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The Impact of Lifestyle and Environmental Factors on Myopia Progression: A Narrative Review

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ABSTRACT

Background: Myopia has emerged as a significant global public health concern, with its prevalence increasing at an alarming rate. While genetics play a role, the rapid rise suggests that modern lifestyle and environmental changes are primary drivers of axial elongation. **Aims and scope:** This narrative review evaluates the current evidence regarding the impact of modifiable lifestyle and environmental factors on myopia progression to provide clinical insights for management. **Methods:** A comprehensive review was conducted using 20 peer-reviewed sources from the last six years, focusing on outdoor light exposure, digital device usage, urbanization, and circadian rhythm disruptions. **Result:** High-intensity outdoor light exposure is strongly protective against myopia progression. Conversely, excessive near-work and digital screen time, exacerbated by recent pandemic-related home confinements, are significant risk factors. Emerging evidence also identifies urbanization and poor sleep quality as critical contributors to axial growth. **Conclusion:** Myopia progression is heavily influenced by modifiable environmental and lifestyle variables. Clinical management must prioritize behavioral interventions alongside optical and pharmacological treatments to mitigate the risk of high myopia complications.

Introduction

The global prevalence of myopia is rising at an unprecedented rate, with projections suggesting that half of the world's population will be myopic by 2050 [1]. This surge represents a major public health challenge due to the associated risks of sight-threatening complications, such as retinal detachment and myopic macular degeneration [2, 9]. While the hereditary nature of refractive errors is well-established, the "myopia boom" observed in recent decades cannot be explained by genetic shifts alone. Instead, environmental and lifestyle factors associated with modern living appear to be the dominant catalysts for the rapid progression of axial length [2, 16]. Recent shifts in social behavior, particularly in high-density urban areas, have fundamentally altered the visual environment of children and adolescents [19, 20]. The COVID-19 pandemic served as a global "natural experiment," where forced home confinement led to a measurable acceleration in myopic shifts among school-aged children [4, 7]. These observations underscore the fact that the ocular growth process is highly plastic and responsive to external stimuli, particularly during the developmental years.

Beyond the immediate clinical implications, the economic burden associated with myopia-related vision loss is profound, affecting both individual productivity and national healthcare expenditures. Since the progression of axial length is most rapid during the school-age years, this period represents a critical 'window of opportunity' for intervention. Understanding the specific mechanisms by which lifestyle choices and environmental exposures influence this developmental trajectory is paramount for clinicians. By shifting the focus from passive refractive correction to active risk-factor modification, healthcare providers can implement more effective, evidence-based strategies that potentially alter the long-term visual prognosis of millions of children worldwide.

The rationale for this study is to synthesize contemporary evidence to provide a clear understanding of these modifiable risk factors. Therefore, the purpose of this narrative review is to examine the impact of lifestyle and environmental settings on myopia progression and to highlight evidence-based behavioral strategies for its control.

Methods

This study utilizes a narrative review design to synthesize current literature on myopia progression. A comprehensive search was conducted across academic databases, including PubMed and Google Scholar, specifically targeting 20 peer-reviewed articles published within the last six years (2020–2026) to ensure the inclusion of the most recent clinical evidence. The selection process prioritized high-impact reviews, meta-analyses, and evidence-based infographics designed for clinical practice [13, 16]. Search terms included "myopia progression," "outdoor activity," "digital screen time," and "circadian rhythms." The analysis categorized findings into thematic sections: environmental light, digital habits, urbanization, and sleep-related factors.

Discussions

The synthesis of recent literature confirms that myopia is a multifaceted condition driven primarily by the interaction between the eye and its environment. The most robust evidence points toward the protective role of outdoor light exposure. The "retinal dopamine hypothesis" suggests that high-intensity natural light (typically >10,000 lux) stimulates the release of dopamine from the retina, which acts as a molecular brake on axial elongation [3, 8]. Interestingly, emerging research into non-visual opsins suggests that the spectral composition of light—specifically blue-light exposure during the day—is crucial for maintaining emmetropization [8, 15].

Conversely, the shift toward an "indoor-centric" lifestyle has increased the dioptric

demand on the young eye. Digital screen time has become a ubiquitous part of modern childhood, but its role is complex. While prolonged screen time is associated with myopic shifts [6], some studies suggest the risk is driven more by the short viewing distance and the continuous nature of the task rather than the digital nature of the device itself [17, 18]. This creates a state of "peripheral retinal blur," a known stimulus for ocular growth [6]. Table 1 summarizes these factors and their proposed mechanisms.

Table 1. Summary of Modifiable Lifestyle and Environmental Factors Affecting Myopia Progression

Factor	Influence	Primary Mechanism
Outdoor Time	Protective	Retinal dopamine release; inhibits axial growth [3, 8]
Digital Screen Time	Risk Factor	Peripheral blur; high accommodative demand [6, 18]
Near-work (Reading)	Risk Factor	Dioptric stress from short viewing distances [17]
Sleep Quality	Risk Factor	Circadian rhythm disruption; hormonal imbalance [5, 10]
Urbanization	Risk Factor	Low spatial frequency; limited long-distance view [19, 20]

Gene-Environment Interaction

A critical nuance in myopia progression is the interaction between genetic susceptibility and environmental triggers. While this review

emphasizes modifiable factors, evidence suggests that the "Gene-Environment (GxE) interaction" explains why children with a high genetic risk (e.g., myopic parents) are more vulnerable to the progression-inducing effects of intensive near-work [2, 16]. Genetic markers associated with scleral remodeling may determine the threshold at which environmental dioptric stress translates into axial elongation. This suggests that while environmental modification is universally beneficial, it is most critical for children with a known family history of high myopia.

Socioeconomic and Educational Policy Implications

The "myopia boom" is heavily concentrated in regions with competitive educational cultures, such as urban centers in East and Southeast Asia [19]. High-stakes academic environments often necessitate prolonged indoor study sessions from a very young age, creating a "myopigenic" social structure. Addressing this requires more than individual clinical advice; it necessitates structural changes in educational policy [1, 13]. Evidence-based infographics and public health initiatives now advocate for mandatory outdoor intervals in school curricula, which have been shown to stabilize refraction rates in large pediatric cohorts [13, 16].

Advanced Technical Interventions and Future Directions

As society remains increasingly digital-dependent, researchers are exploring technological interventions to simulate the visual benefits of the outdoors. Repeated Low-Level Red-Light (RLRL) therapy has emerged as a novel, non-invasive treatment that effectively slows axial growth by increasing choroidal blood flow and thickness [11, 14]. Additionally, the use of wearable sensors to monitor "real-world" visual behavior—such as viewing distance and ambient light intensity—provides clinicians with objective data to personalize lifestyle

recommendations [12, 16]. Integrating these high-tech monitoring tools with behavioral therapy represents the next frontier in holistic myopia management.

Conclusions

In conclusion, this review highlights that modifiable lifestyle and environmental factors are critical determinants of myopia progression. The protective effect of outdoor light and the risks associated with excessive near-work, urbanization, and poor sleep hygiene are well-supported by recent evidence. Clinical management of myopia should move beyond simple refractive correction toward a comprehensive behavioral strategy. Future public health policies should emphasize increasing outdoor duration and improving digital hygiene to prevent the progression to high myopia and its associated ocular morbidities.

Author Contribution Statement

The author performed all aspects of this study.

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