

CHRONO-NIDRA: A HEALTH CARE FRAMEWORK FOR NIDRA (RESTFUL SLEEP) THAT IS CHRONOBIOLOGICALLY ALIGNED

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ABSTRACT

Background: Ayurveda places Nidra (sleep) among the Trayopastambha, the three supportive pillars of life. Classical Ayurvedic descriptions connect appropriate sleep with sukha (well-being), pushti (nourishment), bala (strength), jnana (knowledge) and jivita (life), while improper sleep is associated with adverse states. Contemporary sleep science increasingly conceptualizes sleep as multidimensional, including duration, continuity, timing, regularity, architecture and daytime functioning. The proposed Chrono-Nidra framework explores whether the classical emphasis on appropriate timing and regulated daily conduct can be operationalized through modern chronobiology. **Objective:** To develop the Nidra-Circadian Alignment Model (NCAM), a testable conceptual framework linking Ayurvedic Dinacharya/Ratricharya principles with the endogenous circadian timing system, and to propose a

preliminary Nidra Circadian Alignment Index (NCAI). **Methodology:** An integrative conceptual review was undertaken using the supplied presentation as the primary conceptual source for the framework, classical Ayurvedic references concerning Nidra and regulated daily/night routines, and contemporary peer-reviewed literature on sleep regularity, circadian disruption, light exposure, cardiometabolic health and sleep health. The framework maps Ayurvedic constructs to measurable modern variables without assuming equivalence between traditional and biomedical concepts. Key synthesis: Modern evidence indicates that sleep

health is not adequately represented by duration alone. Sleep regularity and timing have independent associations with cardiometabolic and cardiovascular outcomes, while circadian disruption can affect endocrine, metabolic and autonomic physiology. Light is a major environmental synchronizer of the circadian system. These findings provide scientific plausibility for investigating, rather than proving, whether time-structured Ayurvedic routines may support circadian alignment. Proposed model: Chrono-Nidra is operationally defined as sleep with sufficient duration, adequate continuity/architecture, temporal consistency, and alignment with environmental light–dark exposure and individual circadian phase. NCAM proposes a cycle of appropriately timed daytime light exposure, stable wake timing, evening reduction of stimulating light, sleep at a biologically appropriate phase, and nocturnal restoration. **Conclusion:** NCAM is a hypothesis-generating framework rather than a demonstrated clinical intervention. Its principal contribution is to convert the broad Ayurvedic idea of well-regulated Nidra into a measurable, falsifiable research model. Future studies should prospectively test the NCAI using actigraphy, sleep diaries, light exposure measurement, DLMO or other circadian phase markers, and metabolic/autonomic outcomes.

KEYWORDS: Nidra, Chrono-Nidra, Ayurveda, Circadian Rhythm, Dinacharya, Ratricharya.

INTRODUCTION

Sleep is a biological state with restorative, regulatory and integrative functions. Modern sleep medicine traditionally emphasizes adequate duration and quality, but contemporary frameworks increasingly recognize timing and regularity as distinct dimensions of sleep health. The American Heart Association's scientific statement describes multidimensional sleep health as encompassing duration, continuity, timing, regularity, daytime functioning, architecture and absence of sleep disorders. This shift is important because a person may obtain an apparently adequate number of hours while maintaining an unstable or biologically mistimed schedule. Ayurveda approaches Nidra within a broader lifestyle system. The supplied conceptual presentation identifies Nidra as a component of Trayopastambha and frames “Ardha Roga Hari Nidra” as a starting point for reconsidering sleep through circadian alignment. It further proposes three dimensions-quantity, quality and timing/kala and introduces the NCAM, Chrono-Nidra and NCAI concepts. The present paper develops those ideas into a structured academic framework while separating established evidence from hypotheses.

MATERIALS AND METHODS

Classical Ayurvedic Foundation of Nidra

Ayurvedic literature places sleep among the supportive pillars of health. Charaka Samhita Sutra Sthana 21 describes the dependence of happiness/unhappiness, nourishment/emaciation, strength/weakness, knowledge/ignorance and life/death on proper or improper sleep. Ashtanga Hridaya Sutra Sthana 7 similarly discusses the effects of proper and improper Nidra and recognizes natural sleep associated with night as an important physiological pattern. Recent Ayurvedic literature continues to cite these passages in discussions of Trayopastambha and sleep health. For this paper, the classical material is used as a conceptual foundation rather than as direct biomedical evidence. In particular, terms such as Bala, Pushti, Jnana, Jivita, Ratricharya and Dinacharya should not be treated as one-to-one synonyms for modern biomarkers. Their value in NCAM is as traditional constructs that may generate measurable research questions.

The Problem: Sleep Duration Alone Is Insufficient

Current sleep-health science recognizes that duration is only one component of healthy sleep. A recent American Heart Association scientific statement explicitly identifies duration, continuity, timing, regularity, daytime functioning, architecture and absence of sleep disorders as multidimensional components of sleep health. Reviews of sleep regularity further report associations between irregular sleep patterns and obesity, insulin resistance, hypertension, cardiovascular outcomes and mortality.

Therefore, the research question is not simply “How many hours does a person sleep?” but also “When does the person sleep, how stable is that timing, how does it relate to environmental light, and does the schedule remain compatible with the individual's endogenous circadian phase?” This provides the scientific entry point for Chrono-Nidra.

Contemporary Chronobiological Basis

A. Process S and Process C

The two-process model conceptualizes sleep regulation through homeostatic sleep pressure (Process S) and circadian sleep propensity (Process C). Homeostatic pressure rises during wakefulness and is discharged during sleep, while the circadian system generates approximately 24-hour variations in sleep propensity. The NCAM framework uses this established model to explain why sufficient duration may still be insufficient if sleep is

repeatedly shifted against the individual's circadian phase.

B. SCN and Light

Light is a major zeitgeber for the human circadian system. Intrinsically photosensitive retinal ganglion cells containing melanopsin transmit photic information through the retinohypothalamic pathway to the suprachiasmatic nucleus (SCN), the principal central circadian pacemaker. Consensus guidance emphasizes that daytime, evening and nighttime light exposure can influence circadian rhythms, sleep, alertness and neuroendocrine physiology.

C. Melatonin and Circadian Phase

The pineal hormone melatonin provides a useful marker of circadian phase and is suppressed by appropriately timed light. Dim-light melatonin onset (DLMO) is therefore a candidate objective measure for investigating whether an individual's sleep timing is aligned with their endogenous circadian phase. NCAM does not assume that a universal clock time is optimal for every individual; instead, it proposes alignment between behavior, environmental timing and individual phase.

Chrono-Nidra: Proposed Operational Definition

Chrono-Nidra is proposed as: “sleep characterized by sufficient duration, adequate architectural quality and continuity, temporal consistency, and alignment with environmental light–dark cycles and the individual's endogenous circadian phase.” This definition intentionally expands the concept of Nidra from a binary sleep/no-sleep state into a multidimensional health behavior. It also avoids defining alignment solely by an early bedtime. Early sleep may be beneficial for some individuals, but circadian phase, chronotype, social schedule, light exposure and sleep opportunity must be considered.

Nidra-Circadian Alignment Model (NCAM)

The NCAM integrates traditional daily/nightly regulation with contemporary circadian physiology. The conceptual sequence is: Daylight exposure → stable morning wake signal → SCN synchronization → appropriately timed evening reduction of light/stimulation → endogenous melatonin rise → consolidated nocturnal sleep → restoration and next-day function.

Within the Ayurvedic framework, this is mapped to Dinacharya and Ratricharya. The

mapping is interpretive: Ayurveda and molecular chronobiology arise from different explanatory systems, and NCAM does not claim that Doshas or Ayurvedic constructs are molecular clock genes. Rather, it proposes that both systems may describe aspects of temporal organization that can be studied in parallel.

Three Dimensions of Restorative Nidra

Dimension	Ayurvedic framing	Modern operationalization	Research relevance
Quantity (Mātrā)	Adequate and uninterrupted Nidra	Total sleep time; sleep opportunity; sleep efficiency	Prevents insufficient sleep and supports restorative processes
Quality (Guṇa/continuity)	Samyak Nidra; restorative sleep	Awakenings, N3/REM architecture, efficiency, subjective quality	Separates duration from actual restorative sleep
Timing & Kala	Ratricharya; regulated daily routine	Sleep onset/wake timing, SRI, DLMO phase angle, social jetlag	Tests circadian alignment and regularity

Pathophysiology of Circadian Misalignment

Circadian misalignment can occur when behavioral timing, environmental light–dark exposure and endogenous circadian phase become discordant. Human studies and reviews associate circadian disruption with adverse metabolic and cardiovascular outcomes. Mechanistic pathways proposed in the literature include altered glucose regulation, endocrine dysregulation, autonomic imbalance, inflammation and changes in behavioral timing. Sleep irregularity may amplify these effects by repeatedly shifting the relationship between sleep, feeding, activity and the circadian system. The uploaded presentation specifically highlights desynchronization between the SCN and peripheral clocks and identifies liver glucose output and pancreatic insulin secretion as areas of interest. These statements are best treated as mechanistic hypotheses to be tested rather than as proof that one specific Ayurvedic routine produces a particular molecular outcome.

Reinterpreting “Ardha Roga Hari Nidra”

The phrase “Ardha Roga Hari” is powerful as a preventive-health concept, but it should not be converted into a literal quantitative biomedical claim that exactly 50% of all diseases are prevented by sleep. The safer scientific interpretation is that the classical statement emphasizes the broad systemic importance of appropriate Nidra. NCAM therefore treats “50%” as a traditional rhetorical/holistic proposition and not as a validated epidemiological

percentage. Under this interpretation, the possible preventive pathways include cardiovascular autonomic recovery, glucose and appetite regulation, immune regulation, neurocognitive restoration and improved behavioral regularity. Modern evidence supports important associations between healthy sleep dimensions and these outcomes, but it does not establish that circadian alignment alone prevents a fixed proportion of disease.

Nidra Circadian Alignment Index (NCAI)

The NCAI is proposed as a multidimensional research tool rather than a validated clinical score. The supplied presentation identifies domains of timing, regularity, light profile and biomarkers. For a future empirical version, the score should be normalized to 0–100 after validation, with domain weights determined empirically rather than assumed *a priori*.

Domain	Ayurvedic indicator	Candidate metric	Potential biological correlate	Status
Timing (Kala)	Ratricharya adherence	Sleep onset/wake time; DLMO phase angle	Circadian phase/HPA	Proposed
Regularity (Niyama)	Consistent daily routine	Sleep Regularity Index; SD of onset/wake time	Peripheral clock stability	Supported construct; tool needs validation
Light profile	Prātaḥ Sūrya Sevana / night darkness	Wearable lux/light spectrum; evening light exposure	SCN and melatonin signaling	Proposed
Sleep quality	Samyak Nidra	Actigraphy/PSG, efficiency, awakenings, subjective scales	Restoration and daytime function	Established measures
Health outcomes	Bala/Pushti/Jivita as conceptual domains	HbA1c, lipids, BP dipping, HRV, inflammatory markers	Cardiometabolic/autonomic health	Outcome domain

RESULTS & DISCUSSION; Proposed Research Methodology

1.1 Study Design

A prospective, randomized or pragmatic controlled study can test whether a structured Ayurvedic temporal routine improves circadian alignment and sleep health. A feasibility phase should precede a definitive trial.

1.2 Participants

Adults with relatively stable health may be recruited initially to establish feasibility. Exclusion criteria should include untreated major sleep disorders, unstable serious illness, medications or conditions that substantially alter circadian phase, and other factors that would confound the primary endpoints. Screening should include sleep-disorder assessment where appropriate.

1.3 Intervention

A standardized Chrono-Nidra protocol could include: consistent wake time; morning outdoor light exposure; regular daytime activity; consistent meal timing; reduction of bright/blue-enriched light during the biological evening; a stable pre-sleep routine; and a protected nocturnal sleep opportunity. The protocol should be adapted for season, occupation, chronotype and clinical context rather than prescribing a single universal clock time.

1.4 Measurements

Baseline and follow-up assessment should include actigraphy, sleep diaries, sleep regularity metrics, subjective sleep quality, daytime functioning and light exposure. DLMO using salivary melatonin can provide an objective circadian-phase marker in a research setting. Additional outcomes may include blood pressure, heart-rate variability, fasting glucose/HbA1c, lipid profile and selected inflammatory markers. Multi-omics or clock-gene expression should be considered exploratory rather than mandatory.

1.5 Primary and Secondary Outcomes

A primary outcome could be change in a validated sleep-regularity or circadian-alignment measure. Secondary outcomes could include sleep efficiency, DLMO phase angle, daytime alertness, HRV, blood pressure pattern, glycemic markers and inflammatory biomarkers. The study should prespecify whether the aim is efficacy, feasibility, mechanistic validation or tool development.

2. Proposed Experimental Validation Roadmap

Phase 1 – Baseline: Actigraphy, sleep diaries, light exposure assessment, DLMO sampling and calculation of baseline sleep regularity/alignment metrics.

Phase 2 – Intervention: Implementation of a standardized Dinacharya/Ratricharya-informed temporal routine with individualized timing.

Phase 3 – Biomarkers: Assessment of HbA1c, fasting glucose, lipids, HRV, blood pressure pattern and selected inflammatory markers.

Phase 4 – Mechanistic validation: Exploratory analysis of transcriptomic clock-gene expression or other molecular circadian markers in appropriately powered studies.

3. Conceptual Mapping: Ayurveda to Chronobiology

Ayurvedic construct	Possible chronobiological research question	Important caution
Dinacharya	Does regular daily timing stabilize sleep/wake regularity and phase relationships?	Do not assume equivalence with circadian genes.
Ratricharya	Does a protected nocturnal routine improve sleep timing and continuity?	Clock time should not be treated as universally optimal.
Prātaḥ Sūrya Sevana	Does morning outdoor light advance/stabilize circadian phase where appropriate?	Dose and timing of light must be measured.
Samyak Nidra	Do adequate duration and continuity predict better daytime and cardiometabolic outcomes?	Use validated sleep measures.
Niyama / regulated routine	Does behavioral consistency reduce social jetlag and SRI variability?	Association is not proof of causation.
Bala/Pushti/Jivita	Can traditional health outcomes be represented by validated functional/biomedical endpoints?	Avoid forced one-to-one translations.

4. Scientific Strengths of the NCAM Framework

- Moves beyond sleep duration toward multidimensional sleep health.
- Provides measurable constructs: timing, regularity, light exposure and circadian phase.
- Can be evaluated with non-invasive or minimally invasive tools such as actigraphy and salivary melatonin.
- Creates a bridge between traditional lifestyle recommendations and contemporary preventive chronobiology.
- Supports personalized approaches by considering individual circadian phase rather than imposing a single universal bedtime.
- Generates falsifiable hypotheses suitable for observational, intervention and mechanistic research.

5. Limitations and Safeguards

- NCAM is currently a conceptual model and has not been clinically validated.
- The phrase “Ardha Roga Hari” should not be presented as evidence that sleep literally prevents 50% of diseases.

- Classical Ayurvedic constructs and molecular chronobiological constructs should not be presented as scientifically identical.
- Most current evidence linking sleep regularity/circadian disruption with disease is observational or mechanistic; causality and intervention effects require further testing.
- NCAI weights and cut-offs require derivation and validation in independent cohorts.
- Individual chronotype, latitude, season, occupation, social schedule, age and comorbidities can modify circadian timing.
- The framework is not a substitute for diagnosis or treatment of insomnia, sleep apnea, circadian rhythm sleep-wake disorders or other medical conditions.

6. Future Research Directions

- Validate NCAI against DLMO and actigraphic sleep regularity.
- Study seasonal and geographical variation in light exposure and sleep timing.
- Compare fixed-clock recommendations with phase-based individualized recommendations.
- Examine relationships between Chrono-Nidra and glucose regulation, blood pressure dipping, HRV and inflammatory biomarkers.
- Investigate whether improvements in sleep regularity mediate cardiometabolic benefits of structured Ayurvedic routines.
- Develop a digital Chrono-Nidra dashboard integrating wearable sleep, light and behavioral timing data.
- Conduct randomized controlled trials before making clinical or public-health claims.

CONCLUSION

Chrono-Nidra offers a research-oriented interpretation of Nidra in which restorative sleep is not defined only by hours slept, but by the interaction of quantity, continuity, regularity, timing and circadian phase. The NCAM framework uses Ayurvedic Dinacharya/Ratricharya as a source of temporal-health hypotheses and contemporary chronobiology as the measurement and mechanistic framework. The resulting model is potentially useful for preventive health because it is testable, quantifiable and compatible with personalized timing. Its scientific value will ultimately depend on prospective validation, objective circadian measurements and reproducible clinical outcomes.

Suggested Figure for the Paper

Daylight / morning light → retinal melanopsin signaling → SCN synchronization → stable

wake timing → daytime activity and meal regularity → evening light reduction → melatonin rise → appropriately timed sleep → NREM/REM restoration → next-day function → repeated daily entrainment.

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