**Scholars Journal of Applied Medical Sciences**
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

**Ophthalmology**

# Advancement of Myopia in School-Aged Children During the Era of COVID-19 Remote Learning

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**DOI:** https://doi.org/10.36347/sjams.2025.v13i01.041 | **Received:** 08.11.2024 | **Accepted:** 13.01.2025 | **Published:** 22.01.2025

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## Abstract

**Original Research Article**

***Introduction:*** Myopia, or nearsightedness, has been steadily increasing worldwide, particularly among school-aged children. The COVID-19 pandemic, with its shift to distance learning, significantly increased children's screen time while reducing outdoor activities. This raised concerns about accelerated myopia progression, as prolonged screen exposure and reduced natural light became common. ***Objective:*** To examine how online learning and other environmental factors influenced the progression of myopia during the COVID-19 pandemic. ***Materials and methods:*** A retrospective study conducted from 2020 to 2024 collected data from children aged 6 to 14 during three different periods: before the pandemic, at its onset, and during the pandemic. Information was gathered on demographics, including screen time for educational and recreational activities, outdoor time, and the type of screens used. In addition, measurements of best-corrected distance visual acuity (BCDVA), uncorrected distance visual acuity (UCDVA), and cycloplegic refraction were documented. ***Results:*** Out of 100 patients, 48 were boys, with a mean age of 11.26±2.39 years. The majority used mobile phones (61%) and had inadequate outdoor play (87%). Among 200 eyes examined, 146 (73%) exhibited myopia progression. A significant difference in spherical equivalent (SE) was observed between the pre-pandemic and post-pandemic periods −0.28±0.22 D vs −0.40± 0.12 D ($p = 0.021$). Additionally, uncorrected distance visual acuity (UCDVA) differed between the two periods 0.07±0.11 vs 0.08±0.16 ($p = 0.023$). Significant hazard ratios for changes in SE were associated with older age (>9 years) (HR [95% CI], 0.72 [0.52–0.85]), increased recreational screen use (HR [95% CI], 1.25 [1.14–1.65]), and inadequate outdoor time (HR [95% CI], 1.46 [1.34–1.66]). ***Conclusion:*** Myopia progression accelerated during the COVID-19 pandemic. Factors such as younger age, extended screen time, and inadequate outdoor activity contributed to the increased progression of myopia. Conversely, the type of device used did not have a significant impact.

**Keywords:** COVID-19, Children, distance-learning, myopia, pandemic, school.

## INTRODUCTION

The coronavirus disease (COVID-19) spread quickly across the globe, creating significant challenges for healthcare systems, economies, and education. To address school closures during lockdowns, online learning and virtual classes were introduced. Worldwide, research has indicated a notable increase in myopia among school-aged children during the pandemic, sparking widespread concern [1].

Myopia is a global public health issue, which is why the World Health Organization has included it as one of the five urgent priorities in its "Vision 2020" initiative [1]. The condition has a complex, multifactorial origin and tends to progress over time [2]. Early-onset myopia is particularly concerning, as it is likely to advance into high myopia in adulthood [3]. The global trend shows a rising prevalence of myopia, with projections estimating that by 2050, 5 billion people—roughly 50% of the world's population—will be affected [4].

A cross-sectional study found that near-work activities contributed to the increased prevalence of myopia [5]. Specifically, the rise in myopia was more pronounced in higher-grade levels due to prolonged use of electronic devices during online learning [6,9]. However, previous research has not examined myopia progression using cycloplegic refraction, which is essential for assessing children [3,4]. This study aimed to explore the impact of extended screen time on the progression of myopia in school-aged children during the COVID-19 pandemic.

## MATERIALS AND METHODS

This retrospective study was carried out on children aged 6–14 years who attended the pediatric ophthalmology department at Sir Salimullah Medical College Hospital, Dhaka. Each participant underwent a thorough eye examination, which included an evaluation of uncorrected distance visual acuity (UCDVA), best-corrected distance visual acuity (BCDVA), and cycloplegic refraction. Myopia was defined as visual acuity less than 1.0 or a spherical equivalent (SE) of less than −0.5 diopters (D) in either eye. Patients who were using contact lenses, OrthoK lenses, or low-dose atropine for myopia control, as well as those with developmental delays, systemic illnesses, or a history of previous eye surgery, were excluded from the study. Demographic data were collected through interviews with parents. The eye examinations began with measurements of UCDVA and BCDVA in both eyes using tumbling E-charts, with results recorded in LogMAR units. Cycloplegic refraction was used to measure SE objectively, without subjective adjustments. Cyclopentolate 1% (Bausch & Lomb Incorporated, Tampa, FL, USA) was administered twice at five-minute intervals in both eyes, with a third dose given if necessary. Cycloplegic refraction was performed at least 40 minutes after the initial dose by a pediatric ophthalmologist or an optometrist. Event rates at 36 months were determined based on changes in BCDVA, UCDVA, and SE.

Screen time was categorized into three groups: low (30 minutes to 2 hours), average (>2 to 4 hours), and high (>4 hours). Time spent outdoors was classified as insufficient (<2 hours) or sufficient (≥2 hours) per day [8]. Data were collected on the types of devices used for learning, including televisions, computers, tablets, and phones. Demographic and clinical characteristics were reported as either mean (standard deviation) or percentage (%). The paired sample t-test was used to assess whether the mean difference between paired observations was statistically significant, while the chi-square test was used for comparisons of categorical variables. The primary outcome measured in the study was the change in spherical equivalent (SE), while secondary outcomes included changes in best-corrected distance visual acuity (BCDVA) and uncorrected distance visual acuity (UCDVA). Each event was recorded based on occurrences in either the left (OS) or right (OD) eye. A Cox proportional hazards analysis was conducted to assess the ability of baseline characteristics to predict changes in BCDVA, UCDVA, and SE within the study cohort. Univariate models were developed using factors such as age, sex (male vs. female), educational screen time, recreational screen time, outdoor time, and device use. Hazard ratios (HRs) with 95% confidence intervals (CIs) were calculated for each model. Kaplan-Meier curves were generated to compute event-free survival, and event-free survival was compared between subgroups using the log-rank test. Statistical significance was set at $p < 0.05$ (two-sided). IBM SPSS Statistics for Windows, version 25.

## RESULTS

1. The study included 100 patients, with a mean age of 11.26 years (SD ± 2.39). The majority of patients (72%) were aged between 10 and 15 years, while the remaining 28% were under 10 years old. The gender distribution was nearly even, with 52% females and 48% males. In terms of screen usage, 48% reported average educational screen usage, while 38% had high usage, and 14% had low usage. For recreational screen usage, 41% reported high usage, 31% had low usage, and 28% had average usage, indicating that recreational screen exposure was generally higher compared to educational screen time (Table 1). Myopia progression before and after the COVID pandemic, Best Corrected Distance Visual Acuity (BCDVA) and Uncorrected Distance Visual Acuity (UCDVA) remained stable, with no significant differences observed between the two periods (p=0.599 and p=0.286, respectively). However, the Spherical Equivalent (SE) showed a significant worsening post-COVID (p=0.021), suggesting that the pandemic period may have contributed to increased myopia progression. This worsening of SE is a crucial finding, highlighting the potential impact of lifestyle changes during the pandemic on eye health (Table 2). Risk factors for SE progression revealed that older age was protective, with the high age group showing a 28% reduced risk (p=0.003). On the other hand, increased recreational screen usage significantly raised the risk of SE progression (HR=1.25, p=0.009), while educational screen usage showed no significant effect. Insufficient time spent outdoors was also a notable risk factor (HR=1.46, p=0.033), reinforcing the importance of outdoor activities in preventing myopia progression. Gender and device type were not found to significantly influence SE progression (Table 3).

**Table 1: Patient Characteristics (n=100)**

| Characteristics | Frequency | Percentage (%) |
|---|---|---|

| | | |
|---|---|---|
| **Age in years** | | |
| ≤10 years | 28 | 28 |
| 10-15 years | 72 | 72 |
| Mean±SD | 11.26±2.39 | |
| **Sex** | | |
| Male | 48 | 48 |
| Female | 52 | 52 |
| **Educational screen usage** | | |
| Low | 14 | 14 |
| Average | 48 | 48 |
| High | 38 | 38 |
| **Recreational screen usage** | | |
| Low | 31 | 31 |
| Average | 28 | 28 |
| High | 41 | 41 |
| **Outdoor time** | | |
| Insufficient | 87 | 87 |
| Sufficient | 13 | 13 |
| **Device** | | |
| TV | 12 | 12 |
| Computer | 4 | 4 |
| Tablet | 23 | 23 |
| Mobile phone | 61 | 61 |

**Table 2: Comparison of Myopia Progression Between Pre-and Post-COVID Times (n=100)**

| Myopia Progression | Pre-COVID Time* Mean±SD | Post-COVID Time** Mean±SD | p-value |
|---|---|---|---|
| **BCDVA** | −0.01±0.02 | −0.01±0.02 | 0.599 |
| **UCDVA** | 0.07±0.11 | 0.09±0.16 | 0.023 |
| **SE** | −0.28±0.22 | −0.40±0.12 | 0.021 |

**Table 3: Hazard Ratios for SE Events for Study Characteristics (n=100)**

| Characteristics | | HR | 95% CI for HR | | p-value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Age, high age group | | 0.72 | 0.52 | 0.85 | 0.003 |
| Sex, female | | 1.28 | 0.89 | 1.86 | 0.208 |
| Educational screen usage[a] | | 1.04 | 0.72 | 1.49 | 0.887 |
| Recreational screen usage[b] | | 1.25 | 1.14 | 1.65 | 0.009 |
| Device used[c] | TV | 1.01 | 0.55 | 1.83 | 0.958 |
| | Computer | 1.19 | 0.52 | 2.73 | 0.660 |
| | Tablet | 1.07 | 0.64 | 1.77 | 0.768 |
| Outdoors time, insufficient | | 1.46 | 1.34 | 1.66 | 0.033 |

## DISCUSSION

The increased use of distance learning during the COVID-19 pandemic raised concerns about its potential impact on myopia, particularly in children. At the elementary school level, children were spending 4–6 hours per day on distance learning, which is among the longest durations reported globally [3,6,8–12].

In this study, spherical equivalent (SE) was measured using cycloplegic refraction by trained ophthalmologists or optometrists, providing an accurate assessment of myopia progression. There was a statistically significant difference between pre- and post-pandemic SE values, with a mean change of −0.12 D, indicating an accelerated progression of myopia in the post-pandemic period. Wang *et al.*, reported a mean change of −0.30 D in non-cycloplegic SE refraction in children aged 6–8 years [3]. Hu *et al.*, found a −0.35 D shift in SE cycloplegic refraction, although their study was limited to children in grades 2 and 3 [9]. In comparison, our study included a broader age range and used cycloplegic refraction, which may explain the lower mean change in SE. Picotti *et al.*, They also observed increased myopia progression compared to pre-pandemic median values but did not explore potential risk factors [13].

In this study, 87% of children who engaged in outdoor activities for ≤2 hours daily had a 44% higher risk of myopia progression compared to those who spent sufficient time outdoors. These results align with another study, which found that children with 2 hours of daily outdoor activity had a 33% lower risk of myopia progression [8]. Similarly, in a study by He *et al.*, Engaging in 40 minutes of outdoor activity daily reduced the incidence of myopia over a three-year period [12]. Another study observed increased myopia progression in children aged 7 to 12 during the COVID-19 lockdown; although outdoor time significantly decreased during the pandemic, no direct association was found between myopia progression and outdoor time [11]. Two hypotheses have been proposed to explain the protective effect of outdoor activities on myopia: first, unlike sunlight, indoor lighting tends to focus behind the retina due to its longer wavelengths, promoting axial elongation; second, light-induced dopamine release is believed to help control axial myopia [14].

Patients who spent more than 4 hours per day on recreational screen time had a 25% higher risk of myopia worsening compared to those with less screen exposure. Some studies have also shown that screen time exceeding 5 hours per day accelerated myopia progression [11,12]. In a cross-sectional study, Chen *et al.*, found a higher prevalence of myopia in children who spent extended periods using electronic devices [7]. The "substitution effect" was proposed to explain this, suggesting that increased use of digital devices reduces outdoor time, leading to more near work and contributing to myopia.15 However, Aslan and Sahinoglu-Keskek did not find a statistically significant association between screen time and myopia progression during home confinement [8]. Interestingly, in this study, educational screen time was found to contribute to myopia progression.

In our 3-year follow-up, myopia progression was less pronounced in the older age groups. Survival analysis revealed that the older age group had a 28% lower risk of myopia progression compared to the younger group. Similarly, a study in Shanghai, China, found that older age provided a protective effect against myopia progression [11]. French *et al.*, [16] compared myopia prevalence in younger children (6–8 years old) with older children (9–13 years old). Despite the older group spending more time in online classes, a greater increase in myopia was observed among the younger children, suggesting that younger children are more susceptible to environmental factors [3,17].

Due to the low socioeconomic status of our study sample, the majority of patients (61%) used mobile phones, where significant myopia progression was anticipated. Due to the lack of adequate comparison groups, the mobile phone group was used as the reference for comparisons with other device groups. The differences in myopia progression were not statistically significant, aligning with findings from other studies [8]. Ma *et al.*, reported that patients who used televisions and projectors exhibited slower myopia progression compared to those who used near-distance devices such as phones and tablets [11]. Additionally, low socioeconomic status may be a risk factor for the incidence and progression of myopia. Philip *et al.*, observed that myopia is more prevalent among children from lower socioeconomic backgrounds [17,18]. However, family income was not analyzed as a demographic factor in our cohort.

This study examined the progression and risk factors of myopia in school-aged children over a three-year period during the pandemic, using cycloplegic refraction. However, the findings should be interpreted with certain limitations in mind. As a retrospective study, screen time and outdoor activity levels were reported by parents, which may have affected the accuracy of the actual hours spent on these activities. Additionally, we did not include ocular biometry measurements, such as corneal keratometry and axial length, as these data were not collected. Most of the participants came from low socioeconomic backgrounds and lacked access to devices like laptops or tablets, relying primarily on their parents' phones. Future research incorporating ocular biometry, larger sample sizes, a wider age range, and diverse socioeconomic and ethnic groups could provide further insights into myopia progression.

## CONCLUSION

Myopia progression, measured by changes in spherical equivalent (SE), accelerated during the COVID-19 pandemic compared to pre-pandemic periods. Factors such as younger age, extended screen use, and reduced outdoor time contributed to the increased myopia. However, the type of device used did not have a statistically significant impact on myopia progression.

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