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SCREEN TIME, PHYSICAL ACTIVITY, AND THEIR IMPACT ON VISUAL HEALTH AMONG SCHOOLCHILDREN

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Abstract
Excessive screen time and reduced physical activity are emerging risk factors for childhood visual impairments. This study explores the association between screen exposure, physical activity levels, and visual health among school-aged children. The findings indicate that children with visual impairments spend an average of 4.2 hours per day on screens, significantly more than their peers with normal vision (2.9 hours, $p < 0.001$). Additionally, children with vision problems engage in less physical activity (43.1 minutes per day) compared to those with normal vision (60.7 minutes, $p < 0.001$). These results highlight the urgent need for balanced screen use and increased outdoor activity to mitigate vision deterioration.

Keywords: Screen time, myopia, physical activity, visual health, digital eye strain, childhood vision.

INTRODUCTION

Over the past few decades, there has been a significant increase in childhood myopia worldwide, particularly in urbanized and technologically advanced regions. This trend has been largely attributed to environmental factors, particularly increased screen time and reduced outdoor activity. According to the World Health Organization (WHO, 2021), myopia prevalence among children has reached alarming rates, with projections estimating that nearly half of the world's population could be myopic by 2050 if preventive measures are not taken.

Technological advancements have significantly altered children's lifestyles, leading to increased screen exposure from smartphones, tablets, computers, and televisions. Studies show that excessive digital device usage is associated with digital eye strain (DES), a condition characterized by symptoms such as eye fatigue, dryness, blurred vision, and headaches (Huang et al., 2019). When children spend prolonged hours focusing on close-up digital screens, the ciliary muscles in their eyes remain engaged for extended periods, leading to accommodative stress and an increased risk of myopia progression (Chang et al., 2020).

Moreover, research has found that blue light exposure from digital screens can contribute to retinal damage and disrupted circadian rhythms, further impacting visual health and overall well-being

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(Lan & Agrawal, 2020). Prolonged near-work activities, particularly when combined with poor lighting conditions and improper posture, exacerbate ocular discomfort and refractive errors.

While increased screen time negatively impacts vision, outdoor physical activity has been identified as a protective factor against myopia. Studies suggest that exposure to natural sunlight helps regulate the release of dopamine in the retina, which plays a crucial role in preventing excessive axial elongation of the eyeball—a key factor in myopia development (Rose et al., 2016). Children who spend more time outdoors, especially in well-lit environments, tend to have a lower risk of developing myopia compared to those who engage in predominantly indoor activities. This protective effect is believed to result from higher light intensity levels encountered outdoors, which stimulate healthy eye growth and development (Morgan et al., 2018). However, with the increasing use of digital devices for both educational and recreational purposes, many children now spend significantly less time engaging in outdoor activities, leading to a rise in vision-related problems.

Beyond its benefits for overall health, regular physical activity has been linked to better ocular blood circulation, reduced eye strain, and improved overall eye health. Children who engage in at least 60 minutes of physical activity per day, as recommended by the WHO and the American Academy of Pediatrics (AAP, 2020), tend to have a lower incidence of visual impairments. However, findings indicate that children with visual impairments engage in less daily physical activity (43.1 minutes) compared to their peers with normal vision (60.7 minutes, $p < 0.001$). The reasons for this decline in physical activity include increased screen dependency, lack of outdoor playtime, and sedentary lifestyles.

Additionally, the rise of virtual learning environments, especially during and after the COVID-19 pandemic, has led to prolonged screen exposure among children. Online education, while beneficial, has significantly reduced physical movement and increased the duration of close-up screen use, further exacerbating the prevalence of digital eye strain and refractive errors (Wang et al., 2021).

This study aims to examine the relationship between screen time, physical activity, and visual impairments, emphasizing the importance of balancing digital device usage with active lifestyles to protect children's eye health.

Methods

This study employed a cross-sectional design to evaluate the relationship between screen time, physical activity levels, and the prevalence of visual impairments, including myopia and astigmatism, among 349 schoolchildren. The research focused on assessing the impact of digital device exposure and daily physical movement on ocular health, considering both environmental and behavioral factors that contribute to visual impairments. The study sample consisted of 349 school-aged children recruited from various educational institutions, selected using random stratified sampling to ensure representation across different age groups and socioeconomic backgrounds. Before participation, written informed consent was obtained from both the children's parents or guardians and the school administration, ensuring compliance with ethical guidelines for human research. The inclusion criteria required children aged 6–17 years enrolled in regular school programs with no prior diagnosis of severe ocular diseases such as congenital blindness or

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major retinal disorders, and parental consent for participation in the study. Children with a history of ocular surgeries, neurological disorders, or other medical conditions that could influence vision and physical activity were excluded to maintain the study's internal validity.

To obtain objective and accurate data, structured questionnaires were used to assess screen time exposure, daily physical activity, and environmental factors influencing visual health. Additionally, standardized visual acuity tests and optometric evaluations were conducted by trained specialists to diagnose myopia, astigmatism, and other refractive errors. Screen time exposure was classified into two categories: high screen time (more than 4 hours per day) and low screen time (less than 3 hours per day), covering time spent on smartphones, tablets, computers, televisions, and gaming devices, with separate considerations for educational and recreational use. Physical activity levels were categorized as adequate (more than 60 minutes per day) in line with WHO and American Academy of Pediatrics (AAP) recommendations and insufficient (less than 45 minutes per day), indicating a sedentary lifestyle. Activities considered included organized sports, outdoor play, walking, cycling, and other physical movements, while passive activities such as sitting, reading, or screen-based interactions were excluded.

Standardized Snellen charts and autorefractors were used to measure visual acuity, with refractive errors classified based on spherical equivalent refraction (SER) where myopia was defined as $\leq$ -0.50 diopters (D), astigmatism as a cylindrical error $\geq$ 0.75 D, and normal vision as the absence of significant refractive errors. Measurements were conducted under controlled lighting conditions, ensuring accuracy and consistency. The study also evaluated environmental and behavioral factors such as lighting conditions, where the intensity of ambient lighting at home and in classrooms was measured using lux meters and categorized as adequate (200–500 lux for home, 300–500 lux for classrooms) or insufficient (<200 lux for home, <300 lux for classrooms). Additionally, postural assessments were conducted by observing students' sitting postures, identifying correct versus incorrect sitting positions such as slouching, leaning too close to screens, or tilting the head while reading.

All collected data were processed using SPSS statistical software, and the association between screen time, physical activity, and visual impairments was analyzed using chi-square (χ^2) tests to determine statistical significance. A p-value of <0.05 was considered statistically significant, indicating a strong relationship between exposure variables and the prevalence of myopia and astigmatism. To further explore the strength of associations, odds ratios (OR) with 95% confidence intervals (CI) were calculated, allowing for an assessment of risk factors. Additional subgroup analyses were conducted based on age, gender, and socioeconomic background, identifying potential disparities in visual health outcomes. The study adhered to the principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of the participating institutions. Confidentiality of all participant data was maintained, and children diagnosed with significant visual impairments were referred for further ophthalmologic evaluation and corrective measures. By employing a systematic approach to data collection and statistical analysis, this study provides valuable insights into the role of screen exposure and physical activity in childhood vision health, contributing to public health interventions aimed at reducing myopia progression and promoting healthier screen habits.

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Results

The study revealed significant differences in screen time exposure and physical activity levels between children with visual impairments and those with normal vision. Children diagnosed with myopia or astigmatism reported longer daily screen exposure and lower engagement in physical activity, suggesting a strong correlation between these behavioral factors and the development of vision problems.

Children with visual impairments spent an average of 4.2 hours per day using digital screens, which was significantly higher compared to 2.9 hours per day among children with normal vision ($p < 0.001$). Excessive screen exposure, particularly for non-educational purposes such as gaming and social media, was prevalent among children with refractive errors. The data indicate that prolonged near-work activities increase the risk of myopia progression, aligning with existing research suggesting that screen time negatively affects accommodation and increases eye strain (Table 1.).

Table 1. Association between screen time and visual impairments among schoolchildren

Screen Time (hours/day)	Children with Visual Impairments (n=162)	Children with Normal Vision (n=187)	p-value
< 2 hours/day	12 (7.4%)	64 (34.2%)	<0.001**
2–4 hours/day	49 (30.2%)	78 (41.7%)	
> 4 hours/day	101 (62.3%)	45 (24.1%)	<0.001**
Mean ± SD	4.2 ± 1.3	2.9 ± 1.5	

Note: Statistical significance was determined using chi-square tests.

These findings highlight a statistically significant association between prolonged screen exposure and the prevalence of visual impairments, reinforcing the importance of monitoring children's digital device usage.

In addition to excessive screen time, children with vision problems engaged in less daily physical activity, averaging 43.1 minutes per day, compared to 60.7 minutes per day among children with normal vision ($p < 0.001$). Regular outdoor exposure is known to be protective against myopia development, primarily due to increased dopamine release in the retina, which inhibits axial elongation of the eye (Table 2.).

Table 2. Association between physical activity and visual impairments among schoolchildren

Physical Activity (minutes/day)	Children with Visual Impairments (n=162)	Children with Normal Vision (n=187)	p-value
< 30 min/day	55 (33.9%)	24 (12.8%)	<0.001**
30–60 min/day	82 (50.6%)	76 (40.6%)	
> 60 min/day	25 (15.4%)	87 (46.5%)	<0.001**
Mean ± SD	43.1 ± 12.4	60.7 ± 14.2	

Note: Statistical significance was determined using chi-square tests.

The results indicate that children with insufficient physical activity were at a significantly higher risk of developing vision problems, supporting previous findings that outdoor time serves as a protective factor against refractive errors.

Correlation Between Screen Time, Physical Activity, and Vision Problems

To assess the combined impact of screen exposure and physical activity on visual health, a logistic regression analysis was performed. The results confirmed that: Children spending more than 4 hours/day on screens had a 3.2 times higher risk of developing myopia or astigmatism (OR = 3.2, 95% CI: 2.1–4.8, $p < 0.001$). Children engaging in less than 45 minutes/day of physical activity had a 2.5 times higher likelihood of developing visual impairments (OR = 2.5, 95% CI: 1.7–3.9, $p < 0.001$). Children with both high screen time (>4 hours/day) and low physical activity (<45 min/day) had a 5.7 times higher risk of developing vision problems (OR = 5.7, 95% CI: 3.8–7.9, $p < 0.001$).

These findings suggest that prolonged screen use and inadequate physical activity have a compounding effect on the likelihood of developing myopia and astigmatism, reinforcing the need for balanced screen habits and increased outdoor time as part of vision health strategies.

Conclusion

The findings of this study emphasize the critical role of screen time management and physical activity in preventing vision problems among school-aged children. The significant correlation between prolonged digital device exposure, reduced physical movement, and the prevalence of myopia and astigmatism highlights the urgent need for targeted interventions to mitigate the risks associated with modern lifestyles.

To protect and maintain children's visual health, a multifaceted approach is required, incorporating efforts from schools, parents, and healthcare professionals. Schools should implement structured policies to regulate screen use during academic hours, ensuring adequate breaks from near-work activities and integrating more outdoor sessions into daily schedules. Parents should encourage balanced digital habits at home, setting screen-time limitations in line with World Health Organization (WHO) and American Academy of Pediatrics (AAP) guidelines, promoting regular outdoor play, and fostering healthy habits such as maintaining proper lighting conditions while studying. Additionally, healthcare providers and educators should work collaboratively to raise awareness about the adverse effects of excessive screen time and the benefits of physical activity in reducing the risk of myopia progression.

Given the growing prevalence of digital eye strain and sedentary behaviors among children, future research should focus on evaluating the effectiveness of intervention programs. Potential strategies include school-based vision screening programs, outdoor activity campaigns, and digital eye strain awareness initiatives. Longitudinal studies tracking the impact of reduced screen exposure and increased physical activity on vision health outcomes will be essential for formulating comprehensive public health policies.

Ultimately, a proactive and preventive approach—incorporating screen-time regulations, environmental modifications, and lifestyle adjustments—is essential to safeguarding children's visual health. Addressing these risk factors at an early stage will not only help in reducing the

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incidence of myopia and astigmatism but also contribute to overall well-being and academic performance.

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