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Exploring the Influence of Screen Time on Myopia Risk in Preschoolers and Adults

Nahla Adel Gamaleldin Sayed Shafie [a++*]

[a] Mediclinic Hospitals - Baniyas Clinics, United Arab Emirates.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Review Article

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ABSTRACT

The excessive screen time that has become an evident part of the current generation's agenda has resulted in the comeback of refractive errors and many other related eye conditions in the adult population. Nowadays, the level and the kind of screen time exposure that people have also seized increased, requiring research on whether there exists any association between their consumption and the likelihood of refractive errors becoming worse or even developing. Myopia, hyperopia, and astigmatism are the most typical types of refractive errors that can lead to visual impairments and limit a person's active lifestyle as well as impacting work performance. Many investigations were conducted to discover the level of myopia and hyperopia following a prolonged time in front of screens. A longer period dedicated to close work, like reading and computer use, was found to be strongly correlated with a bigger risk of increased myopia in adult people. On the other hand, the near vision activities being the result of close-up tasks not only proved to be a potential risk factor for developing myopia but also ended up being a protective factor against the same. Several potential mechanisms have been proposed to elucidate the link between screen time exposure and refractive errors. The most widely accepted theory is the "near work hypothesis," which posits that prolonged engagement in close-up activities leads to excessive accommodation and axial

[++] *Specialist Ophthalmology;*
**Corresponding author: E-mail: drnahlaadelgamaleldin@gmail.com;*

elongation of the eyeball, thereby increasing the risk of myopia development. This review shall explore the influence of specific screen-related activities, such as reading from electronic devices and engaging in near-work tasks, on the development of refractive errors. This review discusses potential mechanisms underlying the relationship between screen time and refractive error development, including changes in ocular biometrics, accommodative dysfunction, and environmental factors. By critically evaluating the available literature, this review aims to provide insights into the complex interplay between screen time exposure and refractive error development in adult patients. Understanding these relationships is crucial for informing public health interventions and guidelines aimed at promoting healthy screen habits and minimizing the risk of ocular complications in the digital age.

Keywords: Screen time; refractive errors; ophthalmology; myopia; astigmatism; near-sightedness; far-sightedness.

1. INTRODUCTION

The prevalence of uncorrected refractive error, notably myopia, constitutes a significant global health concern, according to reports by the World Health Organization [1].

Myopia, characterized by impaired distance vision, has emerged as the leading cause of refractive error-related visual impairment [2]. Beyond its immediate visual implications, the progressive nature of myopia presents broader public health challenges, as it heightens the risk of developing sight-threatening conditions such as glaucoma and retinal detachment [3]. This escalating prevalence of myopia, particularly evident in East Asian countries with intense educational pressures and limited outdoor activities, underscores the urgency of addressing its underlying determinants [4].

Hong Kong exemplifies the pervasive nature of myopia, with recent studies revealing alarmingly high prevalence rates among school-aged children. Similarly, in Japan, myopia rates have reached epidemic proportions among schoolchildren, highlighting the urgent need for comprehensive preventive strategies [5].

Myopia onset stems from a failure of emmetropization, with environmental factors such as prolonged near-work activities and insufficient outdoor exposure identified as key contributors to its development and progression. Consequently, there is a pressing need to investigate the impact of contemporary lifestyle factors, such as digital device usage, on myopia progression and overall visual health, particularly among vulnerable populations like school-aged children [6].

The widespread adoption of digital devices, including smartphones and tablets, has fundamentally transformed daily routines and behaviors across all demographics [7].

Among schoolchildren, in particular, the ubiquitous presence of digital screens has raised concerns regarding its potential repercussions on visual health and academic performance. Notably, the phenomenon of young children using smartphones from an early age has become increasingly prevalent, posing additional challenges to visual well-being [8].

Studies examining the relationship between smart device usage and visual health outcomes have highlighted the need for targeted interventions to mitigate potential risks, particularly in settings like Hong Kong where adverse effects on sleep patterns among adolescents have been observed [9].

In 2016, the American Academy of Optometry recommended limiting screen time in children aged between 2 and 5 to 1 hour a day, and they also recommended reducing the use of electronic devices among children over the age of 6 [10]. However, this is a controversial topic, and some research performed between 2009 and 2014 concluded that doing near-vision activities was not a risk factor for the development of myopia [11]. In these cases, the use of digital devices was not considered. In 2009, Dirani et al. studied if the screen time increase is the only risk factor that can be modified to prevent myopia. Facing this question, other authors have written about the importance of considering a historical perspective to propose preventive interventions [12].

Despite the growing body of research on the association between screen time and visual health, conflicting findings persist regarding its long-term implications for refractive error development. While some studies have failed to establish a clear link between screen time and

myopia prevalence, uncertainties remain regarding the potential long-term consequences of sustained digital device usage. Thus, there exists a critical need for further research to elucidate the complex interplay between screen time exposure, sleep patterns, and refractive error development, informing evidence-based interventions and policy measures aimed at safeguarding visual health in the digital age [8].

2. EXPLORING THE ROLE OF EXCESSIVE SCREEN TIME IN CAUSING REFRACTIVE ERRORS IN THE ADULT POPULATION

Several studies have highlighted and explored the relationship between screen exposure and the development of myopia among children, shedding light on the nuanced interplay between digital device usage and visual health. Research findings from diverse geographical contexts embed the significance of screen time as a potential risk factor for myopia progression [13].

In a comprehensive study encompassing primary and middle school students across six provinces of China, it was revealed that children whose parents did not impose restrictions on screen time exhibited a heightened risk of myopia [14].

Similarly, Siofra et al. reported a positive association between prolonged screen usage exceeding three hours per day and increased myopia risk among schoolchildren in Ireland [15]. The North India Myopia Study corroborated these findings, highlighting screen viewing as a significant risk factor for myopia progression among children aged 5 to 15 years [16].

Furthermore, insights from the Copenhagen Child Cohort 2000 Eye Study unveiled a concerning trend: adolescents spending more than six hours per day on screen devices faced nearly double the risk of developing myopia compared to their peers with lesser screen exposure [17]. Moreover, studies conducted in Qatar among older children aged 6 to 18 years demonstrated a highly positive association between extended screen time, exceeding three hours per day, and compromised vision. [18].

While previous research has primarily focused on school-aged children, the present study delves into the relationship between screen exposure and myopia among preschoolers, providing novel insights into this understudied population [6].

Results indicate a noteworthy hypothesis: Early-life screen exposure may be associated with an increased risk of preschool myopia, with the risk escalating in proportion to both daily exposure duration and cumulative years of exposure, particularly during the formative early life years. [19]. Although direct comparisons with studies involving larger cohorts of preschoolers are limited, our findings align with previous research, reinforcing the notion that screen exposure constitutes a significant risk factor for myopia [20].

Of particular interest is the identification of a potentially sensitive period during early infancy wherein screen exposure exerts a disproportionately higher impact on preschool myopia risk [21]. Cross-over analyses revealed that screen exposure during the postnatal first year, either independently or in combination with subsequent years, markedly elevated the risk of preschool myopia [22].

Conversely, exposure during the postnatal second or third year demonstrated insignificant associations with myopia risk. This suggests that the postnatal first year may represent a critical window wherein screen exposure exerts maximal influence on myopia development. This novel finding underscores the importance of early-life interventions to mitigate the adverse effects of screen exposure on visual health [23].

Furthermore, our study aligns with existing pediatric guidelines advocating for limited screen time among infants and toddlers. Recommendations from the American Academy of Pediatrics and other reputable organizations emphasize the importance of minimizing screen exposure for children under 18 months, a stance supported by our findings regarding the sensitive period for screen-related myopia risk [24].

Moving forward, further research is warranted to validate and refine these recommendations, enhancing our understanding of the complex interplay between screen exposure, developmental periods, and visual health outcomes among children [21].

3. THEORIES RELATED TO THE DEVELOPMENT OF REFRACTIVE ERRORS IN ADOLESCENTS AND ADULTS WITH PROLONGED SCREEN EXPOSURE

Understanding the underlying mechanisms driving the hypothesized association between

screen exposure and preschool myopia is important for concluding the observed findings and informing potential interventions. Several key factors may contribute to this complex relationship, shedding light on the multifaceted nature of myopia development in early childhood [25].

Firstly, prior research has underscored the influence of viewing distance on focusing errors, with closer viewing distances correlating with increased focusing errors and higher lags of accommodation, both of which are associated with myopia development [26].

However, our data revealed no significant distinction between the impact of hand-held devices and larger screens like televisions or computers [27]. Given that infants naturally engage in tasks at very short distances, the performance of near tasks alone cannot fully account for our findings. Instead, the prolonged fixation inherent in screen-based activities, such as video games, may disrupt the typical pattern of attention and focus shifts observed in natural environments, potentially contributing to myopia development [28].

Secondly, ample evidence suggests a protective effect of outdoor activities against incident myopia, highlighting the importance of exposure to natural light [29]. Conversely, prolonged indoor screen time may lead to reduced outdoor time and insufficient exposure to natural light, thereby increasing the risk of preschool myopia. This phenomenon underscores the role of environmental factors in modulating myopia risk during early childhood [30].

Thirdly, the unique physiological characteristics of infants' visual systems may render them particularly susceptible to the adverse effects of screen exposure. Infants exhibit low macular pigment density and underdeveloped foveae, compromising their ability to detect and adapt to defocused light exposure from artificial sources. This developmental immaturity may render them more vulnerable to the visual stressors posed by screen devices, potentially exacerbating myopia risk [31].

Furthermore, the rapid growth of the eye during infancy, particularly during the first 10 months of life, underscores the critical period during which environmental influences may exert maximal impact on ocular development. The steady fixation associated with screen exposure during this developmental window may disrupt the natural progression of eye growth, contributing to the onset of myopia [28].

The proposed mechanisms offer valuable insights into the potential pathways linking screen exposure to preschool myopia risk. By elaborating these underlying processes, future research can refine preventive strategies and interventions aimed at mitigating the adverse effects of screen time on early childhood visual health [22].

Moreover, these findings underscore the importance of promoting outdoor activities and minimizing screen exposure during infancy and early childhood to safeguard ocular development and mitigate the risk of myopia [2].

4. CONCLUSION

The evidence presented suggests a multifaceted relationship between screen exposure and preschool myopia, with several key mechanistic insights informing our understanding of this complex association. Prolonged fixation inherent in screen-based activities, disrupted attention and focus shifts, reduced outdoor time and natural light exposure, and the unique physiological vulnerabilities of infants' visual systems collectively contribute to the heightened risk of myopia development during early childhood. Moreover, the critical period of rapid eye growth and developmental immaturity further accentuates the susceptibility of infants to the adverse effects of screen exposure on ocular health.

These findings underscore the importance of comprehensive interventions aimed at mitigating the impact of screen time on preschool myopia risk. Strategies focusing on reducing screen exposure, promoting outdoor activities, and enhancing awareness of the potential consequences of excessive screen time during infancy and early childhood are paramount. Moreover, the identification of sensitive periods during early life highlights the need for targeted interventions during critical developmental windows to optimize ocular health outcomes.

Moving forward, further research is warranted to validate and refine these mechanistic insights, paving the way for evidence-based interventions and policy measures aimed at safeguarding visual health in young children. By addressing the multifactorial nature of preschool myopia

development and integrating these mechanistic insights into preventive strategies, we can effectively mitigate the growing burden of myopia and promote optimal visual well-being in early childhood and beyond.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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