



Research Article

Time as a Regulator of Health: Re-examining Human Biological Rhythms Through Ayurvedic Chronophysiology

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Abstract

Time is a fundamental determinant of physiological regulation, yet its role in maintaining health is often underappreciated in contemporary biomedical practice. Modern chronobiology has established that intrinsic biological rhythms, particularly circadian rhythms, govern essential physiological processes, including sleep–wake cycles, endocrine secretion, metabolism, immune function, and cognitive performance. Disruption of these temporal rhythms is closely associated with the development of metabolic disorders, cardiovascular diseases, immune dysfunction, and other chronic health conditions. Long before the emergence of modern chronobiology, Ayurveda recognized Kala (time) as a dynamic regulatory principle influencing physiological equilibrium, adaptation, and health maintenance. This narrative review explores the concept of biological rhythms through the framework of Ayurvedic chronophysiology by integrating classical Ayurvedic concepts with contemporary scientific evidence. Relevant Ayurvedic principles, including Kala, Dinacharya (daily regimen), Ritucharya (seasonal regimen), and Agni (metabolic and digestive function), are critically examined alongside current knowledge in chronobiology, circadian physiology, and metabolic science. Comparative analysis demonstrates substantial conceptual convergence between Ayurvedic temporal principles and modern circadian biology, particularly regarding the temporal regulation of metabolism, endocrine activity, immune responses, and behavioral adaptation. The findings suggest that Ayurveda provides a comprehensive temporal framework that complements contemporary chronobiological research and offers valuable perspectives for optimizing physiological homeostasis. Integrating Ayurvedic chronophysiological principles with modern biomedical understanding may enhance preventive healthcare, facilitate personalized therapeutic approaches, and contribute to the development of chronomedicine-based strategies for improving long-term health outcomes.

Keywords

Kala, Chronobiology, Chronophysiology, Dinacharya, Agni, Circadian Rhythm, Preventive Health

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1. Introduction

Time is a key but frequently overlooked factor of human physiology. Throughout biological systems, temporal structure governs molecular, cellular, and systemic activities, enabling coordination between internal functions and the external environment. Modern biomedical research has demonstrated that human physiology is intrinsically rhythmic, organized around regular biological cycles—most notably circadian rhythms—that regulate sleep-wake patterns, hormonal secretion, metabolism, immunological function, and cognitive functioning [1-3]. Disruption of these cycles, whether through shift work, irregular sleep, altered meal timing, or persistent exposure to artificial light, has been repeatedly associated with metabolic disorders, cardiovascular disease, neuropsychiatric diseases, and poor general health [4-6]. These findings have resulted in the creation of chronobiology as a significant subject in modern health sciences.

Circadian regulation is based on an endogenous timekeeping mechanism that is coordinated by the suprachiasmatic nucleus and synced by environmental cues like light, food intake, and social behavior [2, 7]. Beyond circadian rhythms, ultradian and infradian rhythms also contribute to physiological stability, highlighting that biological time operates across numerous temporal scales [8]. The notion of chronophysiology—the study of how timing affects physiological function—is increasingly acknowledged as crucial for understanding health and illness, spurring advancements in chronotherapy, chrono diet, and time-tailored clinical interventions [9, 10].

Surprisingly, the identification of time as a regulator of physiological integrity is not unique to modern research. Traditional medicinal systems, particularly Ayurveda, have long viewed time (*Kala*) as a fundamental organizing force of life and health. In Ayurvedic physiology, time is more than just a chronological measure; it is an active determinant of body functions, adaptive ability, and homeostasis. Daily (*Dinacharya*), seasonal (*Ritucharya*), and life-stage-specific temporal frameworks recognize that physiological processes fluctuate over time and must coincide with natural cycles to maintain health [11, 12]. According to this viewpoint, health is maintained through synchronicity between internal functional dynamics and external temporal rhythms, whereas sickness results from a misalignment.

In the Ayurvedic framework of *Kriya Sharir* (physiology), temporal variation is strongly related to the functional dominance of regulatory principles that govern movement, transformation, and structural stability. These cyclical variations are characterized as dynamic processes that change during the day and seasons, influencing digestion, metabolism, cognition, and restorative processes. Although articulated in a separate epistemological language, these insights resonate with contemporary descriptions of rhythmic neuroendocrine activity, metabolic oscillations, and autonomic balance [13, 14]. Despite these conceptual links, Ayurvedic chronophysiological

findings are often underexplored in modern scientific discourse, frequently consigned to descriptive or prescriptive contexts rather than being investigated as theoretical models of biological timing.

The increased prevalence of lifestyle-related illnesses linked to circadian misalignment emphasizes the need for more comprehensive, systems-oriented approaches on biological rhythms. Current biomedical treatments, while mechanistically sound, usually target rhythm disruption at separate levels—genes, hormones, or behaviors without fully accounting for the integrative, whole-person feature of time regulation. Reassessing existing chronophysiological paradigms may provide additional insights into how temporal coherence across physiological systems leads to resilience and health maintenance. Such an integrated investigation does not intend to confuse different medical paradigms, but rather to identify convergences that may expand conceptual knowledge and drive future research approaches.

As a result, the purpose of this essay is to re-examine human biological rhythms through the lens of Ayurvedic chronophysiology, putting traditional conceptions of time in perspective with modern circadian science. By combining insights from modern chronobiology and Ayurvedic physiological thought, the current work aims to articulate time as a health regulator in a scientifically grounded, conceptually integrative, and relevant way to current challenges in preventive and personalized healthcare. This reconsideration may help to a more comprehensive knowledge of temporal biology and emphasizes the need of matching human behavior and physiology with intrinsic biological cycles.

The current study uses a narrative and conceptual integrative review approach. Classical Ayurvedic classics on time management, including *Kala*, *Dinacharya*, *Ritucharyā*, and *Agni*, were compared to peer-reviewed material from chronobiology, physiology, and metabolic research. Rather than undertaking a rigorous quantitative synthesis, the purpose of this review is to discover conceptual convergences and complementary frameworks between Ayurveda and modern biomedical science, with a particular emphasis on temporal control of health and disease. This method enables theoretical integration and interpretative analysis, which is especially useful for investigating interdisciplinary phenomena that transcend many epistemological traditions. Ayurveda recognizes *Kala* as one of the fundamental determinants of physiological change and disease causation (*Charaka Samhita*, *Vimana Sthana* 3/8).

2. Methodology

This study adopts a narrative and conceptual integrative review approach to explore the relationship between Ayurvedic concepts of time and modern chronobiological understanding.

Relevant literature was identified through searches in electronic databases including PubMed, Scopus, and Google Scholar. Keywords used in the search included *chronobiology*, *circadian rhythm*, *Ayurveda*, *Kala*, *Dinacharya*, *Ritucharya*, *metabolic timing*, and *chronophysiology*.

Classical Ayurvedic texts, particularly Charaka Samhita, Sushruta Samhita, and relevant commentaries, were also consulted to interpret traditional concepts related to temporal regulation of physiology.

The inclusion criteria consisted of:

- 1) Peer-reviewed articles related to circadian biology and metabolic timing
- 2) Studies discussing lifestyle rhythms and disease risk
- 3) Classical Ayurvedic descriptions of temporal physiology
- 4) Conceptual or review articles exploring integrative approaches

The purpose of this review was not to perform a quantitative meta-analysis but rather to identify conceptual parallels and theoretical integration between Ayurvedic chronophysiological principles and modern biological rhythm research.

3. Ayurvedic Chronophysiological Concepts

3.1. Concept of Kala (Time) in Ayurvedic Physiology

In Ayurveda, Kala is recognized as a fundamental determinant of physiological order and biological regulation. Unlike a purely linear or mechanical conception of time, Kala is understood as an active, dynamic principle that governs change, maturation, decay, and rhythmic transformation in living systems [11, 12]. Classical Ayurvedic texts describe *Kala* as both *Nimita kāraṇa* (instrumental cause) and *Parinama kāraṇa* (agent of transformation), emphasizing its role in regulating biological change over time (Charaka Samhita, Sutrasthan 1/54-55).

From a physiological perspective, Kala is inseparable from Kriya, the continuous functional activity of the body. Digestion, tissue nourishment (Dhatu poshana), elimination, sleep, mental alertness, and recovery are all described as temporally modulated processes. Health (Swasthya) is maintained when these processes occur in accordance with appropriate temporal patterns, whereas disease (Vyadhi) arises when there is disruption or mistiming of these rhythms. This temporal regulation reflects an early systems-level understanding of biological rhythms that parallels modern chronobiological principles.

Ayurveda further conceptualizes time across multiple scales—daily, seasonal, and life-stage—each exerting distinct influences on physiology. This multilevel temporal framework anticipates contemporary recognition of circadian, infradian, and developmental rhythms in human biology.

3.2. Dinacharya and Diurnal Rhythmicity

Dinacharya, the Ayurvedic daily regimen, represents a structured model of circadian alignment. The day is divided into functional phases characterized by the dominance of regulatory principles responsible for movement, metabolism, and stability. These phases correspond to predictable fluctuations in digestive power (Agni), mental clarity, physical strength, and restorative capacity.

Morning hours are described as optimal for elimination, lightness, and mental clarity; midday for maximal digestive and metabolic efficiency; and evening-night for restoration, assimilation, and sleep. These observations align closely with modern findings demonstrating circadian variation in insulin sensitivity, gastrointestinal motility, hormone secretion, and cognitive performance.

Importantly, Dinacharya is not merely prescriptive but explanatory: it provides a physiological rationale for why activities such as eating, exercise, work, and sleep should occur at specific times. From a chronophysiological standpoint, it reflects an early understanding that timing is as important as the activity itself, a concept now central to chronotherapy and chrono-nutrition.

The importance of daily behavioral regulation (*Dinacharya*) is described in Charaka Samhita Sutrasthana, Chapter 5 (*Dinacharya Adhyaya*), where alignment with natural diurnal cycles is emphasized for maintaining physiological balance.

3.3. Ritucharya and Seasonal Biological Adaptation

Beyond daily rhythms, Ayurveda emphasizes Ritucharya, or seasonal regimen, acknowledging that human physiology adapts continuously to environmental changes such as temperature, daylight duration, and humidity. Seasonal variation influences appetite, metabolic rate, immunity, and psychological state—phenomena increasingly validated by modern research on seasonal gene expression, immune responsiveness, and affective disorders.

Ayurvedic texts describe cyclical patterns of physiological strength and vulnerability across seasons, recommending gradual dietary and behavior transitions to maintain internal stability. This anticipatory model of adaptation contrasts with reactive medical approaches that address pathology only after imbalance manifests.

From a modern perspective, Ritucharya may be viewed as an early ecological model of chronophysiology, recognizing that biological rhythms are not isolated internal clocks but are entrained to broader environmental cycles. Such insights are particularly relevant in the context of climate change, urbanization, and artificial environmental conditions that increasingly disrupt natural seasonal cues.

Seasonal adaptation (*Ritucharya*) is elaborated in Charaka Samhita Sutrasthana, Chapter 6, which describes dietary and

lifestyle adjustments according to seasonal variations to maintain physiological equilibrium.

3.4. Kala, Agni, and Metabolic Timing

A principal component of Ayurvedic chronophysiology is the relationship between Kala and Agni, the functional principle governing digestion, metabolism, and cellular transformation. Agni is described as fluctuating predictably across the day and seasons, influencing nutrient assimilation, tissue formation, and metabolic waste clearance.

Midday is traditionally identified as the period of strongest

digestive capacity, a view that corresponds with contemporary evidence showing peak postprandial glucose tolerance and metabolic efficiency earlier in the day. Conversely, late-night eating is described as physiologically burdensome, a notion supported by modern studies linking nocturnal food intake with metabolic dysregulation, obesity, and insulin resistance.

This temporal understanding of metabolism highlights that dietary quality alone is insufficient for metabolic health; temporal congruence between food intake and biological rhythms is equally critical. Ayurvedic insights thus offer a conceptual framework that complements emerging research in time-restricted feeding and circadian nutrition.

Table 1. Conceptual relationship between Ayurvedic temporal principles and modern biological rhythms.

Ayurvedic Concept	Description	Modern Equivalent
Kala	Temporal regulator of physiological processes	Biological timing system
Dinacharya	Daily behavior rhythm	Circadian rhythm
Ritucharya	Seasonal adaptation	Circannual rhythm
Agni	Metabolic transformation	Metabolic circadian regulation
Prakriti	Individual constitution	Chronotype

The conceptual relationship between key Ayurvedic temporal principles and modern biological rhythm science can be summarized in Table 1.

3.5. Chronophysiological Basis of Health and Disease

Both Ayurveda and modern chronobiology converge on the principle that rhythmic coherence across physiological systems is essential for health. In Ayurveda, disease is often attributed to improper timing—untimely eating, sleeping, exertion, or sensory engagement—which disrupts functional harmony. Similarly, modern medicine increasingly recognizes circadian misalignment as a pathogenic factor underlying metabolic syndrome, cardiovascular disease, immune dysfunction, and neuropsychiatric disorders.

However, Ayurveda extends this concept beyond isolated rhythms to emphasize systemic synchrony, integrating physical, mental, and environmental dimensions. This holistic orientation addresses a key limitation in contemporary biomedical models, which often examine rhythm disruption at molecular or behavior levels without fully accounting for their interconnected effects on the whole organism.

3.6. Integrative Implications for Preventive and Personalized Healthcare

Re-examining biological rhythms through Ayurvedic

chronophysiology offers valuable implications for preventive and personalized medicine. Rather than replacing modern chronobiology, Ayurvedic concepts provide a complementary theoretical lens that emphasizes adaptability, individual variability, and ecological context.

Incorporating temporal principles into lifestyle counselling, dietary planning, and therapeutic scheduling may enhance clinical outcomes, particularly in lifestyle-related and chronic disorders. Furthermore, Ayurvedic chronophysiology may serve as a conceptual bridge for developing integrative research models that explore how traditional temporal frameworks can be empirically evaluated using modern tools such as wearable sensors, biomarker profiling, and systems biology. When viewed together, the evidence from current chronobiology and Ayurvedic physiology reveals that temporal structure is a key determinant of functional coherence in biological systems, rather than an accessory trait. While modern science elucidates the molecular and neurological mechanisms that underpin biological rhythms, Ayurveda provides a systems-level framework for contextualizing these rhythms within everyday life, seasonal adaption, and individual constitution. This synthesis emphasizes timing as a unified regulatory principle that connects mechanistic understanding and holistic health management.

Recognizing individual variability is a key area of convergence between Ayurvedic chronophysiology and current circadian science. Ayurveda provides for temporal tolerance and flexibility through the notion of Prakriti, which recognizes

that constitutional differences influence digestion, sleep habits, activity preference, and stress response throughout time. Similarly, current chronobiology recognizes inter-individual variations in circadian timing, known as chronotypes, which influence metabolic efficiency, cognitive function, and disease risk. Integrating these approaches implies that temporal health advice should not be universally uniform, but rather adapted to individual biological timing, laying the groundwork for fully individualized and preventive healthcare initiatives.

4. Discussion

The present review highlights meaningful conceptual parallels between Ayurvedic chronophysiology and modern chronobiological science. Although the two systems originate from different epistemological frameworks, both emphasize the importance of temporal organization in maintaining physiological balance.

Modern chronobiology has primarily focused on molecular mechanisms underlying biological rhythms, including clock genes, hormonal oscillations, and neural regulation through the suprachiasmatic nucleus. In contrast, Ayurveda conceptualizes temporal regulation at a systems level, integrating environmental influences, behavior patterns, and individual constitutional factors. This broader perspective allows temporal regulation to be understood not only as a biological phenomenon but also as a determinant of lifestyle organization and health behavior.

The Ayurvedic concepts of *Dinacharya* and *Ritucharya* illustrate structured behavioral adaptations aligned with daily and seasonal rhythms. These frameworks closely resemble contemporary findings regarding circadian regulation of metabolism, hormone secretion, immune activity, and sleep cycles. Similarly, the Ayurvedic understanding of *Agni* as a dynamic metabolic regulator corresponds with modern evidence demonstrating diurnal variations in digestive efficiency and glucose metabolism.

Another important convergence lies in the recognition of individual variability. Ayurveda describes constitutional differences through *Prakriti*, while modern chronobiology identifies variations in circadian preference through chronotypes. Both perspectives support the emerging paradigm of personalized medicine, where lifestyle recommendations and therapeutic interventions are adapted to individual biological characteristics.

Despite these similarities, Ayurvedic chronophysiology remains underrepresented in contemporary biomedical discourse. Future research may benefit from empirically evaluating these traditional temporal frameworks using modern tools such as wearable biosensors, metabolic biomarkers, and chronotherapeutic interventions. Such interdisciplinary research could strengthen the scientific understanding of temporal physiology and promote integrative preventive healthcare strategies. Recent studies also highlight the metabolic and physiological

benefits of circadian-aligned nutrition and time-restricted feeding [15-17].

5. Conclusion

Time functions not merely as a passive background for physiological activity but as a fundamental regulator of biological organization and health. Modern chronobiology has clarified the molecular and neurophysiological mechanisms underlying biological rhythms, while Ayurveda offers a comprehensive systems-oriented perspective that integrates temporal patterns with lifestyle, environment, and individual constitution.

Re-examining biological rhythms through the lens of Ayurvedic chronophysiology reveals important conceptual convergences that broaden the understanding of health as a dynamic and temporally coordinated state. Integrating insights from these two perspectives may contribute to the development of preventive and personalized healthcare approaches that emphasize alignment between human behavior and intrinsic biological rhythms.

Recognizing the role of *Kala* in regulating physiological harmony underscores the enduring relevance of temporal awareness in sustaining health and preventing disease.

Abbreviations

BMI	Body Mass Index
CNS	Central Nervous System
SCN	Suprachiasmatic Nucleus
CTS	Circadian Timing System

Author Contributions

Prabhanshu Gupta: Conceptualization, Investigation, Writing – original draft.

Prajakta Korde: Methodology, Data curation, Writing – review & editing.

Abhinay Agrawal: Validation, Supervision, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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