www.ijarp.com ISSN 2456-9992 Page: 01-08

International Journal Advanced Research Publications

Research Article

Volume: 01
Issue: 03

THE CIRCADIAN AND ULTRADIAN RHYTHMS IN HUMAN PHYSIOLOGY: AN INTEGRATIVE ANALYSIS OF AYURVEDIC PRINCIPLES AND CONTEMPORARY CHRONOBIOLOGY

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Article Received: 2November 2025, Article Revised: 22 November 2025, Published on: 12 December 2025

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DOI: https://doi-doi.org/101555/ijrpa.2756

ABSTRACT

Background: Biological rhythms, governed by endogenous circadian (~24-hour) and ultradian (<24-hour) clocks, are fundamental to homeostasis in living systems. Contemporary chronobiology has meticulously mapped these oscillations to molecular transcriptional-translational feedback loops. Parallelly, Ayurveda, the ancient Indian system of medicine, presents a sophisticated framework of diurnal and seasonal cycles governed by the rhythmic dominance of the three *Doshas* (*Vata*, *Pitta*, *Kapha*) and the state of *Agni* (digestive/metabolic fire). **Objective:** To systematically correlate the Ayurvedic theory of *Dinacharya* (daily regimen) and *Ritucharya* (seasonal regimen) with established principles of modern chronobiology, exploring convergences in timing, physiological underpinnings, and therapeutic implications. **Methods:** A narrative and comparative review was conducted. Literature from PubMed, Scopus, and AYUSH research portals was searched using keywords: "circadian rhythm," "chronobiology," "chronotherapy," "Ayurveda," "*Dinacharya*," "*Ritucharya*," "*Dosha*," "*Kala*." Classical Ayurvedic texts (*Charaka Samhita*, *Ashtanga Hridaya*) were consulted for source concepts. Data were synthesized to map temporal cycles described in both systems onto common physiological parameters. **Results:** A profound correlation exists between the Ayurvedic *Dosha* cycles and circadian physiology. The *Kapha* period (6:00 AM-10:00 AM & PM) aligns with rising cortisol and parasympathetic dominance; the *Pitta* period (10:00 AM-2:00 PM & PM) correlates with

peak core body temperature, metabolic rate, and digestive enzyme secretion; the *Vata* period (2:00 PM-6:00 PM & AM) associates with increased cognitive alertness and sympathetic activity. *Ritucharya* recommendations for diet and lifestyle show alignment with seasonal variations in photoperiod, hormone secretion (e.g., melatonin), and immune function. The Ayurvedic emphasis on meal timing, sleep-wake cycles, and activity synchronizes with chronobiological principles of entrainment by *Zeitgebers* (light, food). **Conclusion:** Ayurvedic chronobiology provides a holistic, pre-scientific model that remarkably anticipates modern chronobiological findings. The *Dosha* theory offers a unique functional lens for understanding time-dependent physiological states. Integrating these paradigms can inform personalized chronotherapeutic and lifestyle interventions, promoting *Swasthavritta* (preventive health) through optimal alignment of daily and seasonal routines with endogenous biological rhythms.

KEYWORDS: Chronobiology; Ayurveda; *Dinacharya*; *Ritucharya*; *Dosha*; *Kala*; Chronotherapy; Integrative Medicine.

1. INTRODUCTION

The axiom that life is rhythmic is a cornerstone of both modern physiology and ancient medical systems. Contemporary science has uncovered an intricate hierarchy of biological clocks, from the suprachiasmatic nucleus (SCN) in the hypothalamus to peripheral oscillators in every organ, driving circadian (~24-hour), ultradian (<24 hour), and infradian (>24 hour, e.g., monthly, seasonal) rhythms [1]. These rhythms regulate a vast array of functions, including sleep-wake cycles, hormone secretion, metabolism, cellular repair, and cognitive performance [2]. Disruption of these rhythms, as seen in shift work or social jet lag, is a significant risk factor for metabolic syndrome, cardiovascular disease, mood disorders, and cancer [3].

Independently, over two millennia ago, Ayurveda established a sophisticated science of time (*Kala Vijnana*). It posits that the universe and the human body are microcosms of each other, governed by the same cyclical laws [4]. Central to this is the concept of *Dosha* cycles—the predictable daily (*Dinacharya*) and seasonal (*Ritucharya*) fluctuation in the functional principles of *Vata* (kinetic), *Pitta* (transformative), and *Kapha* (cohesive/stability) [5]. Health (*Swasthya*) is defined not just as balance, but as balance in *time*—aligning one's activities, diet, and sleep with these inherent rhythms. Disease is viewed, in part, as a consequence of *Pratiloma Kala* (acting against time) [6].

While chronobiology elucidates the "how" with molecular precision, Ayurveda provides a functional, experiential, and holistic "why" and "when." This article aims to conduct a systematic correlation, exploring the striking parallels between the two systems. It will analyze the temporal mapping of *Dosha* cycles to circadian physiology, examine the scientific rationale behind *Dinacharya* and *Ritucharya* practices, and discuss the potential for an integrative chronotherapeutic approach to health and disease.

2. Methods

This article employs a narrative and integrative review methodology to synthesize knowledge from two distinct domains. The process involved:

1. **Literature Search:** A systematic search was performed in electronic databases (PubMed, Scopus, Web of Science, Google Scholar, AYUSH Research Portal) for English-language articles published up to October 2023. Search terms included: ("circadian rhythm" OR "chronobiology" OR "biological clock" OR "chronotherapy") AND ("Ayurveda" OR "Ayurvedic" OR "*Dinacharya*" OR "*Ritucharya*" OR "*Dosha*" OR "*Kala*"). Secondary searches were conducted based on references from retrieved articles.
2. **Source Analysis:** Primary classical Ayurvedic texts, namely *Charaka Samhita* and *Ashtanga Hridaya*, were consulted in translation for authoritative descriptions of *Dinacharya*, *Ritucharya*, and *Dosha* theory [7, 8]. Contemporary textbooks and review articles on chronobiology served as the foundation for the scientific perspective.
3. **Data Synthesis and Correlation:** Information from both streams was extracted and tabulated. Key temporal phases (*Kapha*, *Pitta*, *Vata* periods of day and night) were mapped against established circadian peaks and troughs of relevant hormones, physiological parameters, and organ functions. *Ritucharya* recommendations were analyzed in the context of seasonal photoperiod variations and their known effects on human biology.
4. **Interpretive Framework:** Convergences and divergences were identified. Explanatory models were developed to interpret Ayurvedic concepts through a chronobiological lens, focusing on functional outcomes rather than direct ontological equivalence.

3. RESULTS

3.1. The Circadian *Dosha* Cycle: A Triphasic Model of Daily Physiology

Ayurveda divides the 24-hour day into six quadrants, each dominated by a combination of two *Doshas*. A primary correlation with modern parameters is presented in Table 1.

Table 1: Correlation of Ayurvedic Daily (*Dinacharya*) *Dosha* Cycles with Contemporary Chronobiology.

Time of Day	Ayurvedic Phase	Dominant *Dosha*	Correlated Contemporary Physiology	Key Chronobiological Markers
6:00 AM - 10:00 AM	Morning	**Kapha**	Transition from sleep to wakefulness; rising cortisol (CAR); increased mucus secretion; parasympathetic to sympathetic shift.	Cortisol Awakening Response (CAR) peak; lowest core body temperature; melatonin secretion ceases.
10:00 AM - 2:00 PM	Midday	**Pitta**	Peak metabolic activity, alertness, and digestive capacity. Optimal time for main meal (*Anna-kala*).	Peak core body temperature; highest sympathetic tone; maximum secretion of digestive enzymes and gastric acid.
2:00 PM - 6:00 PM	Afternoon	**Vata**	Peak mental coordination, productivity, and physical activity.	Sustained high cortisol; optimal reaction time and cognitive performance.
6:00 PM - 10:00 PM	Evening	**Kapha**	Wind-down phase; preparation for sleep. Metabolism slows.	Beginning of melatonin rise; core body temperature starts to drop; parasympathetic activity increases.
10:00	First part	**Pitta**	Metabolic processing,	Growth hormone surge;

PM - 2:00 AM	of night		detoxification, cellular repair (e.g., liver function).	peak of cellular repair processes; liver detoxification activity.
2:00 AM - 6:00 AM	Late night	**Vata**	Deepest sleep (REM-rich); dream activity; autonomic variability.	Lowest core body temperature; cortisol levels at nadir; highest melatonin secretion; REM sleep dominance.

- *__Kapha Phase (6-10 AM/PM):__ Correlates with the period of the Cortisol Awakening Response (CAR), which promotes gradual energizing [9]. Ayurveda recommends rising during this phase (*Brahma muhurta*, before sunrise) to align with this natural energizing trend, countering *Kapha*'s inherent heaviness with activity.
- *__Pitta Phase (10 AM-2 PM/PM):__ Aligns perfectly with the postprandial zenith of digestive capacity. Gastric acid secretion, pancreatic enzyme output, and liver metabolism are at their circadian peak [10]. Ayurveda's injunction to consume the largest meal at this time (*Pitta kala*) is a direct chronobiological prescription for optimal digestion and nutrient assimilation.
- *__Vata Phase (2-6 PM/AM):__ The afternoon *Vata* period corresponds to the secondary peak in alertness and motor coordination. The late-night *Vata* period (2-6 AM) is dominated by REM sleep, characterized by brain activity, dreaming, and autonomic nervous system fluctuation—all hallmarks of *Vata*'s mobile and neurological nature [11].

3.2. *Ritucharya*: Seasonal Biology and *Dosha* Accumulation

Ayurveda describes a biannual cycle of *Dosha* accumulation (*Sanchaya*), aggravation (*Prakopa*), and pacification (*Prashama*), aligned with six seasons. This maps to seasonal adaptations in photoperiod, thermoregulation, and metabolism.

- **Late Winter/Spring (*Shishira/Vasanta*):** Dominated by *Kapha*, correlating with increased respiratory allergies in spring. *Ritucharya* recommends light, dry, and warm foods and detoxification (*Panchakarma*) to counteract *Kapha* accumulation from winter [8]. This aligns with seasonal variations in immune function and melatonin secretion.
- **Summer (*Grishma*):** Dominated by *Pitta*, due to increased heat. Recommendations include cooling foods, reduced activity during peak heat, and staying hydrated. This

mirrors physiological adaptations to thermoregulation and potential for seasonal exacerbation of inflammatory (*Pitta*-related) conditions.

- **Autumn/Early Winter (*Sharada/Hemanta*):** Dominated by *Vata*, characterized by dry, cold, and windy qualities. *Ritucharya* prescribes warm, unctuous, and nourishing foods, oil massage, and regular routine to ground the mobile *Vata*. This correlates with increased susceptibility to joint pains, dry skin, and anxiety disorders during these seasons, possibly linked to changes in serotonin and melatonin metabolism [12].

3.3. Therapeutic Implications: Chronotherapy and *Kala Chikitsa*

Both systems emphasize "timing" as a critical therapeutic variable.

- **Chronopharmacology:** Modern science shows drug efficacy and toxicity can vary by time of day (e.g., chemotherapy, antihypertensives) [13]. Ayurveda inherently practices this by recommending *Anupana* (vehicle) and administration times based on the *Dosha* involved and the time of day.
- **Lifestyle as Therapy:** *Dinacharya* is essentially a protocol for entraining healthy circadian rhythms. Practices like oil pulling (*Gandusha*), self-massage (*Abhyanga*), and yoga are prescribed at specific times to either stimulate or pacify the dominant *Dosha* of that phase, thereby stabilizing the internal clock [7].

4. DISCUSSION

The correlations presented demonstrate that Ayurvedic chronobiology is not metaphorical but a phenomenologically accurate model of human time-structure. The *Dosha* cycle can be interpreted as a triphasic functional overlay on the continuum of circadian physiology: a **Kapha-phase** (anabolic/preparatory), a **Pitta-phase** (catabolic/metabolic), and a **Vata-phase** (neurological/cleanup/repair).

4.1. Convergences and Insights

1. **The Centrality of Digestion:** Both systems identify midday as the metabolic peak. Modern science locates this in clock-gene expression in the liver and gut [10]. Ayurveda identifies it as *Pitta kala*. This convergence underscores digestion as a primary locus of circadian regulation.
2. **Sleep-Wake Cycle:** The recommendation to sleep during the *Kapha*-dominant evening (before 10 PM) and wake during the late *Vata*/early *Kapha* period leverages the natural dip in core temperature and rise in melatonin. Fighting sleep during the *Kapha* evening creates a misalignment similar to social jet lag.

3. **Seasonal Adaptation:** *Ritucharya* provides a behavioral framework for adapting to seasonal changes in photoperiod and temperature, which are known to affect mood (Seasonal Affective Disorder), immunity, and metabolism [12]. It advocates proactive dietary and lifestyle shifts to maintain homeostasis.

4.2. Potential Mechanisms and Future Research

The link may be mediated through the impact of *Dinacharya* practices on primary *Zeitgebers*:

- **Light:** Waking at *Brahma muhurta* ensures exposure to early morning blue-light, the strongest entrainer for the SCN [1].
- **Food:** Timing the largest meal to *Pitta kala* creates a powerful food-entrainable oscillator (FEO), synchronizing peripheral clocks in the liver and gut [14].
- **Activity & Routine:** Regular timing of sleep, meals, and exercise reinforces temporal order across all organ systems.

Future research should quantitatively test these correlations. Studies could measure circadian phase markers (dim-light melatonin onset, core body temperature rhythm) in individuals strictly adhering to *Dinacharya* versus controls. Molecular studies could explore if *Prakriti* (constitutional typing) correlates with chronotype (morningness-eveningness) or specific clock-gene polymorphisms.

4.3. Limitations

The Ayurvedic model is qualitative and experience-based. *Doshas* are functional principles, not directly measurable molecular entities. This makes direct one-to-one mapping challenging. Furthermore, classical texts describe ideal cycles; individual variations (*Prakriti*), geography, and modern lifestyles necessitate adaptation.

5. CONCLUSION

This integrative analysis reveals that Ayurveda contains a profound and systematic understanding of biological rhythms, expressed through the cyclical language of *Doshas*. The practices of *Dinacharya* and *Ritucharya* constitute a traditional, yet highly scientific, form of chrono-prevention and chrono-therapy. They offer a holistic, accessible framework for aligning human behavior with the intrinsic temporal order of biology. In an era of widespread circadian disruption, the synthesis of Ayurveda's timeless wisdom with contemporary chronobiology holds significant promise for advancing personalized, preventive, and integrative health strategies. By respecting the innate intelligence of our biological clocks—

whether described as *Doshic* cycles or circadian oscillations—we can foster a deeper state of harmony and health.

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