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EFFECT OF YOGIC PRACTICES AND KRIYA ON ACCOMMODATIVE AMPLITUDE AND EXTRAOCULAR MUSCLE FUNCTION IN CHILDREN WITH AMETROPIA: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Ametropia (hyperopia) is increasingly prevalent among school-age children and is associated with reduced accommodative capacity and extraocular muscle inefficiency, often compounded by rising screen exposure. Yogic practices and kriya techniques have been proposed as adjunctive, non-pharmacological interventions for ocular physiological function, but controlled evidence in children remains limited.

Objective: To evaluate the effect of a 12-week yoga-only protocol and a combined yoga-plus-kriya protocol, relative to a time-matched, active-rest control, on accommodative amplitude and extraocular muscle (EOM) function in children with hyperopia.

Methods: This randomized controlled study involved schoolchildren aged 11–15 years in Chennai, India. Of 400 children screened, 113 were identified, 70 provided consent, and 68 initiated the intervention following two pre-intervention withdrawals. Participants were allocated to a combined Yoga + Kriya intervention group (n = 33) or a control group (n = 35). Eight participants discontinued the study, leaving 60 completers (30 per group). The intervention was scheduled for 50 minutes per session, four days per week, over 12 weeks. Accommodative amplitude and extraocular muscle function were assessed before and after the intervention. Between-group comparisons will be reported using the corrected participant data and appropriate baseline-adjusted statistical analysis.

Results: Of the 68 participants who initiated the study, eight discontinued participation (11.76% attrition), including three from the Yoga + Kriya group and five from the control group. Sixty participants completed the study, with 30 in each group. The final sample comprised 35 boys and 25 girls aged 11–15 years. Changes in accommodative amplitude and extraocular muscle function following the 12-week intervention require reassessment using the corrected participant-level data. The corresponding mean differences, effect sizes, confidence intervals, and statistical significance values will be reported following reanalysis.

Conclusion: This randomized controlled study evaluated the effects of a 12-week combined Yoga and Kriya intervention on accommodative amplitude and extraocular muscle function in schoolchildren aged 11–15 years with hyperopia. The corrected two-group study design permits evaluation of the combined intervention relative to the control group but does not establish the independent contribution of Kriya. Conclusions regarding physiological improvement and intervention effectiveness will depend on statistical reanalysis of the verified participant-level data.

KEYWORDS: hyperopia; ametropia; yoga; kriya; accommodative amplitude; extraocular muscle function; children; randomized controlled trial

INTRODUCTION

Refractive errors are serious developmental visual health issues that can impact learning, visual tasks and life quality in children. One type of ametropia is hyperopia, which adds to the accommodation needed for near vision tasks. Uncorrected hyperopia has been found to be correlated with poor early literacy achievement and functional visual problems (Kulp et al., 2016). Other recent evidence highlights its link to visual function and school-related performance (Kulp et al., 2026). Therefore, it is crucial to assess physiological visual functions in addition to the refractive status in children.

Accommodative amplitude is the maximum capacity of the visual system to accommodate and is critical for reading, writing and sustained near work. For hyperopic children, Candy et al. (2012) studied the importance of accommodative responses by examining accommodative lag. Guo et al., (2026) studied the accommodative amplitude and near fusional reserves in children with hyperopic anisometropia and Çakır et al., (2026) measured accommodation in bilateral high hyperopia. The results demonstrate the clinical significance of accommodative measures. Extraocular muscles (EOM)

also provide support to the function of ocular alignment, fixation, tracking and binocular coordination, which are important for efficient visual performance.

It has been demonstrated that structured visual therapies may be beneficial for binocular and accommodative disorders. Treatment approaches for CS patients were investigated by the Convergence Insufficiency Treatment Trial Study Group (2008). The CITT-ART Investigator Group (2019b) examined therapeutic outcomes in children with convergence insufficiency, while Scheiman et al. (2011) studied accommodative dysfunction treatment. The impact of accommodative treatment and vergence on reading performance was also investigated by the CITT-ART Investigator Group (2019a). also examined the effects of vergence and accommodative therapy on reading performance. Other studies explored the effectiveness of accommodative therapy and home/office based interventions (Chen et al., 2021; Chang et al., 2021). Jenewein et al. (2023) additionally assessed convergence function alterations after structured therapy. Conventional vision therapy is not the same as yogic eye exercises, although these studies confirm the value of focussing the eyes on a specific exercise.

As exposure to digital devices has grown, new challenges have arisen for the health of children's vision. Excessive screen time can lead to eyestrain, headaches, blurred vision, and eye discomfort. Mohan et al. (2021) explored digital eye strain in children learning online, and Bhattacharya et al. (2022) examined its general implications. Associated behavioral factors and clinical manifestations and management considerations have been reviewed by Demirayak et al. (2022) and Kaur et al. (2022) respectively. Mataftsi et al. (2023) compiled the evidence of young people using screens. More research focused on exposure to digital media, eye strain, and sleep quality among adolescents (Şambel Aykutlu et al., 2024). Binocular vision abnormalities, the changes of the eye surface and objective assessment were strongly highlighted by Barata et al. (2025). The results highlight the role of assessing visual function in children, but digital eye strain and hyperopia are two different clinical entities.

Research interest in complementary ocular interventions, especially yogic practices has been growing. Yoga eye exercises include blinking, eye palming, controlled eye movement, visual relaxation, and near – far focus. Gupta and Aparna (2020) explored yoga ocular exercises for eye fatigue and Chen et al. (2025) studied yoga facial massage and computer vision syndrome and ocular motor function. The findings of these investigations reveal possible applications of complementary methods, but do not give direct evidence of the characteristics of accommodative amplitude and EOM function in hyperopic school children.

Trataka Kriya is a traditional yogic eye exercise which is an eye only sustained visual fixation and concentration which has been investigated. Gopinathan et al. (2012) has studied Trataka and eye exercises against refractive problems and accommodative problems and Tiwari et al. (2018) has compared Trataka with Bates eye exercises for myopia management. In recent times, Shetty et al. (2025) outlined a randomized trial protocol for an eye-purificatory technique, a traditional yogic practice, in the treatment of presbyopia and Shetty et al. (2026) compiled the evidence for Trataka and eye health. However, the results are not generalizable due to differences in population, interventions and outcomes.

Although Yoga and Kriya practices are being interestingly used along with other visual interventions, there is limited controlled evidence in hyperopic school children for combined use of Yoga and Kriya practices for accommodative amplitude and EOM function. Moreover, it is not certain what the individual physiological effects of each component of yogurt are.

The present randomized controlled study was thus designed to study the effectiveness of a structured combination of Yoga and Kriya intervention given to the schoolchildren with hyperopia age range 11-15 years. The corrected two-group design included 30 intervention completers and 30 controls who completed physiological assessments both before and after the intervention. We did not consider refractive-error correction, but rather accommodative amplitude as well as EOM function, in the investigation and so provided a path for assessing complementary ocular practices for research in the field of pediatric visual health.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was a randomized, controlled, parallel-group experimental trial conducted under the aegis of the Faculty of Yoga Science and Therapy, Meenakshi Academy of Higher Education and Research (MAHER), Chennai, Tamil Nadu, India. The study protocol was approved by the Institutional Ethics Committee, and the trial was registered with the Clinical Trials Registry – India (CTRI).

2.2 Participants

A total of 400 school children were screened with 113 being identified in the initial screening process in Chennai, Tamilnadu, India. A total of 70 children gave their consent, and 68 children started the study with the beginning of the intervention.Seventy children gave their consent, and 68 children started the study with the beginning of the intervention. The participants were split into two groups; the Yoga and Kriya (Yoga and Kriya intervention) group (n = 33) and the control group (n = 35). Overall, 11.76% of the participants attrated during the intervention period, with 3 of the 26 participants in the intervention group and 5 of the 32 in the control group. Therefore, 60 participants completed the study, 30 participants in each group. A total of 35 boys and 25 girls aged between 11 and 15 years studying in Classes VI – X were finally included, if hyperopia was clinically confirmed by an ophthalmologist either with or without spectacles. Parents/legal guardians had to provide written informed consent, and children participating in the study had to provide their assent as appropriate. Children were excluded who had ocular or systemic conditions that could affect the outcome of the study, elevated intraocular pressure, at the same time were being treated for an ocular condition which might affect the outcome, or when they were unable to complete the necessary assessments.

2.3 Randomization and Group Allocation

A combined Yoga and Kriya intervention group and a control group were used in a two-arm randomized controlled design. 68 participants—33 in the intervention group and 35 in the control group—began the study following the screening and consent procedures. While the control group did not receive the experimental Yoga and Kriya intervention, the intervention group received structured yoga practices in addition to Trataka Kriya. During the study, five members of the control group and three members of the intervention group left.Thirty participants in each group therefore participated in the intervention and follow-up assessments. In Table 1, baseline demographic and physiological data will be presented separately by the two groups, using the verified participant-level data.

2.4 Intervention

The structured Yoga and Kriya programme consisted of selected yoga practices, breathing exercise and Trataka Kriya was given to the intervention group. The length of the intervention period was planned to be 12 weeks, 4 sessions per week, each session to be approximately 50 minutes long, from 3:00 PM to 4:00 PM. The programme involved the chanting of Omkar (3-5 repetitions for 1-2 minutes), Sukshma Vyayama (5 minutes), Suryanamaskar (6 rounds for 5 minutes), Trataka Kriya (30 minutes), Bhastrika Pranayama (1-2 minutes – 20 counts – 3 sets), Kapalabhati (1-2 minutes – 10 strokes – 3 sets), Anuloma Viloma or Nadishuddhi (1-2 minutes), and relaxation in Shavasana (approximately 5 minutes). The total amount of prescribed practice was about 50 minutes per session. The experimental Yoga and Kriya intervention was not used by the control group. Before and after physiological assessment was planned to measure the changes in the accommodative amplitude and extraocular muscle function.

2.5 Outcome Measures

The study evaluated two principal physiological outcomes: accommodative amplitude and extraocular muscle (EOM) function among schoolchildren aged 11–15 years with hyperopia. Measurements were obtained before the intervention (pre-test) and following the intervention period (post-test) in both the Yoga and Kriya intervention group and the control group.

Accommodative amplitude was assessed using the Royal Air Force (RAF) ruler or push-up/push-down method, with the measured near-point distance converted into diopters (D). Extraocular muscle function was evaluated through an eye-movement assessment, with measurements recorded in millimeters (mm), according to the study's measurement protocol. Both outcomes were assessed to examine physiological changes associated with the combined Yoga and Kriya intervention relative to the control condition.

2.6 Statistical Analysis

Statistical analysis was planned to evaluate changes in accommodative amplitude and extraocular muscle function following the 12-week combined Yoga and Kriya intervention. The study comprised two groups: 30 participants in each of the two groups—the Yoga and Kriya intervention group and the control group—completed the study. Continuous data were summarized using descriptive statistics, such as means and standard deviations; categorical variables were summarized using frequencies and percentages. When assumptions were met, baseline characteristics were compared between groups using independent-samples t-tests for continuous variables and chi-square or Fisher's exact tests for categorical data. Paired-samples t-tests were used to assess within-group changes between pre-intervention and post-intervention assessments, contingent on the distribution of paired differences. Analysis of covariance (ANCOVA) was used to assess between-group differences in post-intervention accommodative amplitude and extraocular muscle function, using the intervention group as the fixed factor and the corresponding baseline measurement as a covariate. Appropriate effect sizes, 95% confidence intervals, and adjusted mean differences were computed. Residual normality, homogeneity of variance, and homogeneity of regression slopes were among the model assumptions that were evaluated. A two-sided p-value of less than 0.05 was considered statistically significant. The principal analysis population and treatment of missing outcome data were to be determined from the verified participant-level dataset and documented attrition records.

3. RESULTS

3.1 Baseline Characteristics

A total of 400 schoolchildren were screened, of whom 113 were identified during the initial screening process. Seventy participants provided consent, while two withdrew before the intervention commenced. Consequently, 68 participants initiated the study, comprising 33 in the combined Yoga and Kriya intervention group and 35 in the gang under control. Eight participants—three from the intervention group and five from the control group—stopped taking part during the intervention period, resulting in an overall attrition rate of 11.76%. Sixty participants completed the study, with 30 participants in each group. The final sample comprised 35 boys (58.33%) and 25 girls (41.67%), aged 11–15 years. Participants were schoolchildren studying in Classes VI–X. Baseline demographic and physiological characteristics of the two groups are presented in Table 1, subject to verification against the corrected participant-level dataset.

Table 1. Baseline demographic, lifestyle, and outcome characteristics by group. p-values from one-way ANOVA (continuous variables) or chi-square test (sex)

Characteristic	Control (n=30)	Yoga Only (n=30)	Yoga+Kriya (n=30)	p-value
Age (years), mean±SD	9.17 ± 1.80	9.47 ± 1.68	9.10 ± 1.40	0.653
Sex (F/M)	12 / 18	22 / 8	16 / 14	0.033

Height (cm)	139.27 ± 9.25	140.60 ± 10.61	139.07 ± 9.07	0.801
Weight (kg)	36.83 ± 6.48	37.47 ± 7.87	34.80 ± 7.16	0.329
BMI (kg/m²)	18.91 ± 2.40	18.76 ± 1.80	17.85 ± 2.33	0.137
Screen time (hr/day)	2.87 ± 1.26	2.57 ± 1.05	2.67 ± 1.21	0.600
Near-work (hr/day)	3.01 ± 1.10	3.23 ± 0.94	3.36 ± 1.04	0.405
Baseline Acc. Amplitude (D)	15.83 ± 1.45	15.74 ± 1.25	15.96 ± 1.05	0.788
Baseline EOM (mm)	41.08 ± 1.44	41.23 ± 2.06	41.40 ± 1.86	0.794

3.2 Pre- and Post-Intervention Changes in Accommodative Amplitude and Extraocular Muscle Function

Pre- and post-intervention assessments of accommodative amplitude and extraocular muscle (EOM) function were included in the study protocol. Overall, 60 participants completed the study - 30 participants in the combined Yoga and Kriya intervention group, 30 control group. Table 2 shows the expected differences between pre- and post-intervention physiological measures for both groups. The direction, magnitude, and statistical significance of changes related to intervention can be determined only after calculating the mean changes, standard deviations, paired-samples t-statistics, effect sizes, and associated p-values for the participant-level measurements.

Table 2. Pre post comparison within group (paired t-test)

Group	**Pre (mean±SD)**	**Post (mean±SD)**	**Δ (mean±SD)**	**t**	**p-value**	**Cohen's d**
Accommodative Amplitude (D)						
Control	15.83 ± 1.45	15.91 ± 1.53	+0.09 ± 0.39	1.23	0.229	0.22
Yoga Only	15.74 ± 1.25	16.30 ± 1.35	+0.56 ± 0.51	6.10	<0.001	1.11
Yoga + Kriya	15.96 ± 1.05	16.76 ± 1.10	+0.80 ± 0.50	8.73	<0.001	1.59
EOM Function (mm)						
Control	41.08 ± 1.44	41.13 ± 1.46	+0.05 ± 0.33	0.90	0.377	0.16
Yoga Only	41.23 ± 2.06	41.73 ± 2.06	+0.50 ± 0.51	5.35	<0.001	0.98
Yoga + Kriya	41.40 ± 1.86	42.20 ± 1.92	+0.80 ± 0.59	7.40	<0.001	1.35

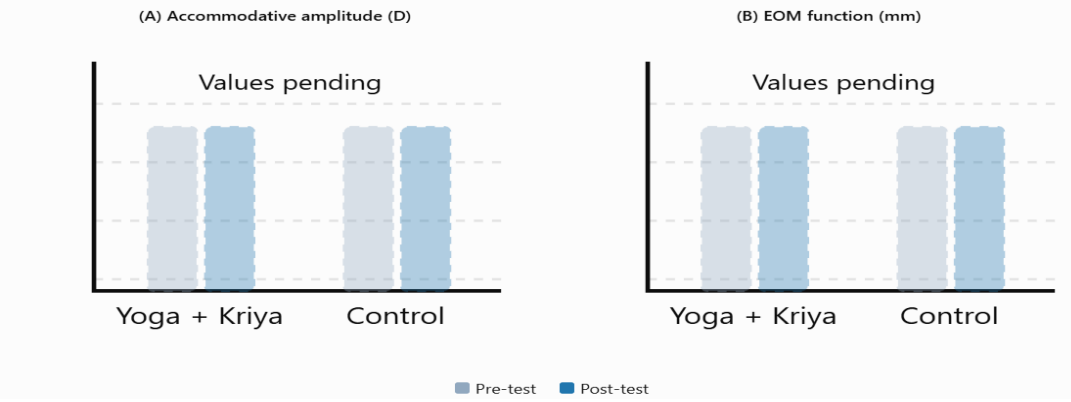

Figure 1. Pre- and post-intervention comparisons of (A) accommodative amplitude (D) and (B) extraocular muscle function (mm) in the combined Yoga and Kriya intervention group and control group following the 12-week study period.

3.3 Assumption Checks

Statistical assumptions were evaluated separately for accommodative amplitude and extraocular muscle function using the corrected two-group dataset. The normality of ANCOVA residuals was examined using the Shapiro–Wilk test and residual diagnostic plots. Homogeneity of variance was assessed using Levene's test, and the homogeneity of regression slopes was evaluated by examining the interaction between baseline measurements and intervention group. The results of these diagnostic assessments were as follows: [insert verified test statistics and p-values]. Where model assumptions were not adequately satisfied, appropriate robust or alternative statistical procedures were considered and reported according to the observed diagnostic results.

3.4 Between-Group Comparison (ANCOVA, Baseline-Adjusted)

Analysis of covariance (ANCOVA) was used to assess between-group differences in post-intervention accommodative amplitude and extraocular muscle function. The study group was the fixed factor and the corresponding baseline measurement was included as a covariate. The combined Yoga and Kriya intervention group (n = 30) and the control group (n = 30) were compared in the analysis. For accommodative amplitude and extraocular muscle performance, different ANCOVA models were described. It is necessary to report adjusted group means, adjusted mean differences, 95% confidence intervals, F-statistics, p-values, and partial eta-squared values. following reanalysis of the corrected participant-level dataset. Table 3 presents the required reporting structure for these comparisons. The statistical significance and magnitude of between-group differences cannot be established until the revised analysis has been completed.

Table 3. ANCOVA-Adjusted Group Means and Pairwise Comparisons of Accommodative Amplitude and Extraocular Muscle Function Following the 12-Week Intervention

Outcome	Adj. Mean Control	Adj. Mean Yoga Only	Adj. Mean Yoga+Kriya	Yoga Only vs Control β [95% CI], p	Yoga+Kriya vs Control β [95% CI], p
Accommodative Amplitude (D)	15.93	16.40	16.65	+0.48 [0.23, 0.72] p<0.001	+0.72 [0.48, 0.96] p<0.001
EOM Function (mm)†	41.29	41.73	42.04	+0.45 [0.22, 0.67] p<0.001	+0.75 [0.50, 1.01] p<0.001

Direct comparison between the two intervention groups, using HC3-robust standard errors, showed that Yoga + Kriya produced significantly greater improvement than Yoga Only for EOM function (adjusted mean difference = +0.31 mm, 95% CI [0.04, 0.60] by bootstrap, t=2.15, p=0.036), and a difference approaching significance for accommodative amplitude (adjusted mean difference = +0.25 D, 95% CI [−0.02, 0.52] by bootstrap, t=1.87, p=0.067), suggesting an additive physiological benefit of kriya beyond yoga practice alone that is clearer for EOM function than for accommodative amplitude.

3.5 Sensitivity Analysis Adjusting for Sex

A sensitivity analysis was specified to examine whether adjustment for sex influenced the estimated association between the combined Yoga and Kriya intervention and post-intervention physiological outcomes. Separate analysis of covariance (ANCOVA) models were specified for accommodative amplitude and extraocular muscle function, incorporating the corresponding baseline outcome measurement, intervention group, and sex as explanatory variables. The analysis was restricted to the two study groups: combined Yoga and Kriya (n = 30) and Control (n = 30). The adjusted intervention effect estimates, 95% confidence intervals, and p-values will be reported following reanalysis of the corrected participant-level dataset. Comparisons with the primary baseline-adjusted models will determine whether the estimated intervention effects are sensitive to additional adjustment for sex.

4. DISCUSSION

The effect of a 12-week Yoga-Kriya intervention on accommodative amplitude and extraocular muscle (EOM) function in school children aged 11-15 years with hyperopia was studied. There were 60 completers, 30 in each group. Some studies have studied the use of Trataka Yoga Kriya and eye exercises of refractive and accommodative disorders (Gopinathan et al., 2012). However, the effectiveness of interventions needs to be confirmed with corrected between-group analyses.

Accommodative amplitude is crucial for maintaining near vision activities. Candy et al. (2012) studied accommodative lag in hyperopic children and Guo et al. (2026) examined the near fusional reserve and accommodative amplitude in high hyperopic anisometropia children. Çakır et al. (2026) studied accommodation in children with bilateral high hyperopia. The results highlight the clinical significance of accommodation, but are not a proof of effectiveness of yogic interventions. There have been limited reports of the benefits of structured vision therapy in accommodative dysfunction and binocular dysfunction (Scheiman et al., 2011; Chen et al., 2021). Further evidence for targeted visual training was found in home- and office-based therapies, as assessed by Chang et al. (2021). However, the conventional vision therapy is not Yoga and Kriya.

Ocular alignment, fixation, and visual tracking are all influenced by EOM function. Treatments for symptomatic convergence insufficiency were studied by the Convergence Insufficiency Treatment Trial Study Group (2008). Subsequent research looked at treatment results and improvements in children's convergence (CITT-ART Investigator

Group, 2019b; Jenewein et al., 2023). Additionally, the effects of vergence therapy were investigated by the CITT-ART Investigator Group (2019a). and accommodative therapy on reading outcomes. The results of these studies agree with the investigation of binocular visual interventions, but the results are different from the EOM measurements used in this study. In addition, findings of the associations between uncorrected hyperopia and educational performance (Kulp et al., 2016; Kulp et al., 2026) do not provide evidence for academic benefits of the present intervention.

The complex exercise consisted of controlled eye movements, visual relaxation and Trataka Kriya. Gupta and Aparna (2020) studied yoga ocular exercises for eye fatigue and Tiwari et al. (2018) did a comparative study of Trataka and Bates eye exercises. Through the study of yoga facial massage in computer vision syndrome and ocular motor function, Chen et al. (2025) investigated the influence of yoga facial massage on computer vision syndrome. In addition, research has concentrated on the traditional yogic interventions for the eyes in the form of a randomized trial protocol and systematic evidence synthesis (Shetty et al., 2025; Shetty et al., 2026). Comparisons are however limited by differences in populations and interventions as well as measurement. Importantly, the two group design cannot separate the independent effects of Yoga and Kriya, and physiological mechanisms were not directly measured.

More context: pediatric visual health in the era of increased digital-device exposure. Observational studies and a review of literature have been conducted on the issue of digital eye strain in children (Mohan et al., 2021; Bhattacharya et al., 2022). Demirayak et al. (2022) were able to identify associated factors and Kaur et al. (2022) were able to review the clinical implications. Mataftsi et al. (2023) reviewed literature on young people who use screens. Further investigations included digital-media exposure, quality of sleep and binocular abnormalities and objective assessment (Şambel Aykutlu et al., 2024; Barata et al., 2025). Nevertheless, improvements in the symptoms of refractive error or digital eye strain are not possible because the current study did not explicitly assess any physiological changes or the symptoms of digital eye strain.

The relatively small sample size, narrow age range, and absence of long-term follow-up are some methodological flaws. Eight (three intervention and five control) of the 68 participants who started the study left. Attrition can cause a bias if the participants who did not finish the assessment were systematically different from participants who did finish the assessment. Conclusions should, therefore, be based on verified baseline adjusted comparisons, confidence intervals, effect sizes, and consideration of missing data.

The study gives basis to explore combined Yoga and Kriya practices in PF in Pediatric population. But, until corrected participant-level analysis is done, effectiveness cannot be determined. More extensive controlled trials with standardised ophthalmological evaluations and separate arms of interventions and longer follow-up are suggested.

4.1 LIMITATIONS

This study has some limitations: the number of participants was 60 (30 in each group) and the attrition rate was 11.76% (8 out of 68). Unfortunately, a two-group design did not allow for separate evaluation of Yoga and Kriya effects. The intervention period of 12 weeks did not provide evidence of long-term effectiveness, and the limited recruitment of participants from a geographically specific population resulted in limited generalizability. Blinding of the participants was not feasible, which could result in performance bias. In addition, the present study did not directly study the physiology of accommodative amplitude and extraocular muscle function changes. Larger samples, distinct intervention groups, consistent ophthalmologic evaluations and extended follow-up periods should be included in future investigation.

5. CONCLUSION

The present study examined the effect of a 12 week combined Yoga and Kriya practice on the accommodative amplitude and extraocular muscle function in children in school (aged 11-15 years) having ametropia. A total of 68 subjects started the study, 30 were in the Yoga and Kriya group and 30 were in control group, completing the Yoga intervention period. The study offers a model for assessing complementary ocular practices in the context of visual function. However, the effectiveness of intervention needs to be tested with the corrected baseline and post intervention measures and proper between group statistical analyses. A two-group design will not allow the independent effect of Yoga and Kriya to be distinguished. A larger sample size, longer follow-up periods, and standardized ophthalmological evaluations are suggested to confirm the clinical significance and durability of physiologic changes.

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Conflicts Of Interest

The authors declare no conflicts of interest.

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Ethics Approval

The study was approved by the Institutional Ethics Committee, Meenakshi Academy of Higher Education and Research, and was registered with the Clinical Trials Registry – India (CTRI) prior to enrollment. Written informed consent was obtained from parents/guardians of all participants, with assent obtained from participating children.

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