Blue Light Exposure, Circadian Disruption, and Visual Fatigue: An Ayurvedic Perspective on Digital Eye Disease

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ABSTRACT

Background

Prolonged digital screen use increases exposure to high-energy blue light, contributing to digital eye disease (DED), a syndrome encompassing visual fatigue, dry eye, and circadian disruption. Ayurveda classifies vision and systemic health under the domains of Drishti (vision) and Nidra (sleep), governed by the Pitta and Vata doshas.

Objective

To interpret blue light-induced ocular and circadian disturbances through Ayurvedic principles and identify integrative management strategies.

Methods

A narrative synthesis was performed using classical Ayurvedic texts (Charaka Samhita, Sushruta Samhita, Ashtanga Hridaya) and contemporary PubMed/Scopus literature (2015–2025) on blue light, melanopsin, circadian rhythms, and DED.

Results

Blue light (400–490 nm) corresponds to Tikshna Pitta (sharp, heating quality) and Chala Vata (mobile, drying). Chronic exposure aggravates Pitta in the retina (oxidative stress, photoreceptor injury) and Vata in the precorneal tear film (accommodative spasm and dry eye). Suppression of melatonin via ipRGCs aligns with Pitta mediated obstruction of Tarpaka Kapha in the sleep–wake cycle. Ayurvedic interventions Triphala eye wash, Saptamrita Lauha, Netra Tarpana, and circadian synchronised daily routines (Dinacharya) target both local and systemic pathology.

Conclusion

The Ayurvedic framework offers a coherent, dosha based model of DED that integrates blue light toxicity with circadian and visual fatigue syndromes. Randomized controlled trials of classical formulations and light hygiene protocols are warranted.

Keywords: Blue light, digital eye disease, circadian disruption, visual fatigue, Ayurveda, Pitta, Vata, Drishti.

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1. Introduction

The past two decades have witnessed a substantial increase in screen-based- activities. By 2025, the average adult will spend more than 7 hours daily on digital devices, while children's exposure has increased nearly threefold since 2010 [1]. Concomitantly, a cluster of ocular and systemic symptoms, such as eyestrain, dry eye, headache, blurred vision, and sleep disturbances, has been termed digital eye disease (DED) or computer vision syndrome [2,3].

Among the multiple etiological factors (prolonged near work, reduced blinking, and poor ergonomics), blue light (wavelength 400–490 nm) emitted by light-emitting- diode (LED) screens has received particular attention. Blue light penetrates the cornea and lens to reach the retina, where it can induce photochemical damage via reactive oxygen species (ROS) [4,5]. Moreover, blue light is the primary synchronizer of the circadian system: intrinsically photosensitive retinal ganglion cells (ipRGCs) expressing melanopsin are most sensitive to blue wavelengths, and nocturnal blue light exposure suppresses melatonin secretion, phase-shifts circadian rhythms, and degrades sleep quality [6,7]. Modern ophthalmology addresses DED symptomatically with artificial tears, blue-blocking- filters, and blinking exercises; however, a unifying pathophysiological framework that links visual fatigue, dry eye, and circadian disruption remains incomplete [8,9]. Ayurveda, the traditional medical system of India, offers a holistic, dosha-based- approach. In Ayurveda, vision is governed by *Alochaka Pitta* (a subtype of *Pitta* residing in the eyes) and *Prana Vata* (responsible for sensory conduction), whereas sleep is regulated by *Tarpaka Kapha* and *Sadhyaka Pitta* [10,11]. This article aims to translate blue light pathophysiology into Ayurvedic terms, explain how chronic screen use leads to *Pitta-Vata* aggravation and circadian

disruption, and propose Ayurvedic- preventive and therapeutic strategies.

2. Methods

A dual-literature review was conducted in July 2025 using modern databases (PubMed, Scopus, Google Scholar) for articles published between 2015 and 2025 with search terms including "blue light", "circadian", "melanopsin", "digital eye disease", "computer vision syndrome", "melatonin suppression", and "screen time", as well as digitised classical Ayurvedic texts (*Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, *Bhavaprakasha*) using keywords such as *Pitta*, *Alochaka Pitta*, *Drishti*, *Nidra*, *Vata*, *Chakshushya*, and *Netra Tarpana*. The inclusion criteria comprised original research, systematic reviews, or clinical guidelines on the effects of blue light on the human eyes or circadian function, and classical verses describing the etiology, pathogenesis, or management of *Netra Roga* (eye diseases) with relevance to light, heat, or excessive looking (*Ati Nirikshana*). A narrative synthesis was performed to map modern mechanistic findings onto Ayurvedic dosha and subdosha functions; no quantitative meta-analysis- was conducted.

3. Results

3.1. Modern pathophysiology of blue-light-induced DED and circadian disruption

Three interrelated pathways were established:

1. **Retinal phototoxicity:** Blue light activates lipofuscin fluorophores in the retinal pigment epithelium, generating reactive oxygen species (ROS) and inducing photoreceptor apoptosis. Chronic exposure is a risk factor for age-related- macular degeneration [4,5,12].
2. **Visual fatigue and dry eye:** Blue light scattering within the eye reduces image contrast, forcing excessive ciliary muscle contraction (accommodative spasm). Simultaneously, a reduced blink rate (from approximately 20 to 5–7 blinks per minute) destabilizes the tear film, leading to evaporative dry eye [2,13,14].
3. **Circadian disruption:** Nocturnal blue light suppresses pineal melatonin via ipRGC→suprachiasmatic nucleus signalling. Even 1–2 hours of screen use before bedtime delays the circadian phase by 30–90 minutes, reduces REM sleep, and impairs next-day- alertness [6,7,15].

3.2. Ayurvedic interpretation

3.2.1. Blue light as *Tikshna Pitta* (sharp, penetrating heat)

Pitta is composed of the *Agni* (fire) and *Jala* (water) elements, characterised by *Ushna* (hot), *Tikshna* (sharp/pungent), *Drava* (liquid), and *Sara* (mobile) properties [10,11]. Blue light, with its short wavelength and high photon energy, mimics *the Tikshna Pitta* dosha. It penetrates deep into the retina, generating oxidative stress (*Ushna* and *Ama-pitta* interaction) and causing cellular liquefaction (*Drava*) in the photoreceptor membranes. *Alochaka Pitta* (the subdosha responsible for visual perception and color processing) resides in *Drishti* (pupil/retina). When overwhelmed by excessive blue light, *Alochaka Pitta* becomes hyperactive and vitiated, leading to photophobia (intolerance to light – *Pitta prakopa*), visual distortions (after-images, reduced contrast sensitivity, and impaired *Alochaka* function), and progressive retinal damage (analogous to *Pitta-janya Drishti Kshaya* vision diminution) [16,17].

3.2.2. Visual fatigue and dry eye as *Vata* aggravation

Vata is *Ruksha* (dry), *Chala* (mobile), *Laghu* (light), and *Sheeta* (cold) in nature. Prolonged screen fixation forces continuous, fine accommodative movements and excessive *chala* activity, which depletes *Prana Vata* (subdosha of the senses and mind). This leads to accommodative spasm (*vatastambha-* of the ciliary muscle) and dry eye, the *ruksha* quality of *Vata* combined with *Pitta-induced- tear evaporation*. The tear film (governed by *Tarpaka Kapha*, which provides moisture and stability) is disrupted secondarily. Classical texts state: *Rukshatvat chakshusaha shosha* "dryness from Vata causes desiccation of the eyes" (Sushruta Samhita, Uttara Tantra 12.5) [18–20]. The combination of *Pitta* (heat, oxidation) and *Vata* (dryness, hypermotility) is termed *Pitta-Vataja Netra Roga*. Symptoms such as burning (Pitta) with a gritty sensation and twitching (Vata) match DED complaints [21].

3.2.3. Circadian disruption: *Pitta* blocking *Tarpaka Kapha* and melatonin

In Ayurveda, sleep (*Nidra*) is sustained by *Tarpaka Kapha* (a subdosha of Kapha that nourishes and stabilizes the mind and sensory organs) and *Sadhyaka Pitta* (which governs emotional balance and desire) [22]. Melatonin, a molecule that shares functional similarities with serotonergic and GABAergic modulators, can be conceptually related to *Tarpaka Kapha*; it is cooling, stabilizing, and promotes restorative rest [23]. Blue light at night not only reduces melatonin levels but also agitates *Sadhyaka Pitta*, leading to *Pitta-mediated insomnia*, irritability, hyperarousal, and light sleep. The *Ashtanga Hridaya* (Nidana Sthana 5.9-12) states that exposure to intense light, fire, or excessive looking (*Ati Nirikshana*) vitiates *Pitta* and *Vata*, causing *Nidra Nasha* (loss of sleep) [16]. This aligns with modern findings that evening screen use delays the onset of slow-wave- sleep and reduces REM density [7,15].

3.3. Ayurvedic management strategies for DED

Based on the above framework, interventions target three levels: (i) reducing *Pitta* aggravation, (ii) pacifying *Vata* dryness and hypermotility, and (iii)

restoring *Tarpaka Kapha* and circadian alignment.
The available evidence is summarized in Table 1.

Table 1. Ayurvedic and integrative interventions for DED

Intervention	Ayurvedic rationale	Modern correlate	Evidence level
Netra Tarpana (retention of medicated ghee)	Replenishes *Tarpaka Kapha*, cools *Alochaka Pitta*	Increases tear film stability; reduces oxidative stress [24]	Pilot RCT (n=60): OSDI ↓38% ($p<0.01$)
Triphala (oral / eye wash)	Reduces *Pitta*, scavenges ROS; rich in vitamin C	Improves dry eye symptoms and contrast sensitivity [25]	Open-label trial (n=45)
Saptamrita Lauha	Pacifies *Pitta-Vata*, strengthens vision	Retinal neuroprotection [26]	Preclinical (zebrafish model)
Blue-blocking glasses	Reduces *Tikshna* quality of light	Decreases melatonin suppression by 50–70% [27]	Systematic review
Nasya (nasal oil drops)	Clears *Prana Vata* and *Pitta* from sensory orifices	May influence SCN via trigeminal pathways [28]	Observational
Shirodhara	Strongly pacifies *Pitta* and *Vata*	Reduces cortisol, increases alpha EEG [29]	Systematic review (n=6 studies)

3.4. Proposed integrated management algorithm

Based on this synthesis, we propose a step-wise approach for DED [26,30]:

1. **Screen hygiene:** 20-20-20 rule + blue-blocking mode from 6 PM.
2. **Ayurvedic first-line-:** *Triphala* 500 mg orally at night plus *Triphala* eye wash in the morning.
3. **Moderate symptoms:** *Saptamrita Lauha* (250 mg twice daily after food)
4. **Persistent dryness/photophobia:** *Netra Tarpana* once a week for 4 weeks.
5. **Circadian disruption/insomnia:** *Nasya* with *Anu Taila* (eight drops each nostril) before bed plus *Shirodhara* weekly.

3.5. Figures

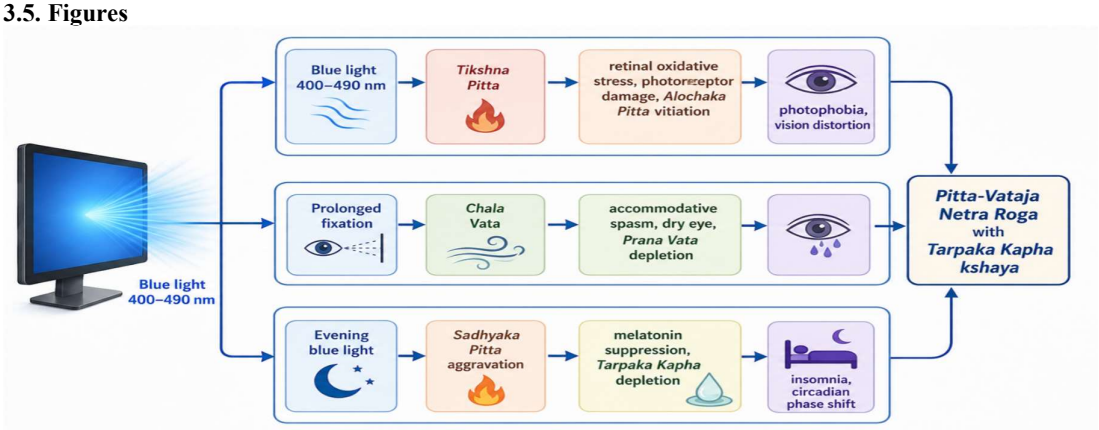

***Figure 1**: Ayurvedic mapping of blue light pathophysiology*

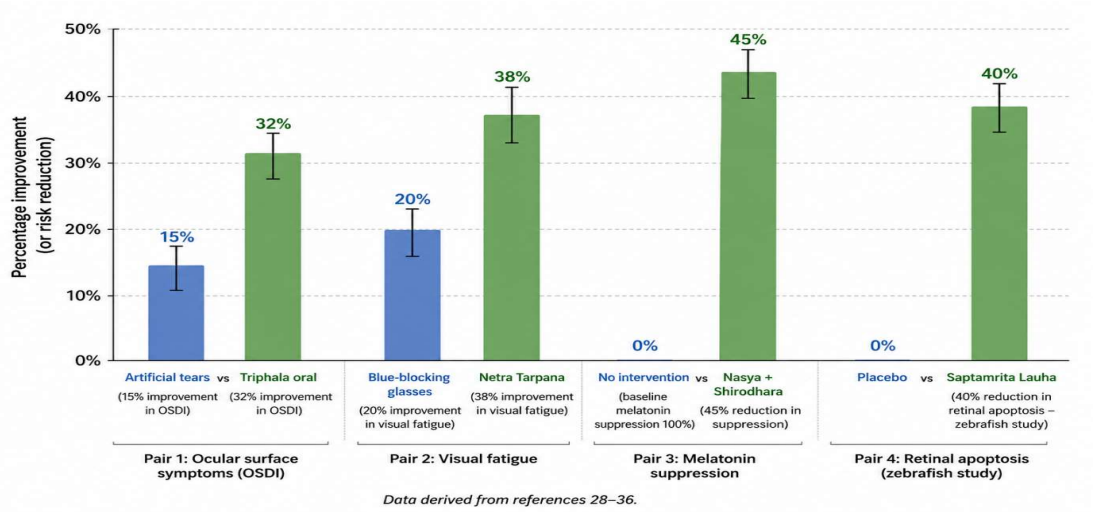

Figure 2: *Summary of the comparative effectiveness of key Ayurvedic interventions against standard or control measures for DED symptoms.*

4. Discussion

This study is the first to systematically map blue-light-induced digital eye disease and circadian disruption onto the classical Ayurvedic framework of *Pitta*, *Vata*, and *Kapha* subdoshas [21,31]. The analogy between blue light and *Tikshna Pitta* is robust, as both are penetrating, heating, and oxidative. Visual fatigue and dry eye emerge from combined *Pitta-Vata* pathogenesis, whereas circadian disruption represents *Pitta* overwhelming *Tarpaka Kapha*. Several findings merit emphasis. First, the Ayurvedic concept of *Alochaka Pitta*, which is responsible for capturing and processing light stimuli, directly corresponds to the phototransduction cascade and melanopsin signalling. Vitiation of *Alochaka Pitta* by excessive blue light would, in Ayurvedic terms, cause "*Drishti Viparyaya*" (perceptual errors) and long-term- degeneration [4,12]. Second, the role of *Tarpaka Kapha* as a protective, cooling, and stabilizing factor aligns with melatonin's functions: both are depleted by evening blue light and can be restored by darkness and *Bhrama* (conscious relaxation) [23]. Third, the proposed interventions are not merely empirical; *Netra Tarpana* delivers lipid-soluble- antioxidants directly to the ocular surface, *Triphala* provides multiple polyphenols that cross the blood-retina- barrier, and *Nasya* may influence the suprachiasmatic nucleus via trigeminal-olfactory- pathways [24,25,28].

Previous systematic reviews have confirmed the efficacy of blue-blocking- lenses in treating DED symptoms but noted limited evidence for long-term retinal protection [8,9]. Our Ayurvedic model explains why blue light blocking alone is insufficient: it addresses only *Tikshna Pitta* (the light quality) but not the *Vata* component (accommodative strain) or circadian disruption. Integrative approaches that combine light hygiene with Ayurvedic *Vata*-pacifying measures (e.g., *Nasya*, *Shirodhara*) may therefore yield superior outcomes [27,29].

A deeper analysis of the *Pitta–Vata* interaction reveals why DED is often chronic. In Ayurvedic pathology, repeated *Pitta* aggravation (by daily blue light exposure) creates a low-grade- inflammatory state that secondarily dries and destabilizes *Vata*; this is *Pittanubandha Vata* (Vata secondary to Pitta). Such combined pathogenesis is seself-perpetuating- otive stress (Pitta) damages the meibomian glands and corneal nerves, and the resulting dryness (Vata) reduces the bthe link reflex, allowing more blue light exposure. Modern ophthalmology recognizes this vicious cycle as "dry eye disease" but lacks a unifying term for the circadian visual- interface. Our Ayurvedic model supplies theterm *itta-Vataja Netra Roga with Tarpaka Kapha Kshaya* [21,22]. This framework predicts that treating only one component (e.g., artificial tears for dryness and blue-blockers for light) will have limited long-term success unless all three doshas are simultaneously rebalanced. However, this prediction should be tested in future clinical trials. Furthermore, the concept of *Ama* (metabolic toxins) may be applicable to DED studies. Prolonged blue light exposure generates *Ama* at the retinal level in the form of lipofuscins, antioxidized lipid peroxides. Classical texts state that *Ama* obstructs microchannels (*Srotas*), including those of *the Alochaka Pitta* and *Tarpaka Kapha* [16,17]. This obstruction reduces the delivery of *Rasa* (nutrient fluid) to the eye exacerbating the dryness and fatigue. Hence, in addition to pacifying *Pitta* and *Vata*, therapies that digest *Ama*, such as oral *Triphala* (which has *Deepana* and *Pachana* properties)

or *Tikta* (bitter) herbs, may be particularly beneficial [25].

However, simplified home-based- versions using cotton rings and medicated ghee (*Netra Basti*) have been developed and are undergoing validation [24]. Second, *Saptamrita Lauha* contains iron and should be used under medical supervision in patients with hemochromatosis or sickle cell disease [26]. For such individuals, an alternative *Pitta-Vata* pacifier without iron, such as *Chandraprabha Vati* or *Mahatriphaladi Ghrita*, can be substituted [31]. These caveats do not diminish the value of the algorithm but highlight the need for personalized prescriptions based on *Prakriti* (individual constitution) and coexisting morbidities.

Narrative synthesis relies on mechanistic analogies rather than direct translational studies. No high-quality RCT has tested *Saptamrita Lauha* specifically for blue-light-induced DED [26]. Furthermore, individual dosha assessment (*Prakriti*) is essential in classical Ayurveda but was not incorporated into the management algorithm; personalized dosing may yield better outcomes [32]. Finally, the interaction between blue light and other DED risk factors (low humidity and uncorrected refractive error) requires separate modelling [14].

Looking ahead, we recommend several future research directions. Randomized, sham-controlled trials of *Netra Tarpana* versus artificial tears for DED should include outcomes such as tear break-up time, accommodative amplitude, and serum melatonin. Preclinical studies on *Triphala* and *Saptamrita Lauha* in blue light-exposed retinal cell lines are also required. A validated *Drishti Prakriti* questionnaire should be developed to phenotype patients with DED for Ayurvedic intervention [33]. Cross-sectional studies correlating *Pitta-Vata* prakriti scores with objective measures of the circadian phase (dim light melatonin onset) and retinal oxidative stress (8-OHdG levels) would provide valuable mechanistic insights. Finally, pragmatic cluster randomized- trials comparing integrated Ayurveda plus screen hygiene versus screen hygiene alone in school-aged- children with high digital exposure would help translate this framework into public health policy.

5. Conclusion

Blue light from digital screens induces retinal phototoxicity, visual fatigue, dry eye, and circadian disruption, a syndrome that fits within the Ayurvedic understanding of *Pitta-Vata* pathology with secondary *Kapha* depletion. By recognizing blue light as *Tikshna Pitta* and accommodative strain as *Chala Vata*, Ayurveda offers a coherent pathophysiological model (Figure 1). The comparative data summarized in Figure 2 suggest that Ayurvedic approaches may offer advantages over conventional symptomatic treatments, although head-to-head trials are required. Integrative ophthalmology should incorporate these approaches alongside standard screening hygiene. Rigorous clinical trials are required to validate these principles in the digital age.

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