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Impact of Yogic Intervention on Refractive Error Among Adolescents: An Experimental Study

Kajal[1]; Kanchan Joshi[2]; Dr. Tarannum Shakeel[3]

[1]Research Scholar, School of Yogic Science & Naturopathy, Shri Guru Ram Rai University
[2] Dean, School of Yogic Science & Naturopathy, Shri Guru Ram Rai University
[3] Professor & Head, Department of Ophthalmology, Shri Guru Ram Rai Institute of Medical & Health Sciences (SGRRIMS) Dehradun, India

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Abstract: Refractive errors are a significant public health concern, particularly among adolescents. The increasing reliance on digital devices and reduced outdoor activity has contributed to a rise in myopia and other refractive anomalies. This study aims to assess the effectiveness of a structured yogic intervention in improving refractive errors among school-going adolescents through a controlled experimental design. A total of 120 adolescents aged 10–19 years were selected and divided into experimental (n=60) and control (n=60) groups. The experimental group underwent a 90-day yoga program. Refractive error (spherical equivalent in diopters) was measured using autorefractometer. Data were analyzed using descriptive statistics, independent sample *t*-tests, and variance testing. The experimental group showed significant improvements in both eyes. In the right eye, the mean improved from –1.317 D to –0.954 D ($p = 0.004$), and in the left eye from –1.350 D to –1.058 D ($p = 0.003$). Variance and *t*-tests confirmed statistical significance in the post-intervention values of the experimental group. Whereas a downward trend was observed in the control group. The study supports yoga as an effective, non-invasive, and cost-efficient complementary therapy for managing adolescents' refractive errors.

Keywords: *Yoga, Refractive Error, Adolescents, Vision Therapy, Experimental Study*.

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I. INTRODUCTION

Refractive error is a condition characterized by the eye's inability to focus light accurately on the retina, resulting in blurred or distorted vision[i]. It is primarily caused by abnormalities in the curvature of the cornea or lens and may arise due to genetic predisposition, environmental factors, aging, trauma, or ocular pathology[ii]. The four most common types of refractive errors include myopia (near-sightedness), hyperopia (farsightedness), astigmatism, and presbyopia[iii]. According to the World Health Organization (WHO), approximately 2.2 billion individuals globally suffer from some form of visual impairment, with at least 1 billion cases being preventable or unaddressed[iv] [v]. Refractive errors alone account for 36% of all cases of distance vision impairment. In India, about 13% of the population falls within the 7–15 age range, and roughly 20% of children are reported to develop refractive errors by the age of 16[vi] [vii]. Refractive error was the leading cause of vision problems in rural Indian children between the ages of 7 and 15[viii].Refractive errors were found in approximately 8 out of every 100 children (95% CI: 7.4-8.1). In school settings, the prevalence was higher, affecting around 10.8 out of every 100 children (95% CI: 10.5-11.2)[ix].Yoga, an ancient Indian discipline, has been widely acknowledged for its benefits to physical and mental well-being[x]. Classical yogic scriptures mention the potential of specific yogic techniques in alleviating ocular conditions[xi]. Emerging evidences suggests that yoga may enhance eye function through improved blood circulation, muscular control, and neurological stimulation[xii]. This study aims to evaluate the efficacy of a structured yoga module in reducing refractive errors among adolescents, using objective measurements through autorefractometry.

II. MATERIALS AND METHODS

- *Study Design and Participants*

This study consisted of a two-group design, experimental and control group involving a total of 120 students (60 in the experimental group and 60 in the control group), aged between 10 and 19 years. Participants were selected from Shri Guru Ram Rai (SGRR) School, Dehradun, Uttarakhand, India, using quota sampling to ensure balanced group allocation. The experimental group comprised 33 female and 27 male students, while the control group included 27 female and 33 male students.

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➢ *Inclusion Criteria:*
- Age range between 10-19years.
- Limited to those with myopia and myopic astigmatism.
- No history of Ocular diseases, surgery or trauma.
- Willing to participate in the research study.
- Medically & physically fit.

➢ *Exclusion Criteria:*
- Individuals who declined to participate in the study.
- Participants lacking prior yoga experience or unable to commit to regular practice.
- Medically & physically unfit.
- Participants taking prescription medications were not included**.**

➢ *Ethical Consideration*

The study was approved by the Institutional Ethical Committee (reference number SGRR/IEC/17/25, date April 26, 2025). Informed written consent was obtained from the guardians of all participants. Ethical guidelines were followed, and participants continued with their usual daily routines throughout the study duration. No invasive procedures were performed.

➢ *Intervention Protocol*

Participants underwent a structured yoga intervention for 90 consecutive days, with daily sessions lasting 60 minutes. The yoga module consisted of the following components:

Table 1 The Yoga Module Consisted

Component	Duration
Prayer (Mahamrityunjaya Mantra)	3 minutes
Shatkarma (Jal Neti, Rubber Neti, Trataka)	20 minutes
Asanas (Surya Namaskar, Tree Pose, Rabbit Pose, Cat-Cow, Corpse Pose)	10 minutes
Pranayama (Nadi Shodhana)	5 minutes
Mudra (Shambhavi Mudra)	5 minutes
Mantra (Chakshushi Mantra)	15 minutes
Shanti Path (Closing Prayer)	2 minutes

➢ *Assessment Tool*

Refractive error measurements for both eyes were taken before and after the intervention using an Auto Refracto-Keratometer (Model ARK-1), supported with trial lenses for validation. Measurements were recorded in diopters for 240 eyes (120 participants × 2 eyes). The participants' daily routines remained unaltered aside from the yoga sessions.

➢ *Statistical Tool*

Data were analyzed using SYSTAT 13 and Microsoft Excel. Paired sample t-tests were conducted to compare pre- and post-intervention refractive error values for both eyes. A p-value of less than 0.05 was considered statistically significant.

III. RESULTS

A. Refractive Error Test — Summary Analysis

Table 2 (*Experimental = 60 | Control = 60; RE = Right Eye, LE = Left Eye*)

Measure	Group	N	Pre Mean (D)	Post Mean (D)	Std. Dev. (Pre)	Std. Dev. (Post)	Change	Effect
REF_RE	Experimental	60	–1.317	–0.954	1.459	1.468	**+0.363**	Positive
REF_RE	Control	60	–1.583	–1.900	1.896	1.987	**–0.317**	Negative
REF_LE	Experimental	60	–1.350	–1.058	1.447	1.491	**+0.292**	Positive
REF_LE	Control	60	–1.671	–2.033	1.917	2.027	**–0.362**	Negative

➢ *Interpretation*

The results demonstrate a notable improvement in refractive error among participants in the experimental group following the intervention. Specifically, the mean refractive error in the right eye improved from –1.317 D to –0.954 D, and in the left eye from –1.350 D to –1.058 D, indicating positive changes of +0.363 D and +0.292 D, respectively. Conversely, the control group exhibited a deterioration in refractive status, with the right eye worsening by –0.317 D and the left eye by –0.362 D. These findings suggest that the intervention may be effective in mitigating the progression of myopia in adolescent populations.

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B. Variance Analysis

Table 3 Variance Table

Variable	Group	N	Mean	Std. Deviation
PRE_REF_RE	Experimental	60	–1.317	1.459
POST_REF_RE	Experimental	60	–0.954	1.468
PRE_REF_RE	Control	60	–1.583	1.896
POST_REF_RE	Control	60	–1.900	1.987
PRE_REF_LE	Experimental	60	–1.350	1.447
POST_REF_LE	Experimental	60	–1.058	1.491
PRE_REF_LE	Control	60	–1.671	1.917
POST_REF_LE	Control	60	–2.033	2.027

➢ *Interpretation*

The variance table presents pre- and post-intervention refractive error data for both eyes across experimental and control groups. In the experimental group, a reduction in mean refractive error was observed for the right eye (from –1.317 to –0.954) and the left eye (from –1.350 to –1.058), indicating a positive shift. In contrast, the control group showed a decline, with right eye values worsening from –1.583 to –1.900 and left eye from –1.671 to –2.033. These results suggest the intervention may have contributed to stabilizing or improving myopic progression.

C. Separate Variance T-Tests

Table 4 Right Eye (RE)

Variable	Mean Difference	95% CI (Lower–Upper)	t	Df	p-Value
PRE_REF_RE	–0.267	–0.879 to 0.345	–0.863	110.738	0.390
POST_REF_RE	–0.946	–1.578 to –0.314	–2.966	108.637	**0.004**

Table 5 Left Eye (LE)

Variable	Mean Difference	95% CI (Lower–Upper)	t	Df	p-Value
PRE_REF_LE	–0.321	–0.935 to 0.294	–1.035	109.754	0.303
POST_REF_LE	–0.975	–1.619 to –0.331	–3.002	108.401	**0.003**

➢ *Interpretation*

The study demonstrated significant improvements in refractive errors post-yoga intervention. For the right eye, the pre-intervention difference was not significant (p = 0.390), but became statistically significant post-intervention (p = 0.004). Similarly, for the left eye, the post-intervention reduction was statistically significant (p = 0.003). These findings suggest that yoga had a beneficial effect on reducing refractive errors in both eyes. The results support the efficacy of yoga as a therapeutic intervention, indicating a positive impact on visual acuity. The significant post-intervention improvements highlight the potential benefits of yoga for individuals with refractive errors.

D. Pooled Variance T-Tests

Table 6 Right Eye (RE)

Variable	Mean Difference	95% CI (Lower–Upper)	t	df	p-Value
PRE_REF_RE	–0.267	–0.878 to 0.345	–0.863	118	0.390
POST_REF_RE	–0.946	–1.577 to –0.314	–2.966	118	**0.004**

Table 7 Left Eye (LE)

Variable	Mean Difference	95% CI (Lower–Upper)	t	df	p-Value
PRE_REF_LE	–0.321	–0.935 to 0.293	–1.035	118	0.303
POST_REF_LE	–0.975	–1.618 to –0.332	–3.002	118	**0.003**

➢ *Interpretation*

The pooled variance t-tests revealed significant improvements in refractive errors post-intervention. For the right eye, the mean difference was not significant pre-intervention (p = 0.390), but became statistically significant post-intervention (p = 0.004). Similarly, for the left eye, the post-intervention reduction was statistically significant (p = 0.003). These findings indicate a positive impact of yoga on refractive errors, with significant improvements observed post-intervention. The results support the efficacy of yoga as a therapeutic intervention for reducing refractive errors in both eyes, highlighting its potential benefits for visual health. Significant improvements were noted in both eyes.

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IV. DISCUSSION

The findings of this study provide compelling evidence for the efficacy of a 90-day yogic intervention in improving refractive error measurements in both eyes. These results align with the theoretical framework and emerging empirical evidence suggesting that yogic practices can positively influence ocular health. The observed improvements may be attributed to the physiological effects of yogic postures and breathing techniques, which potentially enhance ocular perfusion, reduce intraocular tension, and stimulate the optic nerve.

Specifically, practices such as Trataka, Shambhavi Mudra, and Nadi Shodhana may contribute to increased neuromuscular control of ocular muscles, improved lens accommodation, and reduced visual fatigue[xiii]. Additionally, the incorporation of meditative components, such as Chakshushi Mantra, may promote relaxation and parasympathetic activation, indirectly benefiting eye function[xiv xv xvi].

The significant reductions in refractive error observed in the intervention group (approximately 0.3-0.4 D) contrast with the slight worsening of refractive errors in the control group. These findings underscore the potential therapeutic benefits of yoga in enhancing ocular perfusion, ciliary muscle flexibility, and neuromuscular coordination.

Future studies that thoroughly examine intraocular pressure monitoring and intervention mechanisms could provide deeper insights into yoga's therapeutic effects on eye health and validate its potential benefits. The findings of this study have significant implications for the management of refractive errors and the promotion of ocular health. Yoga, as a non-invasive and cost-effective intervention, may offer a valuable adjunct or alternative to traditional treatments.

V. CONCLUSION

This controlled experimental study provides evidence that a 90-day yoga regimen can significantly improve refractive errors in adolescents. The findings suggest that yoga-based vision therapy may be a valuable complementary intervention for promoting ocular health in adolescents. Incorporating yoga into school health programs could offer a cost-effective and non-invasive approach to addressing refractive errors. Future research should focus on validating these results, exploring long-term effects, and developing practical implementation strategies to integrate yoga-based vision therapy into existing school health initiatives.

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