



REVIEW ARTICLE

Understanding the Biological Rhythm of *Tridosha* Based on Physiology - A Review

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ARTICLE HISTORY

Received: 28 February 2023

Accepted: 01 March 2023

Available online

Version 1.0 : 31 March 2023

Version 2.0 : 07 April 2023

Keywords

Dosha rhythm, biological rhythm of *Tridosha*,
dinacharya, *prakrithy*

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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CITE THIS ARTICLE

Ananda Lakshmy K N. Understanding the Biological Rhythm of *Tridosha* Based on Physiology-A Review. Kerala Journal of Ayurveda. 2023; 2 (1): 35-43.

<https://doi.org/10.55718/kja.141>

Abstract

Biological rhythm of *Tridoshas* has been explained in classical texts. Impact of *dosha* on various stages of life, day and night and on phases of digestion has been explained as biological rhythm. This *dosha* predominance in each phase; when analysed is almost synchronous with the neuroendocrine physiology of the body. When one fails to align oneself with this rhythm; *doshic* equilibrium is lost. This may lead to various illness and decreased life quality. A need to understand and optimize these *doshic* rhythms is a major building block to health as today's life style is always threatening to uproot this balance at all times. The Search engines on the internet and classical Ayurvedic books were studied using keywords for relevant concepts like biological rhythm, circadian rhythm, sleep wake cycle and '*prakrithy*'. Ayurveda daily regimen terms and their English equivalents as provided in bracket were also screened. Ayurveda has identified the effects of circadian cycles on human health and it advocates sticking to this daily regimen schedule for harmonization of *dosha* for its perfect functional acumen. How the predominance of *dosha* is physiologically understood based on hormonal and basic neurology was also screened from journals on physiology. At all levels of preventative domains, incorporating practises into daily life is essential to maintain health. However, to formally validate the same, prospective large-scale, long-term cohort studies are still required.

Introduction

Ayurveda aims at living life in accordance with the laws of nature. Understanding the basic concepts in Ayurveda help to live life with peak physical, emotional and intellectual abilities. Every individual aspires to this; irrespective of age and gender. Peak performance ability differs according to age and sex. But due to metabolic or chronic illnesses like diabetes, obesity, cardiovascular diseases, neurodegenerative conditions like dementia or Alzheimer's disease, one is not able to have the full peak performance in life. In addition; there is always infectious diseases ranging from flu to Covid, that threaten the peak performance of an individual which happens mostly due to deficiencies in immune barriers.

The mortality rates for coronary artery disease (CAD) in Kerala are 382 for men and 128 for women per 100,000, which is really three to six times higher than those for rural Chinese and Japanese. Also, it is higher than in other developed nations. According to statistics, there are 974 female cancer patients and 913 male cancer patients in Kerala per million people. Compared to the national range of 157 to 180mg/dl, people from Kerala had the highest levels of cholesterol in India, ranging from 197 to 229mg/dl.^[1]

So it is high time that Kerala need to look at an ideal longevity plan that also enables one to have efficient performances. Even if there is a disease, it should be identified and a plan should be made to recover faster with full functionality at the earliest. In Ayurveda such a longevity code plan exists and it is actually pre-programmed in our cells .It is called biological rhythm .Understanding these biological rhythm based on neuroendocrine hormonal background can help develop better management strategies by incorporating dietary and lifestyle components of *Dinacharya* (daily regimen practices).^[2]

Physiological functions vary based on how well an individual adapt to the rhythms of the sun and moon. This is explained by Ayurveda using the *Tridosha* cyclic rhythm. *Vata* ,*pitha* and *kapha* exhibit their predominance respectively in the end, middle and beginning of life, day, night and digestion.^[3] The capacity of life to adapt to its surroundings is a crucial characteristic. As a result of the earth's rotation on its axis, environmental changes, such as those in temperature and light, happen every day at any particular point. *Dosha* has evolved a biological clock or internal clock that anticipates day/night cycles and helps to optimise their physiology and behaviour.

The terms *circa* (about) and *dies* (day), which in Latin denote one day, are combined to form the term circadian rhythm. Jeffrey Hall and Michael Rosbash of Brandeis University and Michael Young of Rockefeller University received Nobel prize in 2017 in Physiology and Medicine, for extending work on how time is measured each day in a biological system which also includes one's own body ^[4] According to contemporary physiology, the circadian clock is made up of two components: a central clock located in the suprachiasmatic nucleus (SCN) of the hypothalamus, which receives cues from light, and peripheral clocks located in various body tissues. ^[5] A self-sustaining 24-hour rhythm generator or oscillator, that connects the internal oscillator, makes up the fundamental components of a biological system.

Doshic rhythms are internal timetable of every single element in the body .It is the master program that makes an individual identify and adjust one's daily regime according to the increase or decrease of a *dosha* to a particular phase .Genes or cells are made on or off with this diurnal variation of *dosha* . Alignment has to be made with this natural increase of *dosha* in the body with the activities an individual aiming for optimal health.

Methods

The review searched Pubmed, google scholar databases and relevant Ayurvedic literature for articles that were published between 2000 to 2023 .In addition 4 articles published in 1984,1993,and 1996 were added .Basically Google academic ,Pubmed, Scopus ,web of science were used to review this article. Besides Ayurveda college, Thiruvananthapuram library and departmental library were also reviewed for relevant articles and books. The terms such as *doshic* predominance in health ,biological clock, circadian clock ,circadian rhythm, *agni* and metabolism ,hormones and metabolism, energy expenditure ,thermogenesis, metabolic regulation or clock genes ,meal timings and physical activity, alignment of circadian rhythm, *prakrithy* and circadian genes ,*agni* and circadian rhythm were used as keywords .At the end of scanning, 297 articles were found .Duplicate articles were excluded. Final count of 53 articles which were free and available in full text were taken for this review. Certain book chapters from Modern physiology were also used to examine the topic.

Here an attempt to understand the overview on the molecular and hormonal architecture of the biological rhythm is made.

Review Literature

Circadian Rhythm

Science which study the mechanism of biological clock is called chronobiology.^[6] Biological rhythm is responsible for physiological process such as sleep, cardiovascular health, metabolism and body temperature regulation. Chronopharmacology, chrononutrition and chrono exercise are the novel approaches taken for optimum health and metabolic balances.^[7] All overt rhythms in the body are coordinated by a central pacemaker in the suprachiasmatic nucleus (SCN), which is found in the ventral hypothalamus. In humans, the SCN is made up of two very small clusters of neurones, each of which contains a self-sustaining, cell-autonomous molecular oscillator. Recent studies have

revealed that every cell in the body has its own internal clock, and that these clocks are identical to those found in SCN neurones.

Biological Rhythm

As per Ayurvedic science, a day is split into six time zones each with four hour period duration .Each period is related to a specific *dosha* and it is repeated twice in 24 hour period.

Table No.1

Time	<i>Dosha</i> increase pattern
6 AM TO 10 AM, 6 PM TO 10 PM	KAPHA
10 AM TO 2 PM 10PM TO 2AM	PITHA
2 PM TO 6 PM 2 AM TO 6AM	VATHA

Several hormones are released and their concentration fluctuates during the sleep wake cycle and thus it affects feeding and general behaviour of an individual. The optimum *nidra* state is governed by the *kapha dosha*, and it has been discovered that a decline in the sleep-wake cycle, particularly in otherwise healthy people, can be the primary cause of a number of diseases, including early mortality, obesity, diabetes, depression, cancer progression and fatigue.

Melatonin rhythm

One of the major hormones influencing sleep is melatonin which has robust circadian rhythmicity.^[8] Melatonin help to reset the body's sleep wake cycle .All the *nidra janaka dravya* mentioned in science are aimed at reducing sleep latency thereby increasing sleep timing and improve sleep by balancing out *kapha* and *tamas*.^[9,10]

Melatonin is a molecule synthesized by neuroendocrine organ- pineal gland .Its production is linked to sleep wake cycle ,and it coordinate behavioural and physiological adaptations to the geophysical day and season.^[11] Maternal melatonin, according to recent studies, initiates the foetus behaviour and physiology to adapt to the environment's cycle of light and dark. Both adult and foetal human SCN express melatonin receptors. Maternal melatonin enters the foetal circulation transplacentally, giving the foetus photoperiodic information thus affecting the child's internal rhythms.^[12] Light during the night inhibits the generation of melatonin, an effect mediated by the retinal melanopsinergic system and a well-functioning neuronal system. Moreover, it has been proposed that melatonin acts directly as a proteasome inhibitor to affect

the expression of clock genes. It guards against DNA deterioration because of its antioxidant properties. The melatonin circadian production cycle comprises three distinct phases: the rising evening phase, the night time peak phase, and the dawn falling phase. These phases determine the melatonin's immediate effects.^[13]

When *doshic* pattern is analysed ,*kapha* functions to attribute joint stability, unctuousness, stability of body ,forbearance and strength.^[14]So *doshic* increase at certain times coincide with functional hormonal peaks .Hormonal peaking if checked could be understood that it is for specific functions connected to immunity, healing and repair. Same way, the *dosha* predominance at a specific period is having functional significance and can be synced with daily activities which can bring the *dosha* pattern back in track along with functional utility.

Kapha dosha pattern peaking at 6 am to 10am and 6 pm to 10 pm, thus can be utilized for improving sleep, improving immunity, improved joint strength ,joint stability and mental attributes like forbearance. Slight physiological increase should be diverted to improve the functional utility of *kapha* in the body which is an essential key in relationship and work atmosphere, thereby indirectly helping an individual to attain peak performance. *Kapha dosha* dominance in biological rhythm will improve immune function; accelerate any sort of repair mechanisms, so that recovery is made faster.

Growth hormone

Growth hormone is a major metabolic homeostatic factor that is secreted with a circadian pattern. The level of growth hormone at night peaks and is responsible for carbohydrate, fat and protein metabolism thus aiding in growth. When this sleep cycle is disturbed, in shift workers, it is seen that compensatory and generally unpredictable pulses of GH release are monitored during the light/awake state thus supporting the *nidra nasha* effects explained in Ayurveda.^[15]

Bhutadhatri aspect of *nidra* contributed by *kapha* can be understood from the above said hormonal activities.^[16] The impact of sleep disruption on hormones and metabolism have been widely explored. Lack of sleep results in *vata vridhi* and *rukshata*.^[17] According to research, in real-life model, one night of sleep deprivation appears to alter immunological regulation and cardiovascular autonomic response separately by activating the hypothalamic-pituitary axis, which causes a wide spectrum of bodily dysfunctions.^[18]

Sleep deprivation is always connected with increased screen timings and excessive munching. In several studies, strong evidence of obesity risk and sleep deprivation has been provided. Appetite for high carbohydrate food was increased by 32 % during sleep deprivation. These findings suggested that those who are sleep deprived will eat more calories as a result of increased appetite and lower satiety.^[19] Consistent sleep deprivation may alter the quantity of human food consumption. Benefits of *nidra* as happiness, strength, growth, reproductive health and knowledge are only acquired in proper sleep quality and quantity effectively mediated by *kapha* and *tamas*.

Kapha increase in morning should be dealt with bright light and engaging in physical activities thus aligning to circadian rhythm. Elrod and Hiroshi strongly recommended people to get up early in the morning.^[20] Comprehension on how crucial light is in regulating circadian clocks in bodies will make a person understand this. After waking up, seeing adequate light immediately helps to balance the circadian cycle and allow the *dosha* states to roll normally. Widespread study on chronotype night owl has revealed a connection between disease development and changes in circadian timing, particularly in the case of metabolic and psychiatric problems.^[21] Evidence exist which points to a connection between chronotype and affect, with morning people expressing a larger overall experience of feelings linked to positive activation, such as enthusiasm, joy, and alertness, as opposed to people who favour later times of the day.

Pitha –dominance will ensure to supercharge metabolism and eliminate the mala from our body naturally. *Pitha* dominance in particular times is the key regulator of metabolism.

Circadian rhythm and Hormonal peaks

TSH concentrations reach a maximum in the middle of biological night consistent to *pitha* dominance in night. Shift working has a negative impact on sleep quality and serum TSH level. Night shift workers have increased risk of sleep disorders and also increased risk of subclinical hypothyroidism compared to day shift workers.^[22, 23]

Sleep naturally involves fasting. At the end of the night, when REM sleep occurs, the brain uses more glucose, creating a negative energy balance in the body.^[24] Sleep "resets" the brain's metabolism and energy expenditure rates, allowing for efficient and adaptable control of energy use in response to shifting environmental demands.

The appetite-suppressing pro-opiomelanocortin

(POMC) and amphetamine-related transcript (CART) neurons are inhibited by the appetite-promoting neuropeptide Y (NPY) and agouti-related protein (AGRP) neurons. Leptin is a hormone made by adipose tissues that, regardless of meal consumption, increases satiety by inhibiting NPY/AGRP neurons and activating POMC/CART neurons. Its levels are higher when sleeping than when awake.^[25] The 24-hour leptin profile, which is highly reliant on dietary intake, exhibits rising levels during the day and culminate maximum at nights.^[26] Leptin may help regulate sleep by decreasing REM sleep, according to recent animal studies.^[27]

In accordance with the circadian rhythm, cortisol levels rapidly rise in the middle of the biological night and reach their peak in the morning.^[28] Ghrelin, a hormone that promotes food intake, rises during routine mealtimes and falls afterward.^[29] The 24-hour profile of ghrelin levels reveals a significant nocturnal increase, which at least in part reflects the hormone's rising level after being suppressed by the evening meal. A study has looked at how sleep loss affects the nocturnal ghrelin profile, and it is found that when people are sleep deprived, the nocturnal ghrelin rise is suppressed.^[30]

Circadian Rhythm and Metabolism

The circadian oscillator plays a fundamental role in the regulation of glucose metabolism. In glucose metabolism and homeostasis, there is an exogenous and endogenous mechanisms involved. Exogenous is through digestion and absorption and endogenous is to gluconeogenesis and utilization mechanisms.

The hepatocyte circadian clock also regulates glucose homeostasis showing *pitha* dominance in physiology at *jadaragni, dhatwagni* and even *bhutagni* level.^[31,32] In lipid regulation also one can identify daily rhythms. Circadian clock disruption promotes the accumulation of triglycerides in white adipose tissue possibly giving literal hints to *staulaya nidana* and role of *agni-Jadharagni and dhatwagni* and its de-synchronization.^[33,34] Circadian rhythms in mice regulate the synthesis of bile acids and cholesterol. Forty one circadian genes were shown to fluctuate in a circadian manner in various mouse tissues, with a notable consistency of circadian phases in the different tissues, as a result of an extensive bioinformatics analysis carried out in mice. Nonetheless, liver periodicity demonstrates a certain degree of independence from the primary regulator.^[35]

Pitha by its functional balance is responsible for bidirectional interaction with almost all metabolic processes. Circadian de-synchronization induced by shift

work or chronic jet lag has harmful effects on metabolic regulation, inducing diabetes and obesity. This suggests that *dosha* may be acting as central clock, while *dhatu, dhatwagni, bhutagni* and channels may be functioning as peripheral clocks. Alignment of *dosha* with *dhatu, agni, srothas* are thus absolutely essential for health.

Circadian Rhythm and Retina -The main stimulator for the SCN is light indicating the role of *pitha* in *doshic* rhythm. The suprachiasmatic nuclei are most effectively synchronised by light by retina. Retinal photo pigments, specifically melanopsin expressed in a small population of ganglion cells, as well as rods and cones that project to melanopsinergic cells carry out photo detection.^[36] The timing of sleep-dependent processes, such as nocturnal prolactin and growth hormone releases, is determined by SCN.

With connections to the neuroendocrine and autonomic nervous systems, the central clock system can control the rhythmic release of melatonin and cortisol. Via bodily fluids and brain connections, the peripheral clocks are brought into phase with the central clock. The retina and olfactory bulb exhibit the most powerful self-sustaining oscillations, aside from the suprachiasmatic clock. Understanding this disruption of timely *pitha* dominance which is responsible for several metabolic activities, temperature regulation may increase the success in managing life style disorders.

Vata dosha is responsible for *gati* and *gandhana*.^[37] Clock gene circadian oscillations are observed in several brain regions. Numerous other brain areas, including the cerebellum and the arcuate nuclei of the hypothalamus, exhibit brief rhythmic features when isolated in vitro.^[38] The cell cycle is one of the processes that the circadian rhythm controls. Consequently, the disruption of circadian rhythms is what causes malignant cells to divide abnormally. It was determined that variations in circadian rhythms and the development of tumours in several malignancies, including adenocarcinoma, are related.^[39] In neurodegenerative pathologies, the clock mechanism appears to be disrupted, which leads to the deregulation of neurogenesis. The control of circadian rhythm and neuroplasticity depends heavily on gamma-aminobutyric acid (GABA)ergic neurons that produce the vasoactive intestinal peptide (VIP) in the brain.^[40]

Production of melatonin suffers a dramatic decline with age. These neurochemical alterations may be the root cause of the altered behaviour seen in elderly people and a contributing factor to a number of geriatric disorders,

including as immunosenescence and disrupted sleep/wake cycles, which are associated with aging due to increased *vata* and decreased *kapha*.^[41]

Prakrithy and biological pattern –though a general increase in *dosha* in a day is explained, it should be understood that it has variations according to *prakrithy* also.^[42] Some genes of scientific interests are period and cytochrome genes.^[43] Nobel prize winning researchers found that the genes produce a protein that builds up in cells overnight, then breaks during the day showing evidence that the quality of sleep and circadian variations affect bodily functions in all systems. Given that the timing of sleep-wake cycles is influenced by the interactions of numerous genes, the genetics behind such behaviours is complex. It may be possible to identify genes associated with advanced and delayed sleep phase syndromes, which have a significant effect on when sleep begins.^[44] The circadian transcriptome, which determines physiology and behaviour, is produced by the interaction of clock transcription factors and tissue-specific transcription factors, which overlay a circadian rhythm onto tissue-specific gene expression patterns.^[45] Genes associated to cell cycles were up-regulated in *Vata* types, immunological signalling pathways were up-regulated in *Kapha* types, and metabolic pathways were up-regulated in *Pitha* types.^[46]

Living in sync with circadian rhythm based on *dinacharya* with a practical approach

Dinacharya is daily regimen from waking up to sleep. Though several activities in *dinacharya* without doubt helps to align the *doshic* pattern, it will be best to filter some of them considering its practical aspects. Waking up early and at a consistent time have a lot of benefits as explained in review literature. Evacuation of bowels and engaging in a physical activity preferably outdoors based on *prakrity* and *ardhasakti vyayama* should be done thus aligning the central *dosha* and peripheral *dhatu/agni/channel* clocks.^[47] A bath after a simple massage is also advocated (oil depends on *prakrity* and age) for the sync with biological rhythm. Simple breakfast with wholesome food is to be followed for aligning *kapha* dominance.

Noon time-since *pitha* is at its natural dominance, it is best to have a wholesome lunch aiming for micro and macronutrients. Mindful eating as per *ahara vidhi vishesha ayatana* is needed to sync with *pitha* predominant rhythm.^[48] It is preferable to engage in physical exercise, such as walking or climbing stairs, to improve digestion if the job is sedentary. It would be ideal to explore nutritional education with regular meal frequencies and circadian alignment of

food intake.

When *vata* increases in its natural state between 2pm and 6 pm, it will be good to accommodate activities that doesn't aggravate *vata*. Since *anulomana* of *vata* has to be attained basic physical activities in evenings is a must. The important thing is to make activities align with *vata* so that it can do those functions that fall under the category of "gati gandanam." The central processor important for this biological pattern is the chala guna of *vata*, which is accountable for gati.

Dinacharya to be followed in evening -6 to 10 pm is again *kapha* dominant state. A warm, easily digestible dinner and a consistent sleep time is to be maintained. *Nidra* should be initiated in a *kapha* dominant condition since once the natural *kapha* predominance time has passed, it is typical to experience trouble going asleep. It is best to avoid eating just before bedtime and engaging in bright light activities straight before bed.

Usually the *pitha* dominance in midnight is not felt as it is deep sleep phase which help to reset metabolism. But in disease condition, the person may wake up with acid regurgitation or abdominal cramps. The effective way to manage is to take early non spicy light dinner. The *paka* or transformative /repair of body cells and tissues naturally occur at this state. *Pitha* can actively participate in the body's natural transition of its elements during this time because the agni isn't working for digesting food.

Acharya Charaka has defined the relationship between *Loka* (Nature) and *Purusha* as *Loka-Purusha samyasiddhanta*.^[49] The interaction and exchange between *Loka* and *Purusha* continue in a natural way impact on human body. So harmony with external environment to sync with internal environment is absolutely necessary as one can see in circadian rhythm.

Upavasa can also be included periodically, in addition to daily regimen for resetting circadian rhythm. *Upavasa* which is a type of *langhanam* helps in circadian optimization.^[50] Lab animals when put to circadian rhythm and withheld food, lived longer and maintained the activities with overall brain health.^[51] The findings of multiple studies in mice demonstrated that timing food access is the cue rhythm to entrain hepatic oscillators and, as a result, evoke upregulation of mRNA and diverse protein synthetic pathways, including enzymes involved in carbohydrate and fat metabolism.^[52] This provides an indication of how *upavasa* can be used to reset the circadian cycle.

Discussion

Daily variations of metabolism, physiology and behaviour are controlled by a network of *doshic* biological clocks which acts as master clock and multitude of secondary clocks in the *dhatu*, *agni* level. The *dosha*, transmits temporal cues to other clocks via *srothas*, and is synchronised by light cues. Most *dhatu* and *agni* level clocks can have their phases reset by central *dosha* or have a phase of its own.

Biological rhythm is the internal regulator of the body thus affecting and coordinating physiological and behavioural activities. While the biologic regulation of *doshic* pattern has been underappreciated, this review stress on aligning activities based on these patterns for better life performances with an understanding of Neuroendocrine physiology.

The timing of sleep wake cycles and hormone peaks are altered by an erratic lifestyle that affects the innate *doshic* patterns, which results in a various disorders. Understanding this powerful regulation and adjusting life style based on this pattern beneficially influence activities. In a number of brain diseases, a characteristic circadian rhythmicity is disrupted that result in degeneration or functional defects in the VIP neurons of the SCN as well as by defective sensory inputs that show central *prana vayu* regulating other divisions of *vata*.

Dinacharya is a very effective mechanism for aligning with biological rhythm. Aligning is the body's natural way to keep with the 24 hour body *dosha* increase pattern, helping body to operate on a healthy sleep wake cycle. The *doshic* pattern exhibit itself by establishing a natural sleep wake cycle, the body temperature cycle and hormonal cycle. Variety of factors consisting of lifestyle and biological molecules affect this *doshic* pattern. *Prakrithy* play a role in the individual variations in the biological variations. In addition to studying circadian rhythms in many ways, it is also the role of researchers in Ayurveda to inform the public on how to manage circadian rhythms for health.

Conclusion

In response to the capacity of the digestive system, the temperature of the atmosphere, and various sensory inputs from light and dark conditions, the *doshic* rhythm represents a biological chronometer of the living system that regulates, intertwines, overlaps, and synchronises various physiological, biochemical, cellular, and genetic

events. *Doshic* pattern is timed to the peak with hormones having circadian rhythm markers like melatonin, cortisol, grelin and leptin.

The *doshic* pattern avoids the simultaneous occurrence of conflicting behaviours (such as feeding and sleeping) or conflicting cellular functions by organising a time-based segregation, allowing metabolic, physiological, and behavioural functions to oscillate (i.e., to alternate periods of activity and rest over 24 h) (*agni* and *srothas*) Also, the biological system enables these functions to anticipate or coexist with daily environmental occurrences that may be predicted, such as the daily alternation of light and darkness.

The knowledge on *prakrithy* and biological rhythm concept in physiology holds promises for improving regimens with regard to drug efficacy and tolerability in future. Knowledge will motivate clinicians to take circadian physiology into account when designing the therapeutic regimens.

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