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Progressive Myopia in the Digital Era: Reassessing *Timira* Through Environmental and Lifestyle Ophthalmology

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ABSTRACT

Background: The prevalence of myopia is increasing globally, accelerated by the use of digital devices and near work. Ayurvedic ophthalmology describes *Timira* as a progressive vision disorder with environmental and lifestyle etiologies. This review reassesses *Timira* through the lens of modern environmental and lifestyle-related ophthalmology.

Methods: A narrative synthesis of peer-reviewed literature (2010–2026) on myopia epidemiology, risk factors, prevention, and Ayurvedic concepts of *Timira*, including digital eye strain, outdoor time, and lifestyle interventions, was conducted.

Results: The global myopia prevalence is projected to reach 50% by 2050 [1,2]. Each additional hour of daily digital screen time is associated with 21% higher odds of myopia [3]. Spending ≥ 120 minutes outdoors daily reduces the onset of myopia by up to 50% [4,5]. Ayurvedic *Timira* correlates with modern myopia, sharing lifestyle and dietary risk factors [6,7].

Conclusions: Reassessing *Timira* through the lens of environmental and lifestyle ophthalmology offers integrated prevention and management strategies. Reduced near work, increased outdoor time, evidence-based optical interventions, and Ayurvedic lifestyle modifications can synergistically control myopia progression.

Keywords: Myopia, *Timira*, Ayurveda, digital eye strain, lifestyle ophthalmology, environmental ophthalmology.

1. INTRODUCTION

Myopia (near sightedness) is a global public health crisis. The worldwide prevalence increased from an estimated 22.9% in 2000 to 33.9% in 2020, with high myopia (≤ -6.00 D) nearly doubling from 2.7% to 5.2% over the same period [1]. Alarmingly, projections indicate that by 2050, 49.8% of the world population (5.1 billion people) will be myopic and 9.8% (≈ 1 billion) will have high myopia [1,2]. This rapid increase cannot be explained by genetic shifts alone, underscoring the critical role of environmental and lifestyle factors.

The burden of myopia extends far beyond the need for corrective lenses: each 1 dpt increase raises the risk of myopic maculopathy by 67%, retinal detachment by 30%, posterior subcapsular cataract by 20%, and open-angle glaucoma by 20%, and the annual global productivity loss from uncorrected myopia is estimated at \$244 billion [2]. Therefore, effective prevention and progression control- strategies are an urgent public health priority.

The digital era has profoundly altered children's visual habits, with prolonged near work (especially on smartphones and tablets) and reduced outdoor time being the dominant modifiable risk factors. A 2025 systematic review and dose-response meta-analysis (45 studies, $n > 185,000$) found that each additional hour of daily digital screen time was associated with 21% higher odds of myopia (with risk increasing sigmoidal between 1 and 4 h of daily exposure), whereas smartphone use alone conferred 30% higher odds compared with less than one hour per day [3].

In contrast, outdoor time in natural light is the strongest protective factor. A landmark meta-analysis of 23 studies ($n=29,000$) reported that each additional hour of weekly outdoor time reduced the odds of myopia by 2% (OR 0.98; 95% CI 0.97-0.99) [4]. The protective effect plateaus at approximately 120 min per day, beyond which the additional benefit is minimal [5]. A large randomized controlled trial in Guangzhou, China, demonstrated that adding 40 minutes of outdoor activity to the school day reduced 3-year myopia incidence from 39.5% to 30.4% (relative risk reduction 23%) [8]. The mechanism involves light-induced- retinal dopamine release, which inhibits axial elongation [4].

Ayurveda describes *Timira* as a progressive visual impairment characterized by blurred distance vision and is classified as *Drishtigata Roga* (eye disease). Among its graded stages, *Prathama Patalagata Timira*, where vitiated *doshas* disturb the outermost ocular layer, is correlated with simple myopia [6]. The hallmark feature is *Avyakta Darshana* (indistinct vision), which closely mirrors the blurred vision of modern myopia [7]. The *Nidana* (causative

factors) such as *Akshi Darshana* (excessive near work/prolonged fixation), *Ratri jagarana* (late nights/sleep deprivation), and *Virudha Ahara* (incompatible diet) directly parallel today's digital screen use and disrupted sleep patterns [6,7]. Ayurvedic management prioritizes *dosha* pacification and ocular rejuvenation through therapies, including *Akshi Tarpana* (retention of medicated ghee over the eyes), *Aschyotana* (herbal eye drops), *Nasya* (nasal instillation of oils), and lifestyle modifications [6,7,9].

Given the escalating global burden of myopia and the limitations of a purely correction-based approach, this review aims to bridge the traditional concept of *Timira* with contemporary evidence from environmental and lifestyle ophthalmology. It explores how an integrated, holistic framework can provide a more effective and sustainable strategy for preventing and managing progressive myopia in the digital era.

2. METHODS

A narrative synthesis was conducted. PubMed, Scopus, and Google Scholar were searched (January 2010 – May 2026) using the following terms: “myopia,” “prevalence,” “progression,” “digital devices,” “screen time,” “near work,” “outdoor time,” “lifestyle,” “environmental factors,” “*Timira*,” “Ayurveda,” and “myopia control.” Inclusion criteria: original research, systematic reviews, meta-analyses-, or clinical guidelines reporting quantitative data on myopia risk factors or prevention. The exclusion criteria were conference abstracts, case reports, non-English- publications, and non-human- studies. The extracted data included sample size, odds ratios, hazard ratios, intervention effects, and Ayurvedic conceptual descriptions. No meta-analysis- was performed because of heterogeneity.

3. RESULTS

3.1 Global burden and projections

The global prevalence of myopia increased from 22.9% (1.4 billion) in 2000 to 33.9% (2.6 billion) by 2020. High myopia (≤ -6.00 D) increased from 2.7% (163 million) to 5.2% (399 million) [1]. By 2050, 49.8% of the world population (5.1 billion) is projected to be myopic, and 9.8% (1 billion) will have high myopia [1,2].

3.2 Digital device use and near work

A systematic review and dose-response meta-analysis of 45 studies ($n > 185,000$) found that each additional hour of daily digital screen time increased the odds of myopia by 21% (OR

1.21, 95% CI 1.18–1.24) [3]. The dose-response curve was sigmoidal, with the risk notably increasing between 1 and 4 h of daily exposure. Compared with <1 hour/day, >2 hours/day of digital screen time was associated with 50% higher odds (OR 1.50, 95% CI 1.30–1.73). Smartphone use alone was associated with 30% higher odds (OR 1.30, 95% CI 1.12–1.51) [3]. Each additional hour of traditional near work per day increased myopia odds by 2% (OR 1.02, 95% CI 1.01–1.03) [10]. The Sydney Adolescent Vascular and Eye Study (SAVES) reported that baseline near work >3 hours/day was associated with 2.5-times faster myopic progression over five years [11].

3.3 Outdoor time as a protective factor

A meta-analysis of 25 studies (n=29,000) demonstrated that each additional hour of weekly outdoor time reduced the odds of incident myopia by 2% (OR 0.98, 95% CI 0.97–0.99) [4]. For prevalent myopia, the OR was 0.964 (95% CI 0.945–0.982). A dose-response- analysis showed a non-linear relationship, with most benefits accruing up to approximately 120 min daily [5]. In clinical trials, outdoor time as an intervention reduced myopic shift by –0.30 D compared with controls (WMD –0.30, 95% CI –0.41 to –0.18) after three years [4].

The Guangzhou randomised trial (n=1,903) found that adding 40 minutes of outdoor activity to the school day reduced 3-year myopia incidence from 39.5% to 30.4% (difference –9.1%, 95% CI –14.1% to –4.1%; p<0.001) [8]. The intervention also significantly slowed the myopic shift (change in spherical equivalent refraction –1.42 D vs. –1.59 D; difference 0.17 D, 95% CI 0.01–0.33 D; p=0.04). Axial length elongation was not significantly different (–0.03 mm, 95% CI –0.07 to 0.003 mm; p=0.07) [8]. Notably, outdoor time was effective in preventing myopia onset but not in slowing the progression of myopic eyes [4].

3.4 Ayurvedic concept of *Timira*

Timira is a progressive, reversible (in early stages) or irreversible (in advanced stages) blurring of distant vision, often accompanied by *Akshi Shrama* (eye fatigue) and photophobia [6,7]. Its *Nidana* includes *Akshi Darshana* (excessive near work), *Ati Swapna* (excessive sleep), *Ratrijagarana* (late nights), *Dhumadi Seva* (exposure to smoke/pollutants), and *Virudha Ahara* (incompatible diet) [6,7]. *Samprapti* (pathogenesis) involves the vitiation of *Vata* (leading to drying/degeneration) and *Pitta* (inflammation/oxidative stress) [7]. Modern parallels are strong: excessive screen time leads to *Vata* vitiation (manifesting as dry eyes and accommodative spasm), while digital blue light causes *Pitta* aggravation (resulting in retinal oxidative stress). [6]

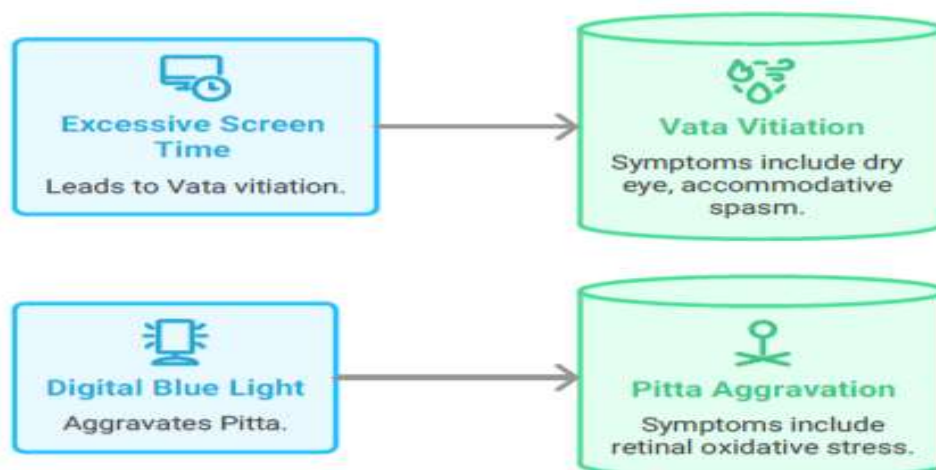


Figure 1: Impact of screen time of Doshas

Ayurvedic management includes *Pathya Ahara* (wholesome diet: leafy greens, ghee, *Triphala*), *Vihara* (lifestyle: outdoor walks, adequate sleep), and *Kriyakalpas* (ocular therapies) such as *Tarpana*, *Putapaka*, *Anjana*, and *Nasya* [7,9]. *Trataka* (steady gazing at a small object or candle flame) is prescribed to improve accommodation and reduce eye strain [12].

3.5 Evidence-based myopia management

Defocus Incorporated Multiple Segments (DIMS) lenses: A 2-year RCT (n=183) showed that DIMS lenses slowed myopia progression by 52% and axial elongation by 62% compared with single-vision lenses (mean progression -0.41 ± 0.06 D vs. -0.85 ± 0.08 D; $p < 0.0001$) [13].

Orthokeratology: A 2026 meta-analysis of 15 trials (1,065 participants) reported that ortho-K reduced axial elongation by a mean difference of -0.15 mm (95% CI -0.20 to -0.10) at 12 ± 2 months, with sustained benefit up to 3 years [14]. Modified lens designs provided an additional -0.12 mm reduction (-0.23 to -0.01) at one year [14].

Low-dose atropine (0.01–0.05%): The 3-year LAMP trial (n=350) found that continued 0.05% atropine slowed spherical equivalent progression to -0.73 ± 1.04 D over three years, compared with -1.60 ± 1.32 D for 0.01% atropine ($p=0.001$) [15]. The 0.05% concentration remained the most effective, and rebound effects after washout were concentration-dependent- but clinically small [15].

3.6 Integration of Ayurvedic and modern approaches

Triphala (a formulation of three myrobalans) has demonstrated antioxidant, anti-inflammatory, and neuroprotective properties in preclinical studies [16]. A network pharmacology approach identified interactions between *Triphala*'s bioactive compounds and 78 proteins involved in oxidative stress, inflammation, and angiogenesis, suggesting potential benefits for retinal protection against digital blue light-induced damage [17].

Trataka (yogic gazing) was shown to significantly improve accommodative amplitude and reduce asthenopia symptoms in a quasi-experimental study of 130 junior college students ($p=0.00001$) [12]. After 14 days of *Trataka* practice, 100% of the experimental group had only mild asthenopia, compared with 20% of the control group who still experienced moderate symptoms [12].

Table 1 summarizes the key environmental and lifestyle factors of myopia, and Table 2 correlates Ayurvedic *Timira* concepts with modern management.

Table 1: Key environmental and lifestyle factors in myopia onset and progression

Factor	Effect	Effect size (95% CI)
Outdoor time (per hour/week)	↓ risk	OR 0.98 (0.97–0.99) [4]
Outdoor time (≥ 120 min/day)	↓ onset	50% reduction [5]
Digital screen time (per hour/day)	↑ risk	21% higher odds [3]
Digital screen time (> 2 h/day)	↑ risk	OR 1.50 (1.30–1.73) [3]
Near work (per hour/day)	↑ risk	OR 1.02 (1.01–1.03) [10]

Table 2: Correlation of Ayurvedic *Timira* with modern myopia management

Ayurvedic concept	Modern parallel	Clinical implication
<i>Vata</i> vitiation (dryness, degeneration)	Scleral thinning, axial elongation	Nourishing therapies (e.g., <i>Tarpana</i> , omega-3)
<i>Pitta</i> aggravation (inflammation, oxidative stress)	Retinal phototoxicity from blue light	Antioxidant-rich diet (<i>Triphala</i> , leafy greens)
<i>Akshi Darshana</i> (excessive fixation)	Prolonged near work, digital devices	20-20-20 rule, regular breaks
<i>Ratrijagarana</i> (late nights)	Circadian disruption, reduced outdoor time	Sleep hygiene, morning outdoor exposure

<i>Trataka</i> (steady gazing)	Accommodation and vergence training	Reduces accommodative spasm [12]
<i>Triphala</i> (herbal formulation)	Antioxidant supplementation	Retinal protection against oxidative stress [16,17]

4. DISCUSSION

The convergence of modern environmental ophthalmology and Ayurvedic concepts of *Timira* offers a powerful and integrated framework for myopia prevention and management. The evidence is unequivocal: prolonged digital screen time and insufficient outdoor exposure are the dominant modifiable drivers of the myopia epidemic [3,4,10], while the *Nidana* of *Timira*, particularly *Akshi Darshana* and *Ratrijagarana*, directly parallel these same factors [6,7]. This alignment validates the observational wisdom of classical Ayurveda and provides a culturally resonant rationale for lifestyle-based interventions.

Modern interventions have proven to be highly effective. DIMS lenses reduce myopia progression by 52% and axial elongation by 62% [13]; orthokeratology yields a sustained 0.15 mm reduction in axial elongation at 12 months [14]; and low-dose atropine, especially 0.05%, provides robust three-year control [15]. However, these are primarily reactive and are initiated after the establishment of myopia. The Ayurvedic framework emphasizes proactive, daily routine-based prevention (*Dinacharya*) through outdoor activity, regulated near work, and ocular exercises such as *Trataka* [7,12].

The integration of both paradigms could produce synergistic benefits. For example, a child prescribed low-dose atropine could also receive *Triphala* as an antioxidant adjunct [16,17] and be counselled on *Trataka* to reduce accommodative strain [12]. The results from the Guangzhou trial a 23% relative risk reduction with only 40 minutes of additional daily outdoor activity [8] demonstrate that low-cost, high-impact behavioural interventions can be implemented at scale.

However, several barriers remain. First, most myopia intervention trials have been conducted in East Asian populations, limiting their generalizability to other ethnic groups. Second, the evidence base for specific Ayurvedic therapies (e.g., *Tarpana* for myopia progression) remains limited to small observational studies and requires rigorous randomized controlled trials. Third, compliance with lifestyle modifications (reducing screen time and increasing outdoor time) is

challenging in urban, digital-immersive- environments. Finally, health systems rarely cover myopia control devices or atropine, creating inequities in access.

Nevertheless, the public health implications are evident. National myopia control programs should:

- Mandate daily outdoor time in schools (≥ 120 minutes/day). [5,8]
- Regulate continuous screen time in educational settings (e.g., 30-minute blocks, 20-20-20 rule).
- Subsidize DIMS lenses, orthokeratology, and low-dose- atropine for at-risk children.
- Integrate Ayurvedic lifestyle counselling into school eye health programmes in regions where Ayurveda is part of the national health system.

Future research must address: (1) the minimal effective outdoor time for different age groups and baseline risk levels; (2) the long-term- safety and efficacy of integrated Ayurveda-modern care in prospective trials; (3) the effect of air pollution on the protective benefit of outdoor time; and (4) implementation science to identify barriers and facilitators of lifestyle-based myopia control in diverse settings.

5. CONCLUSION

Progressive myopia in the digital era demands an urgent reassessment of *Timira* through environmental and lifestyle ophthalmology. Modern evidence confirms that outdoor time reduces myopia onset, whereas digital screen time and near work increase the risk. Ayurveda provides etiological and therapeutic frameworks that align closely with these findings, offering proactive, culturally appropriate lifestyle modifications. An integrated approach combining increased outdoor time, reduced near work, evidence-based optical/pharmacological interventions, and Ayurvedic practices such as *Trataka* and *Triphala*, provides a holistic, cost-effective, and sustainable strategy to curb the global myopia epidemic.

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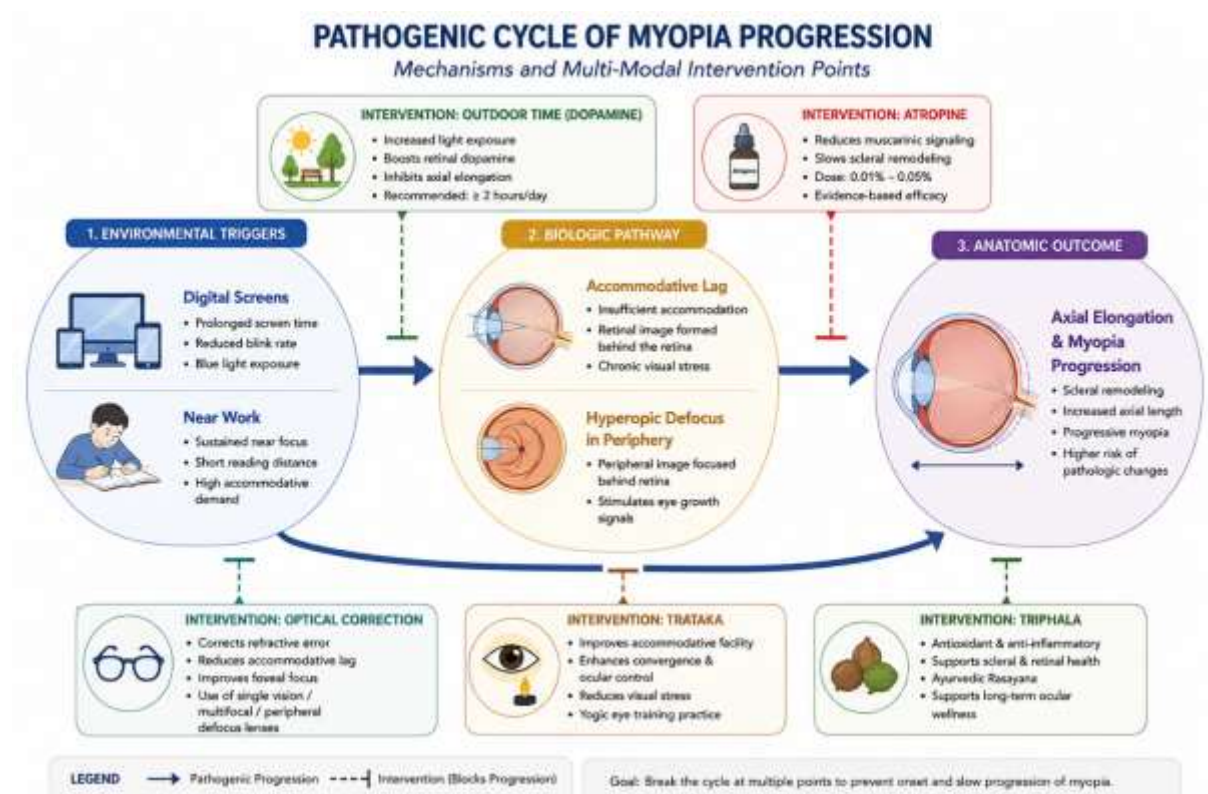


Figure 2: Schematic representation of myopia pathogenesis and intervention points, integrating environmental, lifestyle, and Ayurvedic factors.

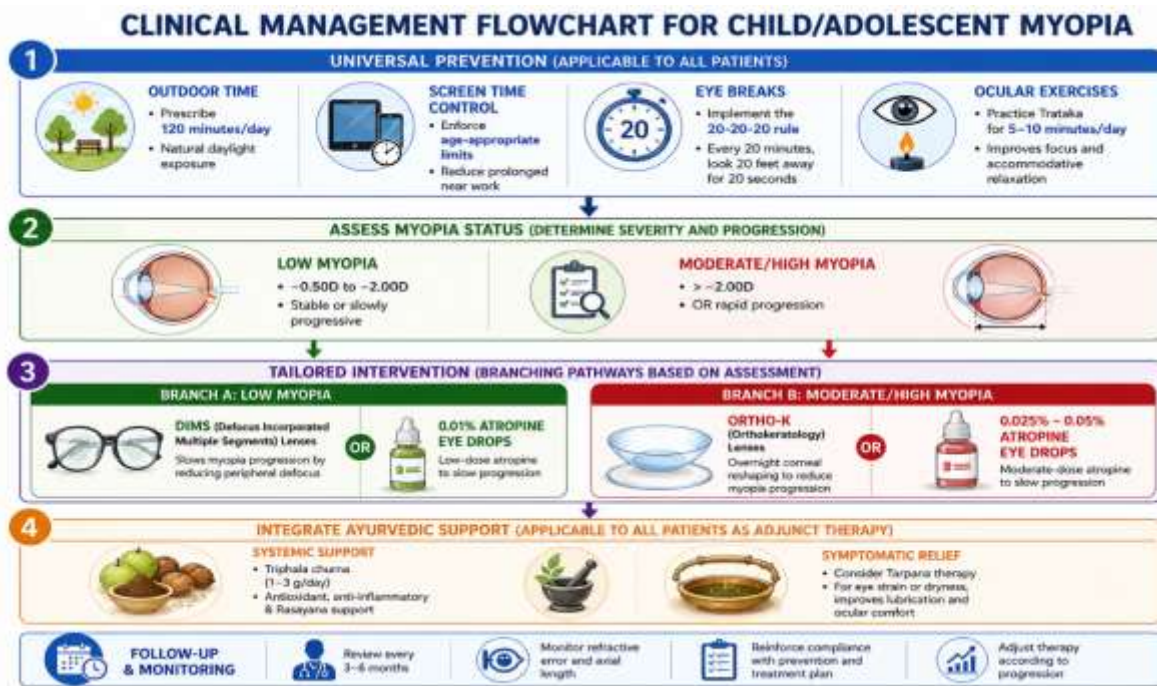


Figure 3: Proposed algorithm for myopia management in children combining outdoor time targets, near-work reduction, optical/pharmacological interventions, and Ayurvedic lifestyle modifications.