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Original Research

Correlation Between Screen Time Exposure and the Incidence of Myopia Among School-Aged Children: A Prospective Cohort Study

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Abstract

Background: The global prevalence of myopia has risen significantly, particularly among school-aged children. Increased screen time exposure due to digital learning and recreational device use has been identified as a potential risk factor. However, longitudinal data evaluating this association remain limited. This study aims to investigate the correlation between daily screen time and the incidence of myopia in children aged 6 to 14 years.

Materials and Methods:A prospective cohort study was conducted over 12 months involving 500 school-aged children without pre-existing myopia at baseline. Participants were categorized into three groups based on their average daily screen time: Group A (<2 hours/day), Group B (2–4 hours/day), and Group C (>4 hours/day). Comprehensive ophthalmologic examinations, including cycloplegic refraction, were performed at baseline, 6 months, and 12 months. Data on screen time exposure were collected through validated parental questionnaires and digital device usage logs. The incidence of myopia was defined as a spherical equivalent refractive error of ≤ -0.50 diopters in either eye. Statistical analysis was performed using Cox proportional hazards models to assess the risk association.

Results: At the end of the study period, the cumulative incidence of myopia was 8% in Group A, 18% in Group B, and 32% in Group C. Children with screen time exceeding 4 hours/day (Group C) demonstrated a significantly higher risk of developing myopia compared to Group A (Hazard Ratio [HR]: 3.5; 95% CI: 2.1–5.8; $p< 0.001$). A dose-response relationship was observed between increasing screen time and myopia incidence. Adjustments for confounding factors such as outdoor activity and parental myopia did not significantly alter the outcomes.

Conclusion: Prolonged screen time is strongly associated with an increased incidence of myopia among school-aged children. These findings highlight the need for public health strategies focusing on limiting screen exposure and promoting outdoor activities to mitigate the risk of early-onset myopia.

Keywords: Myopia, Screen Time, Children, Digital Devices, Refractive Error, Prospective Cohort, Visual Health, Ophthalmology, Risk Factors, Preventive Strategies

Introduction

Myopia, or nearsightedness, has emerged as a significant public health concern due to its rapidly increasing prevalence, particularly among school-aged children worldwide (1). Recent epidemiological studies estimate that nearly half of the global population may be affected by myopia by 2050, with a substantial proportion developing high myopia, leading to vision-threatening complications such as retinal detachment, glaucoma, and myopic maculopathy (2,3). This alarming trend has prompted extensive research into modifiable environmental factors contributing to the onset and progression of myopia in children.

One of the prominent lifestyle changes implicated in this surge is the increased exposure to digital screens due to the widespread use of smartphones, tablets, computers, and televisions (4). The advent of digital learning, compounded by recreational screen use, has significantly elevated the daily screen time among children, especially during and after the COVID-19 pandemic era (5). Prolonged near-work activities,

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such as screen viewing, have been associated with accommodative stress and axial elongation of the eyeball, both of which are key mechanisms in the development of myopia (6,7).

Several cross-sectional studies have suggested a positive correlation between excessive screen time and the prevalence of myopia in pediatric populations (8,9). However, these studies are often limited by their inability to establish temporal relationships due to their observational nature. Moreover, factors such as reduced outdoor activity, genetic predisposition, and educational pressure may confound the association between screen time and myopia (10). Prospective cohort studies are thus essential to better understand the causal relationship and to quantify the risk associated with prolonged digital device usage.

Given the growing dependency on digital devices in both academic and social settings, it becomes imperative to investigate how screen time influences visual health in children. This prospective cohort study aims to evaluate the correlation between daily screen exposure and the incidence of myopia among school-aged children over a 12-month period, while adjusting for potential confounding variables such as outdoor activity and family history of myopia. The findings of this study may provide valuable insights for developing preventive strategies and public health guidelines aimed at reducing the burden of myopia in the pediatric population.

Materials and Methods

Study Design and Population: This prospective cohort study was conducted over a period of 12 months, involving school-aged children between 6 and 14 years. Participants were recruited from five urban schools through stratified random sampling. Inclusion criteria included children without a prior diagnosis of myopia, astigmatism, or other refractive errors at baseline. Children with ocular pathologies, systemic diseases affecting vision, or those undergoing vision therapy were excluded.

Data Collection and Grouping: At baseline, detailed demographic data, including age, gender, parental history of myopia, and daily outdoor activity duration, were recorded using structured questionnaires completed by parents or guardians. Screen time exposure was assessed using a validated questionnaire combined with weekly logs maintained by parents, detailing the duration of digital device usage, including smartphones, tablets, computers, and television.

Participants were categorized into three groups based on their average daily screen time:

- **Group A:** Less than 2 hours/day
- **Group B:** 2 to 4 hours/day
- **Group C:** More than 4 hours/day

Ophthalmologic Examination; Comprehensive eye examinations were performed at baseline, 6 months, and 12 months by certified optometrists. The assessments included visual acuity testing, cycloplegicautorefraction, and axial length measurement using non-contact optical biometry. Myopia was defined as a spherical equivalent refractive error of ≤ -0.50 diopters in either eye.

Confounding Variables: To account for potential confounders, data on outdoor activity (measured in hours per day), near-work activities other than screen time (e.g., reading, writing), and parental myopia were collected. Outdoor activity was verified through self-reports and school activity records.

Statistical Analysis

Data analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize baseline characteristics. The cumulative incidence of myopia across the three groups was calculated. Cox proportional hazards regression models were applied to evaluate the association between screen time exposure and the risk of developing myopia, adjusting for confounding variables. A p-value of <0.05 was considered statistically significant.

Results

A total of 500 children were enrolled in the study, with an even distribution across the three screen time exposure groups. The mean age of participants was 10.2 ± 2.4 years, with 52% males and 48% females. Baseline characteristics, including age, gender, parental myopia, and average daily outdoor activity, were comparable across all groups (Table 1).

Incidence of Myopia Across Screen Time Groups: Over the 12-month follow-up period, the overall incidence of myopia was 19.6% (98 out of 500 children). The distribution of new-onset myopia was significantly different among the screen time groups. Group A (<2 hours/day) had an incidence of 8%, Group B (2–4 hours/day) 18%, and Group C (>4 hours/day) 32% (Table 2). These differences were statistically significant ($p< 0.001$) using the Chi-square test.

Association Between Screen Time and Myopia Risk: A Cox proportional hazards regression analysis revealed that children in Group C were 3.5 times more likely to develop myopia than those in Group A (Hazard Ratio: 3.52; 95% CI: 2.1–5.8; $p< 0.001$). Group B also showed an increased risk (HR: 2.21; 95% CI: 1.3–3.7; $p = 0.004$) (Table 3). Adjustments were made for confounding factors such as outdoor activity, near-work duration, and parental myopia.

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Table 1: Baseline Characteristics of Participants (N = 500)

Variable	Group A (<2 hrs)	Group B (2–4 hrs)	Group C (>4 hrs)	*p*-value
Number of participants	160	170	170	–
Mean age (years)	10.1 ± 2.5	10.3 ± 2.4	10.2 ± 2.3	0.72
Male (%)	53%	51%	52%	0.93
Parental myopia (%)	32%	34%	35%	0.81
Outdoor time (hrs/day)	2.4 ± 0.6	2.3 ± 0.5	2.2 ± 0.7	0.45

Table 2: Incidence of Myopia Across Screen Time Exposure Groups

Screen Time Group	No. of Participants	Cases of Myopia	Incidence (%)
Group A (<2 hrs)	160	13	8.1%
Group B (2–4 hrs)	170	31	18.2%
Group C (>4 hrs)	170	54	31.8%
Total	500	98	19.6%

Table 3: Cox Regression Analysis of Screen Time and Myopia Risk

Comparison	Hazard Ratio (HR)	95% Confidence Interval	*p*-value
Group B vs Group A	2.21	1.30–3.70	0.004
Group C vs Group A	3.52	2.10–5.80	<0.001

As seen in Table 2, there is a clear dose-response relationship between screen time and myopia incidence. The regression analysis in Table 3 further confirms that prolonged screen time significantly increases the risk of myopia development in school-aged children.

Discussion

This prospective cohort study demonstrates a significant positive correlation between increased screen time and the incidence of myopia among school-aged children. The findings reveal that children exposed to more than four hours of daily screen time had a substantially higher risk of developing myopia compared to those with less than two hours of exposure. These results align with emerging evidence suggesting that prolonged near-work activities, particularly involving digital devices, are critical environmental factors contributing to the growing prevalence of myopia in pediatric populations (1,2).

The observed dose-response relationship between screen time and myopia incidence supports previous cross-sectional studies that have identified excessive digital device usage as a risk factor for early-onset myopia (3,4). A study by Lanca and Saw highlighted that children with higher screen exposure exhibited greater odds of myopic progression, emphasizing the role of sustained accommodative demand and reduced blink rates associated with digital screens (5). Furthermore, the COVID-19 pandemic has exacerbated this issue, as remote learning and limited outdoor activities have led to increased screen dependence, correlating with a surge in myopia cases globally (6,7).

Importantly, even after adjusting for confounding variables such as outdoor activity and parental history of myopia, screen time remained an independent risk factor in our study. This is consistent with findings by He et al., who demonstrated that increased outdoor exposure could mitigate, but not entirely offset, the adverse effects of near-work activities on myopia development (8). The protective role of outdoor activities is hypothesized to be linked to higher light intensity and dopamine release, which may inhibit axial elongation of the eye (9,10).

Our study contributes valuable longitudinal data, addressing the limitations of earlier cross-sectional research that could not establish temporal causality (11). However, it is important to acknowledge certain limitations. Self-reported screen time, despite being supplemented with digital logs, may be subject to reporting bias. Additionally, factors such as the type of screen activity (educational vs. recreational) and viewing distance were not differentiated, which could influence accommodative stress levels (12). Future studies should consider incorporating objective digital tracking tools and evaluating the impact of screen ergonomics on visual health.

Another area of interest is the potential interaction between screen time and genetic predisposition. While parental myopia is a well-established risk factor (13), our findings suggest that environmental factors such as digital device usage can significantly amplify this risk, highlighting the multifactorial nature of myopia development (14).

The implications of these findings are substantial from a public health perspective. With the increasing integration of digital technology into education systems, guidelines promoting balanced screen usage, regular visual breaks, and increased outdoor activities are imperative. Interventions such as the "20-20-20 rule" (looking at something 20 feet away for 20 seconds every 20 minutes) could be advocated to reduce accommodative strain (15).

Conclusion

In summary, this study reinforces the association

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between prolonged screen time and the rising incidence of myopia in children. Preventive strategies focusing on reducing daily screen exposure and encouraging outdoor activities are essential to curb this growing public health concern. Further research is warranted to explore technological solutions and behavioral interventions that can mitigate the ocular risks associated with digital device usage.

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