RESEARCH PAPER

Circadian Disruption via Indoor Illuminance and Light Modulation: An Integrative Review of Ratricharya Principles.

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ABSTRACT

Background: The evolutionary synchronization of human physiology with natural solar cycles has been fundamentally disrupted by the ubiquitous adoption of Artificial Light At Night (ALAN). High indoor illuminance and spectral modulation are leading drivers of circadian misalignment, contributing to global increases in metabolic, psychological, and autonomic disorders. While contemporary interventions predominantly focus on pharmacological management, Ayurvedic preventive medicine formally known as Swasthavritta offers a comprehensive lifestyle framework through Ratricharya (the nocturnal regimen).

Objective: This extensive conceptual review aims to systematically synthesize the biophysical properties of modern indoor illumination specifically static illuminance, spectral composition, and temporal light modulation (TLM)-with Ayurvedic Dosha-Dushya Siddhanta (pathogenesis).

Methods: An integrative scoping methodology was applied to map modern chronobiological literature regarding intrinsically photosensitive retinal ganglion cell (ipRGC) activation, melatonin suppression, and autonomic arousal against classical Ayurvedic treatises focusing on physiological transitions (Kala Parinama) governed by light exposure.

Results: Modern indoor environments utilizing cool-white light-emitting diodes (LEDs) heavily stimulate ipRGCs. In Ayurvedic pathophysiology, this sustained exposure acts as continuous Tejas (light energy), which aggressively maintains Sattva and Rajo Guna (neurological wakefulness). This artificial stimulus blocks the necessary Kapha-driven onset of Tamo Guna required for restorative sleep. Furthermore, TLM (invisible flicker) mimics Chala Guna (mobility), directly vitiating Prana Vata and exhausting Alochaka Pitta (visual receptors).

Conclusion: Contemporary indoor lighting acts as a profound pathogenic factor leading to autonomic arousal and circadian misalignment. Integrating the preventive principles of Ratricharya including the transition to low-lux lighting, regulation of early meal timing to synchronize peripheral clocks, and utilization of Padabhyanga (foot massage) demonstrates significant preventive relevance for mitigating light-induced psychosomatic morbidity.

Keywords: Artificial Light At Night (ALAN), Ratricharya, Temporal Light Modulation,Chronobiology, Swasthavritta.

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INTRODUCTION

For millennia, human physiology evolved in strict synchronization with the Earth's 24-hour rotational light-dark cycle. This solar dependency embedded a complex, highly conserved circadian timing system virtually into every mammalian cell. The circadian clock regulates critical homeostatic functions, including the sleep-wake cycle, core body temperature, hormone secretion, and cellular metabolism[1]. However, the rapid urbanization of the global environment and the advent of solid-state lighting have fundamentally severed human physiology from natural solar cycles. Over the past century, the ubiquitous adoption of Artificial Light At Night (ALAN) has precipitated a significant increase in circadian rhythm disruptions.

Modern chronobiology has extensively documented that continuous exposure to high-illuminance indoor environments delays Dim Light Melatonin Onset (DLMO)[2]. This artificial extension of the photoperiod alters natural sleep architecture, predisposing populations to a cascade of pathologies, including autonomic dysregulation, metabolic syndrome, functional dyspepsia, and psychiatric morbidities[3,4]. The mandate of 24/7 indoor productivity forces populations into a continuous state of artificial daylight, systematically overriding the biological requirement for nocturnal sensory withdrawal.While contemporary medical approaches frequently utilize reductionist or pharmacological interventions to address the downstream symptoms of circadian disruption (e.g., hypnotic sedatives for insomnia), Ayurveda presents a foundational system of preventive lifestyle medicine known as *Swasthavritta*. The core objective of this discipline is unequivocally stated in classical texts:

'स्वस्थस्य स्वास्थ्य रक्षणं, आतुरस्य विकार प्रशमनं च!'

Preserving the health of the healthy, and curing the disorders of the diseased[5].

Within this paradigm, *Ratricharya* (the nocturnal regimen) provides a comprehensive framework detailing specific dietary, behavioral, and environmental protocols necessary for transitioning the human body from an active daytime physiological state (*Rajo Guna* dominant) to a restorative nocturnal state (*Tamo Guna* dominant)[6].

Despite the growing recognition of lifestyle medicine in addressing chronobiological disorders, a rigorous academic synthesis mapping modern lighting biophysics to Ayurvedic pathogenesis is lacking. This review aims to bridge that gap by synthesizing the biophysical properties of modern indoor illumination-specifically static illuminance and temporal light modulation-with Ayurvedic *Dosha-Dushya Siddhanta*. By establishing these neurophysiological alignments, this paper proposes *Ratricharya* as a vital, evidence-based adjunctive framework for mitigating light-induced psychosomatic morbidity.

MATERIALS AND METHODS

This study was structured as an integrative conceptual review following modified scoping review guidelines. The methodology required a systemic correlation of modern biophysical lighting metrics with classical Ayurvedic chronobiological classifications.

A comprehensive literature search was conducted utilizing biomedical databases including PubMed, Scopus, and the Cochrane Library, alongside traditional knowledge repositories such as the DHARA (Digital Helpline for Ayurveda Research Articles) and the Ayush Research Portal. The search strategy employed combinations of the following MeSH terms and keywords: ("Circadian Rhythm" OR "Chronobiology" OR "Artificial Light At Night" OR "Temporal Light Modulation") AND ("Ratricharya" OR "Ayurveda" OR "Swasthavritta" OR "Sleep Hygiene").

Peer-reviewed articles, clinical trials, and epidemiological studies published between 2010 and 2025 detailing the physiological impacts of light spectra, lux levels, and TLM on human health were included. Classical Ayurvedic texts (*Brihatrayee*) were referenced for foundational concepts. Studies focusing exclusively on pharmacological sleep aids or animal models without direct human translational value were excluded.

The synthesis mapped documented physiological responses to artificial light exposure against Ayurvedic principles of *Kala Parinama* (physiological timing) and *Tridosha* fluctuation. Specifically, literature regarding intrinsically photosensitive retinal ganglion cell (ipRGC) activation was analyzed alongside the Ayurvedic concepts of *Tejas*, *Guna* (qualities), and *Prana Vata* vitiation.

RESULTS

The mammalian central circadian pacemaker is located in the Suprachiasmatic nucleus (SCN) of the anterior hypothalamus. Light serves as the primary external cue (zeitgeber) that synchronizes the SCN to the 24-hour solar day via the retinohypothalamic tract[7].

In Ayurvedic chronobiology, this physiological timing is dictated by the natural fluctuation of the *Tridosha* across the diurnal cycle. *Acharya Vagbhata* clearly delineates that the onset of the night naturally corresponds with the physiological dominance of *Kapha Dosha*, establishing a stable metabolic environment conducive to rest[8].

In Ayurvedic pathology, acharya shushruta stated that-

हृदयं चेतनास्थानमुक्तं सुश्रुत! देहिनाम् |
तमोभिभूते तस्मिंस्तु निद्रा विशति देहिनम्
निद्राहेतुस्तमः, सत्त्वं बोधने हेतुरुच्यते |
स्वभाव एव वा हेतुर्गरीयान् परिकीर्त्यते |[9]

The *Hridaya* which is the designated spot for *Chetana* (consciousness). And when this Hridaya overwhelmed (*abhibhuta*) by *Tamo guna Nidra* enters in the body. In that contrary the contemporary Modern indoor environments, however, frequently utilize cool-white LEDs (4000K–6500K) that emit peak wavelengths in the blue spectrum (~460-480 nm). These specific wavelengths aggressively stimulate melanopsin-containing ipRGCs[10].

This high-Kelvin light exposure acts as sustained *Tejas* (light/fire energy). This continuous exogenous *Tejas* maintains *Sattva* and *Rajo Guna* (alertness and mobility) in the mind, thereby mechanically blocking the *Kapha*-driven onset of *Tamo Guna* (heaviness and sleep)[11]. The failure to transition into *Tamo Guna* not only induces *Khandita Nidra* (fragmented sleep) but fundamentally impairs daytime *Agni* (metabolic fire) the following day.

Indoor lighting environments are defined by static illuminance (measured in lux). The continuous exposure to high-intensity lux long after sunset constitutes a severe sensory overload. Since throught the evolution our human body has been adapted the shift to darkness for sleep and thus Classically, this is categorized as *Atibhaswara darshanam* (excessive/improper contact of the visual sense with bright objects), representing an *Atiyoga* of the *Chakshurendriya* (visual organ)[12].

The timing of this exposure is critical. High lux levels during the evening hours directly contradict the physiological requirement for *Indriya Vishrama* (sensory withdrawal). Sustained visual processing under high lux leads to *Alochaka Pitta dushti*[13]. Clinically, this manifests as widespread ambient digital eye strain, accommodative dysfunction, and dry eye disease, which are now globally prevalent among office workers and students[14].

Beyond static brightness and color temperature, modern alternating current (AC)-powered LEDs frequently exhibit Temporal Light Modulation (TLM), commonly known as Invisible flicker. Even when operating at high frequencies (>100 Hz) that are imperceptible to conscious vision, this rapid fluctuation is detected by the retina and processed by the visual cortex. This places an unceasing systemic burden placed on the nervous system by prolonged stress exposure[15].

From an Ayurvedic perspective, TLM is the exact biophysical embodiment of *Chala Guna* (mobility/instability), which is the primary and most pathogenic characteristic of *Vata Dosha*[16]. The constant, rapid micro-fluctuations in light intensity continuously stimulate the nervous system, leading directly to *Prana Vata Prakopa* (vitiation of the neurological sub-dosha)[17]. This mechanism explains why chronic exposure to high-flicker environments is strongly correlated with tension-type headaches, evening anxiety, and neuro-fatigue[18].

Ratricharya protocols are deliberately structured to actively induce *Tamo Guna* and pacify *Vata Dosha*, counteracting the sensory and metabolic exhaustion accumulated during the day.

Dietary Regulation (*Ratri Bhojana*): Classical texts mandate that the evening meal must be *Laghu* (light), *Snigdha* (unctuous), and consumed early in the evening (typically within a standard window post-sunset). This dietary regulation ensures that the metabolic heat (*Pachaka Pitta*) required for digestion does not interfere with the neurological cooling required for sleep onset[19].

Behavioral and Hygienic Guidelines: Behavioral protocols emphasize the calming of the mind through *Sadvritta* (virtuous, unstimulating conduct). Excessive intellectual, emotional, or physical strain at night is strictly prohibited to prevent further aggravation of *Vata*. Furthermore, hygienic practices such as *Netra Prakshalana* (eye washing) and *Padabhyanga* (foot massage with oil) are employed to physically remove accumulated energetic debris and ground the nervous system[20].

DISCUSSION

The synthesis of findings clearly indicates that *Ratricharya* functions fundamentally as an advanced system of circadian synchronization. The classical transition to light diets and absolute sensory withdrawal perfectly mirrors the modern clinical requirement to down-regulate sympathetic nervous system arousal prior to DLMO. The traditional Ayurvedic use of the *Deepa* (oil/ghee lamp) exemplifies highly scientific illuminance control. The gentle, warm, ultra-low Kelvin (approx. 1800K–2000K), non-flickering light emitted by a *Deepa* almost entirely lacks the blue-wavelength trigger responsible for melanopsin activation and melatonin suppression. This allows *Tamo Guna* to rise naturally without biophysical resistance[21]. Modern sleep hygiene research confirms that reducing ambient illumination to dim, warm conditions significantly improve sleep latency, duration, and architecture[22].

Modern chronobiology has advanced beyond the SCN, confirming the existence of peripheral circadian clocks located in the liver, gut microbiome, and adipose tissue. These peripheral clocks are primarily entrained by food intake rather than light[23]. By enforcing early, easily digestible meals, the *Ratricharya* regimen prevents desynchronization between the central clock (governed by light) and peripheral metabolic clocks (governed by digestion). Epidemiological evidence heavily indicates that late-night eating correlates directly with circadian misalignment, impaired glucose tolerance, and functional dyspepsia[24]. Thus, the classical prohibition of heavy night meals is validated as a crucial mechanism for maintaining systemic metabolic homeostasis.

To explicitly counteract the light-induced autonomic arousal and *Prana Vata* vitiation caused by ALAN and

TLM, *Ratricharya* employs localized transdermal therapies, most notably *Padabhyanga*. Modern neuroimaging and clinical trials demonstrate that cutaneous stimulation of the lower extremities significantly increases parasympathetic vagal tone[25]. By drawing physiological energy away from the overstimulated visual cortex (*Urdhwajatrugata*) and grounding it downward, *Padabhyanga*[26] *and Tratak* (yogic gazing)[27]. may improves Pittsburgh Sleep Quality Index (PSQI) scores, effectively reversing the neurological distress associated with artificial daylight simulation

Integrating these ancient concepts into modern clinical settings presents profound translational potential. For populations highly vulnerable to circadian disruption-such as shift workers, IT professionals, and students prescribing a modified *Ratricharya* protocol acts as a potent, non-pharmacological intervention.

This requires a paradigm shift in environmental design. There is a critical need for technological advancements in architectural lighting to develop "Ayurvedic-compliant" indoor luminaires. These systems must be designed to emit ultra-low TLM (flicker-free) and automatically shift to low color temperatures and reduced lux levels post-sunset, mimicking the biophysics of the traditional *Deepa* (Traditional lamp).

The primary limitation of this review is its conceptual nature, relying on the theoretical synthesis of cross-disciplinary literature. While the mechanistic overlaps are striking, empirical validation within specific lighting environments is required. Future clinical trials must utilize validated diagnostic scales (e.g., PSQI, CVSS17) to objectively measure the clinical efficacy of Ayurvedic interventions, such as *Padabhyanga* and *Netra Prakshalana*, specifically in populations chronically exposed to high-TLM and high-lux environments. Furthermore, interventions must eventually be tailored to individual *Prakriti* (psychosomatic constitution) for optimal precision practice.

CONCLUSION

The biophysical properties of modern solid-state indoor lighting—specifically high illuminance, blue-enriched spectral composition, and temporal light modulation—act as sustained *Tejas* and *Chala Guna*. This chronic exposure directly vitiates *Prana Vata* and causes *Alochaka Pitta Dushti*, systematically violating the fundamental biological requirements for *Tamo Guna* and *Indriya Vishrama*. By forcing human physiology into a continuous, unrelenting state of artificial daylight, contemporary indoor lighting acts as a profound pathogenic factor, driving severe circadian disruption, autonomic arousal, and digital eye strain.

Integrating the preventive principles of *Ratricharya* is an evidence-based biological necessity. Transitioning to low-lux, flicker-free ambient lighting, enforcing early metabolic synchronization through meal timing, and utilizing *Padabhyanga* for neurological pacification demonstrate significant therapeutic potential. These classical principles warrant formal, urgent integration into modern integrative clinical practices, occupational health guidelines, and public health policies to preserve the health of the healthy in an increasingly illuminated world.

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