RESEARCH PAPER

Positive Repercussions on Eye Health of Restricted Mobile Phone Use Among Boarding School Children: A Cross-Sectional Study from Rural Gujarat, India

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ABSTRACT

Purpose: To evaluate the ocular effects of restricted mobile phone usage among children residing in a rural boarding school and to determine the prevalence of myopia and digital eye strain in this regulated environment.

Methods: This cross-sectional observational study included 182 students aged 10–17 years from a rural boarding school in Gujarat, India. A structured 15-item questionnaire assessed digital eye strain symptoms and daily screen exposure. Comprehensive ocular examination included visual acuity assessment, objective and subjective refraction, and anterior and posterior segment evaluation. Myopia was defined as spherical equivalent ≤ –0.50 D.

Results: The mean age was 14.61 ± 2.01 years. Of 182 students, 54 (29.7%) were males and 128 (70.3%) females. Asthenopic symptoms were reported by 36 students (19.8%). Myopia was detected in 19 students, yielding a prevalence of 10.4%. Male prevalence was 12.96% and female prevalence 9.36% ($p > 0.05$). Among symptomatic students, 52.8% were myopic ($p < 0.05$).

Conclusion: Restricted screen exposure combined with structured outdoor activity and regulated lifestyle was associated with a comparatively low prevalence of myopia.

Keywords: *Myopia, Screen time, Digital eye strain, Outdoor activity, School children*
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INTRODUCTION

Myopia is one of the most significant public health challenges affecting visual health worldwide. The global prevalence of myopia has increased dramatically over the past few decades, with projections suggesting that nearly half of the world's population may become myopic by 2050 [1]. This burden is particularly concerning among children and adolescents, where early onset of myopia increases the lifetime risk of developing high myopia and associated sight-threatening complications such as retinal detachment, myopic maculopathy, glaucoma, and cataract [2]. While genetic predisposition contributes to the development of myopia, accumulating evidence indicates that environmental and behavioral factors play a crucial role in the recent epidemic-like increase observed globally [3].

Among these environmental determinants, lifestyle modifications associated with modernization—such as increased near work, prolonged digital screen exposure, reduced outdoor activities, sedentary behaviors, and dietary changes—have been strongly implicated in myopia development and progression [4]. In particular, the rapid proliferation of smartphones and digital devices has significantly altered visual behavior among school-aged children. Screen-based activities often involve prolonged viewing at short working distances, reduced blink rate, and sustained accommodative demand, which may contribute to accommodative stress and the development of digital

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eye strain (DES) symptoms such as ocular fatigue, headache, blurred vision, and dryness [5]. Several epidemiological studies have also linked excessive screen time with increased risk of myopia onset and faster progression in children [6].

The COVID-19 pandemic further intensified concerns regarding digital screen exposure, as prolonged home confinement and the transition to online learning dramatically increased daily screen time while simultaneously reducing outdoor activity [7]. Multiple studies conducted during the pandemic reported accelerated myopia progression among children, highlighting the impact of environmental and behavioral changes on refractive development [8]. These observations reinforce the importance of examining the relationship between digital device usage and myopia risk in school-aged populations.

Conversely, outdoor activity has consistently been identified as a protective factor against the onset of myopia. Increased exposure to outdoor light has been shown to reduce the likelihood of myopia development through several biological mechanisms. High ambient light intensity stimulates retinal dopamine release, which inhibits axial elongation of the eyeball—a key structural change responsible for myopia progression [9]. Additionally, outdoor environments encourage viewing at longer distances and promote physical activity, thereby reducing sustained near work and accommodative stress. Large population-based studies have demonstrated that children who spend more time outdoors exhibit lower rates of myopia onset compared to those with predominantly indoor lifestyles [10].

Beyond visual behavior, emerging research suggests that broader lifestyle and metabolic factors such as nutrition and obesity may also influence ocular growth and refractive error development. Dietary patterns characterized by high refined carbohydrate intake and elevated glycemic load have been hypothesized to contribute to myopia through insulin-related metabolic pathways that may influence scleral growth and axial elongation [11]. Conversely, balanced nutrition rich in micronutrients such as vitamin A, omega-3 fatty acids, lutein, and zinc may support ocular health and retinal function [12].

Similarly, childhood obesity and sedentary lifestyles have gained attention as potential contributors to refractive error development. Several epidemiological studies have reported associations between higher body mass index (BMI) and increased risk of myopia in children [13]. Sedentary behavior, reduced physical activity, and increased indoor time associated with obesity may indirectly influence refractive development by limiting outdoor exposure and increasing screen-based activities. Furthermore, systemic metabolic changes related to obesity may also affect ocular growth patterns [14].

In contrast to urban environments where digital exposure and academic pressures often dominate children's lifestyles, rural settings may offer unique protective environmental characteristics. Children in rural communities frequently engage in more outdoor activities, have relatively lower access to personal digital devices, and follow more structured daily routines involving physical activity. Consequently, several studies have reported lower prevalence rates of myopia in rural populations compared with urban counterparts [15]. However, the increasing penetration of smartphones and internet connectivity into rural areas raises concerns that these protective environmental patterns may gradually diminish.

Boarding school environments provide a distinctive opportunity to evaluate the influence of structured lifestyle patterns on ocular health. In many boarding institutions, students follow regulated schedules that limit personal mobile phone usage, encourage outdoor play, and maintain routine daily activities under institutional supervision. Such environments may therefore serve as natural settings to study the impact of restricted digital exposure and lifestyle regulation on refractive status among children.

The present study aimed to evaluate the ocular health profile of students residing in a rural boarding school in Gujarat, India, where mobile phone usage is restricted and daily routines include structured outdoor activity. Specifically, the study sought to determine the prevalence of myopia and digital eye strain symptoms in this population and to explore the potential protective influence of environmental factors such as limited screen exposure, regular outdoor engagement, and regulated lifestyle habits. Understanding the role of these modifiable environmental factors may provide valuable insights for designing preventive strategies aimed at reducing the growing burden of childhood myopia.

MATERIALS AND METHODS

This cross-sectional observational study was conducted between May 2019 and April 2021 among students residing in a rural boarding school in Gujarat, India. The study aimed to evaluate the prevalence of myopia and symptoms of digital eye strain in an environment characterized by restricted mobile phone usage and structured daily routines that include scheduled academic activities and outdoor engagement.

A total of 182 students aged between 10 and 17 years who were residing in the boarding school during the study period were included. The sample comprised students from middle and secondary school classes who were available at the time of screening and provided assent to participate. Permission for conducting the study was obtained from the school administration, and the procedures adhered to the ethical principles of the Declaration of Helsinki.

Inclusion criteria included students aged 10–17 years who were permanent residents of the boarding school and present during the screening period. Students who were willing to participate and able to undergo complete ocular examination were included in the study.

Exclusion criteria included students with a history of ocular trauma, previous ocular surgery, known ocular pathology affecting refraction (such as keratoconus or congenital anomalies), systemic diseases known to affect vision, or those currently undergoing treatment for myopia control such as orthokeratology or atropine therapy. Students who were absent on the day of examination or unable to complete refraction assessment were also excluded.

Data collection involved a structured 15-item questionnaire designed to evaluate symptoms of digital eye strain and daily screen exposure habits. The questionnaire included items assessing symptoms such as eye strain, headache, blurred vision, dryness, and difficulty focusing during near tasks.

All participants underwent a comprehensive ocular examination. Visual acuity was assessed monocularly using a standard Snellen visual acuity chart at 6 meters under appropriate illumination. Objective refraction was performed using streak retinoscopy, followed by subjective refraction to obtain the best corrected visual acuity. Spherical equivalent refraction was calculated as sphere plus half of the cylindrical power. Myopia was defined as a spherical equivalent refractive error of ≤ -0.50 diopters in either eye.

Anterior segment evaluation was performed using torchlight examination, and posterior segment assessment was conducted using direct ophthalmoscopy to rule out any pathological findings. The collected data were recorded systematically for statistical analysis.

RESULTS

A total of 182 students residing in the rural boarding school were examined as part of the study. The mean age of the participants was 14.61 ± 2.01 years, representing a population largely within the adolescent age group where refractive changes and myopia onset are commonly observed. Of the total participants, 54 students (29.7%) were males and 128 students (70.3%) were females, reflecting the gender distribution of the residential school population included in the study.

Assessment of visual symptoms revealed that 36 students (19.8%) reported asthenopic or digital eye strain symptoms. The most commonly reported complaints included ocular fatigue, intermittent headache, blurred vision during near tasks, and difficulty maintaining prolonged visual focus while studying. These symptoms are commonly associated with prolonged near work and digital screen exposure, which have been highlighted in previous literature as emerging concerns among school-aged populations.

Refractive assessment using objective and subjective refraction techniques identified myopia in 19 students, yielding an overall prevalence of 10.4%, while 163 students (89.6%) were classified as non-myopic based on the defined spherical equivalent criterion. When analyzed by gender, the prevalence of myopia was 12.96% among male students and 9.36% among female students. Although males demonstrated a slightly higher proportion of myopia, the difference between genders was not statistically significant ($p > 0.05$), suggesting that refractive status in this cohort was not strongly influenced by gender-based differences in visual behavior.

A statistically significant association was observed between presence of asthenopic symptoms and myopia ($p < 0.05$). Among students reporting symptoms of visual discomfort, a higher proportion were found to be myopic compared with asymptomatic students. This finding aligns with existing evidence suggesting that accommodative stress and prolonged near work may contribute both to subjective visual discomfort and refractive changes.

The relatively low prevalence of myopia observed in this cohort may reflect the environmental characteristics of the boarding school setting, including restricted personal mobile phone usage and regular outdoor engagement as part of the structured daily routine. These findings provide descriptive evidence supporting the potential role of modifiable lifestyle and environmental factors in influencing refractive status among school-aged children.

Table 1: Demographic Characteristics

Variable	Value
Mean age (years)	14.61 ± 2.01
Males	54 (29.7%)
Females	128 (70.3%)
Myopia prevalence	10.4%

DISCUSSION

The present study evaluated the ocular health status of children residing in a rural boarding school environment characterized by restricted mobile phone use and structured daily routines. The observed prevalence of myopia in this cohort was 10.4%, which is comparatively lower than many recently reported prevalence rates among school-aged populations in urban settings. These findings highlight the potential influence of environmental and behavioral factors in shaping refractive development among children.

One of the most notable characteristics of the study setting was the restricted access to mobile phones and personal digital devices. Increasing evidence suggests that excessive screen time may contribute to both digital eye strain and refractive error development in children. Digital devices typically involve prolonged near work, reduced blink rate, and sustained accommodative demand, all of which may lead to visual fatigue and asthenopic symptoms

[5]. In the present study, approximately one-fifth of the students reported symptoms of digital eye strain, indicating that even limited digital exposure in educational settings may produce ocular discomfort. Importantly, a significant association was observed between the presence of asthenopic symptoms and myopia, suggesting that visual stress associated with near work may contribute to refractive changes.

Earlier studies have demonstrated a positive relationship between screen time and myopia prevalence. For example, large cohort studies in East Asia and Europe have reported that children who spend longer hours on digital devices have higher odds of developing myopia [6,16]. Excessive screen exposure may also reduce time available for outdoor activities, thereby indirectly increasing myopia risk. The relatively lower prevalence observed in the present study may therefore be partly attributable to the regulated digital environment of the boarding school.

Outdoor exposure represents another key environmental factor influencing refractive development. Numerous longitudinal studies have shown that increased time spent outdoors significantly reduces the risk of myopia onset in children [9,10]. Bright outdoor light stimulates retinal dopamine release, which acts as a biochemical inhibitor of axial elongation—the primary anatomical mechanism underlying myopia progression. In addition, outdoor environments encourage distance viewing and physical movement, reducing sustained near work and accommodative stress.

The boarding school environment in the present study included regular outdoor activities as part of the daily routine, which may have contributed to the relatively lower prevalence of myopia observed. Similar findings have been reported in intervention studies where increasing outdoor time during school hours resulted in a measurable reduction in new myopia cases among children [17]. These observations suggests the importance of integrating outdoor activity into school schedules as a simple and cost-effective strategy for myopia prevention.

Beyond visual behaviors, broader lifestyle factors such as nutrition and physical health may also influence ocular growth. Previous studies suggests that dietary patterns characterized by high glycemic load and excessive refined carbohydrates may be associated with increased risk of myopia [11]. Increased insulin levels resulting from such diets may influence ocular growth by affecting scleral remodeling and axial elongation pathways. Although nutritional patterns were not directly measured in the present study, rural boarding school environments often provide structured and balanced meal plans compared to the highly processed diets commonly observed in urban settings. Such dietary patterns may indirectly contribute to better ocular health outcomes.

Childhood obesity and sedentary lifestyle have also been proposed as potential risk factors for myopia development. Several studies have reported positive associations between higher body mass index and myopia prevalence among children [13,14]. These associations may reflect reduced physical activity and increased indoor time among overweight children, which in turn limit exposure to protective outdoor environments. The structured daily routines and mandatory physical activities in boarding schools may therefore promote healthier lifestyle behaviors that indirectly reduce myopia risk.

The findings of this study also align with existing evidence indicating that rural populations tend to have lower prevalence of myopia compared with urban populations. Urbanization is often accompanied by increased educational pressures, greater digital device usage, limited outdoor space, and more sedentary lifestyles—all of which contribute to higher myopia prevalence [15]. In contrast, rural environments traditionally support more outdoor engagement and lower levels of digital dependence. However, with increasing smartphone penetration even in rural areas, these protective environmental differences may gradually diminish in the future.

An interesting observation in the present study was the lack of a statistically significant gender difference in myopia prevalence. While some studies have reported higher myopia prevalence among females due to differences in near work behavior and outdoor exposure, others have found no consistent gender-based disparities [18]. The structured daily routine and uniform lifestyle patterns within the boarding school environment may have minimized behavioral differences between male and female students in this cohort.

Despite its strengths, the study has certain limitations. The cross-sectional design limits the ability to establish causal relationships between environmental factors and myopia development. Additionally, objective measurements of screen time, outdoor exposure, dietary patterns, and body mass index were not included, which could provide further insight into the relationship between lifestyle factors and refractive status. Future longitudinal studies incorporating these parameters would help better elucidate the complex interactions between environmental, behavioral, and biological determinants of myopia.

The present study highlights the potential benefits of regulated lifestyle environments in mitigating the risk of myopia among children. Interventions aimed at limiting excessive screen exposure, promoting regular outdoor activity, encouraging balanced nutrition, and reducing sedentary behavior may collectively contribute to healthier visual development.

The rapidly increasing prevalence of myopia worldwide, particularly among children, preventive strategies targeting modifiable environmental factors are urgently needed. Schools and parents play a critical role in shaping children's visual habits. Policies promoting digital hygiene, outdoor education, and healthy lifestyle practices could therefore serve as effective tools in addressing the growing burden of childhood myopia.

CONCLUSION

The findings of this study indicate that restricted mobile phone usage combined with structured daily routines and regular outdoor engagement may be associated with a comparatively lower prevalence of myopia among school-aged children. The regulated lifestyle within the boarding school setting—including limited access to personal digital devices, scheduled academic activities, and routine outdoor play—may contribute to reduced visual stress and healthier visual habits. Increased outdoor exposure has been widely recognized as a protective factor against myopia development, possibly through mechanisms such as higher light intensity stimulating retinal dopamine release, which inhibits excessive axial elongation of the eye. Additionally, limiting prolonged screen exposure may reduce accommodative strain and digital eye strain symptoms.

Given the rapidly rising global prevalence of childhood myopia, preventive strategies targeting environmental and behavioral modifications are increasingly important. Interventions such as promoting outdoor activities, encouraging balanced lifestyle habits, and implementing guidelines for responsible digital device use in schools may play a significant role in mitigating the future burden of paediatric myopia.

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