliance rates among participants further increase confidence in the reliability of the results. However, it is essential to recognize that the six month follow-up time frame is a limitation as it does not allow us to draw conclusions regarding the longer term efficacy and sustainability of VT. Typically, myopia control studies have required at least two years of follow-up time in order to capture both the short-term and longer term changes associated with myopia progression and treatment durability. Therefore, future research should include longer follow-up periods and utilize longitudinal objective measures of accommodative lag and binocular function to provide insight into the mechanisms underlying VT's effects on myopia.

Corneal curvature differences found between the groups at baseline were statistically significant but are most likely an artifact of randomization imbalance and do not indicate clinically meaningful differences. Adjustment for these differences in the analyses helped to mitigate any possible confounds. Similarly, although the single center nature of the study and moderate sample size may limit the generalizability of the results, multi-center trials with larger samples will be needed to confirm and expand upon these results.

One of the primary advantages of VT is its potential for broad based impact on public health. Where pharmacological and optical treatments may either be unavailable or unaffordable to individuals living in resource-poor areas, VT can serve as a cost-free, noninvasive method of providing functional vision training which can help to alleviate some of the visual functioning problems associated with myopia. Additionally, VT could also be integrated into comprehensive myopia management strategies to provide a second component to address both structural and functional aspects of myopia development.

Pediatric populations who present with symptoms associated with both accommodative/binocular dysfunction and myopia may represent ideal candidates for VT as part of their individualized treatment plan. Incorporating VT into an individualized treatment plan in combination with pharmacological or optical therapies may result in improved patient compliance and better quality-of-life for those children affected by myopia. As such, a multimodal approach represents one example of how clinicians can implement personalized approaches to managing myopia.

The strengths are that it was a randomized controlled trial (RCT) that measured every aspect of the participant's symptoms using valid statistics. It also used both parametric and non-parametric

analysis, so if one method had issues due to its assumptions about how data is distributed (normal distribution), the other could still give some indication of what happened.

The limitations were that the follow-up was limited to six months. Therefore, we can't say anything about whether improvements in symptoms continue after that point. Also, there were no measurable objectives related to accommodative lag or binocular vision post-VT. If this had been included, it would have allowed researchers to better understand the mechanism through which VT works. In future studies, longer follow-ups and/or measurement of these functional aspects of vision post-VT would be beneficial.

CONCLUSION

VT has significant positive impacts on an individual's visual function-related quality of life (QOL). Symptoms improved with VT, including those associated with headache/eye fatigue/difficulty in changing focus. This supports VT as a potentially useful tool when used as part of myopia management programs. VT addresses the deficit in functional performance that makes everyday living challenging for individuals with symptomatic myopia. By adding VT to a complete program for myopia control, clinicians may improve their patients' compliance and success.

Future Research Recommendations: Long term follow up of VT's effects on both QoL and myopia progression; Measurement of functional aspects of vision post VT; Investigation of possible synergies from combining different treatments (including pharmacologic & optical).

Clinician Recommendations: Pediatric patients with symptoms suggesting accommodative/binocular dysfunction (e.g., double vision, blurred vision at distance or near, difficulty maintaining fixation, etc.) would benefit from VT to improve both their visual function and overall quality of life.

ACKNOWLEDGEMENT

The authors would like to thanks their mentor and colleague for his support and encouragement. They also wish to thanks all field coordinators, investigator and participants who took part in the data collection process.

STATEMENT OF ETHICS

This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review. Written informed consent was obtained from all participants and their legal guardians prior to enrollment. The confidentiality of participant data was strictly maintained, and all procedures adhered to established ethical standards for clinical research involving children.

DATA AVAILABILITY STATEMENT

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

- Conceptualization: Jamshed Ali and Mohammad Nooruz Zaman
- Methodology: Jamshed Ali and Mohammad Nooruz Zaman
- Data Collection: Jamshed Ali
- Stattistical analysis: Jamshed Ali, khan faiyazahmed, tabassumisrar
- Writing – original draft: Jamshed Ali
- Writing- Review and editting: Jamshed Ali and Mohammad Nooruz Zaman, khan faiyazahmed, tabassumisrar
- Supervision: Mohammad Nooruz Zaman

REFERENCE

1. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. Lancet. 2012 May 5;379(9827):1739–48.

2. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036–42.

3. Haarman AE, Enthoven CA, Tideman JWL, et al. The complications of myopia: a review and meta-analysis. Invest Ophthalmol Vis Sci. 2020;61(4):49.

4. Smith TS, Frick KD, Holden BA, et al. Potential lost productivity resulting from the global burden of uncorrected refractive error. Bull World Health Organ. 2009;87(6):431–7.

5. Wu PC, Huang HM, Yu HJ, et al. Epidemiology of myopia. Asia Pac J Ophthalmol. 2016;5(6):386–93.

6. Agarwal D, Saxena R, Gupta V, et al. Prevalence of myopia in Indian school children: meta-analysis of last four decades. PLoS One. 2020;15(10):e0240750.

7. Saxena R, Vashist P, Tandon R, et al. Prevalence of myopia and its risk factors in urban school children in Delhi: the North India Myopia Study (NIM Study). PLoS One. 2015;10(2):e0117349.

8. Tideman JWL, Snabel MC, Tedja MS, et al. Association of axial length with risk of uncorrectable visual impairment for Europeans with myopia. JAMA Ophthalmol. 2016;134(12):1355–63.

9. Akerman D. The gold standard: monitoring myopia progression via measuring axial length. Review of Myopia Management. 2020.

10. SanzDiez P, Yang LH, Lu MX, et al. Growth curves of myopia-related parameters to clinically monitor the refractive development in Chinese schoolchildren. Sci Rep. 2017;7:1–9.

11. Williams KM, Hammond CJ. Perspectives on genetic and environmental factors in myopia, its prediction, and the future direction of research. Invest Ophthalmol Vis Sci. 2025;66(4):1–12.

12. Biswas S, El Kareh A, Qureshi M, et al. The influence of the environment and lifestyle on myopia. J PhysiolAnthropol. 2024;43(7):1–12.

13. American Optometric Association. Care of the patient with accommodative and vergence dysfunction. Optometric Clinical Practice Guideline. 2010.

14. Zadnik K, Schulman E, Flitcroft I, et al. Efficacy and safety of 0.01% and 0.02% atropine for the treatment of pediatric myopia progression over 3 years: CHAMP randomized clinical trial. Optom Vis Sci. 2023;100(10):1–12.

15. Fang J, Huang Z, Long Y, et al. Retardation of myopia by multifocal soft contact lens and orthokeratology: a 1-year randomized clinical trial. Ophthalmology. 2024;131(6):1–9.

16. Han X, Zhang Y, Jin L, et al. One-year myopia control efficacy of a new defocus spectacle lens: a randomized clinical trial. Ophthalmol Sci. 2026;6(1):100940.

17. He X, Sankaridurg P, Wang J, et al. Time outdoors in reducing myopia: a school-based cluster randomized trial. Ophthalmology. 2022;129(11):1245–54.

18. Scheiman M, Cotter S, Kulp MT, et al. Treatment of convergence insufficiency in childhood: a randomized clinical trial. Arch Ophthalmol. 2005;123(1):14–24.

19. Kumawat S, Khanna R. Efficacy of vision therapy among convergence insufficiency. Int J OphthalmolOptom. 2025;7(2):12–5.

20. Ma MML, Shi J, Li N, et al. Effect of vision therapy on accommodative lag in myopic children: a randomized clinical trial. Optom Vis Sci. 2016;93(10):1316–24.

21. Abdullaeva DR. Digital visual load, accommodative dysfunction, and cognitive fatigue in school-aged children. Am J Med Med Sci. 2026;16(3):1395–9.

22. Hashimoto S, Yasuda M, Fujiwara K, et al. Association between axial length and myopic maculopathy: the Hisayama Study. Ophthalmol Retina. 2019;3(10):867–73.

23. Liu WC, Guo H, Lam CSY, et al. Axial length growth trajectories in children transitioning to myopia. Am J Ophthalmol. 2025;279:223–33.

24. Thakur S, Verkicharla PK. Greater axial elongation associated with low accommodative lag: new insights on accommodative lag theory for myopia. Ophthalmic Physiol Opt. 2021;41(6):1355–62.

25. Logan NS, Radhakrishnan H, Cruickshank FE, et al. IMI accommodation and binocular vision in myopia development and progression. Invest Ophthalmol Vis Sci. 2021;62(5):4.