

REVIEW ARTICLE

Circadian Dysregulation and Hormonal Imbalance in Polycystic Ovary Syndrome: *Ayurvedic* Correlation

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ABSTRACT

Background: Modern lifestyle factors such as irregular sleep, artificial light exposure, stress and poor dietary habits disrupt circadian rhythm, leading to metabolic and hormonal imbalance. Polycystic ovary syndrome (PCOS), a common endocrine disorder, is increasingly linked to such circadian misalignment. *Ayurveda* describes similar causative factors through concepts such as *Pragyaparadha* and *Asatmya Indriyarthasamyoga*, resulting in *Dosha* imbalance and impaired physiological processes.

Aim: This study aims to evaluate the impact of circadian misalignment on PCOS through an integrative perspective of modern chronobiology and *Ayurveda*.

Materials and Methods: This study is based on a comprehensive literary review of classical *Ayurvedic* texts, including *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*, along with contemporary scientific literature on circadian rhythm and PCOS. Conceptual analysis and correlation methods were employed to establish an integrative framework.

Results: Circadian disruption affects the hypothalamic–pituitary–ovarian axis, insulin regulation and inflammatory pathways, contributing to PCOS. *Ayurveda* correlates these changes with *Vata–Kapha* imbalance, *Mandagni*, *Ama* formation, and *Artavavaha Srotas* dysfunction. Concepts such as *Kala*, *Dhatu* formation, and *Oja* parallel modern chronobiology, emphasizing the importance of biological rhythms in reproductive health.

Conclusion: Circadian alignment through structured lifestyle (*Dinacharya*), proper nutrition, stress management, herbal support and *Panchakarma* can effectively manage PCOS. Integrating *Ayurvedic* principles with modern chronobiology offers a holistic, preventive, and therapeutic approach for improving reproductive health and overall well-being.

1. INTRODUCTION

The 21st century has witnessed a profound transformation in human lifestyle due to technological advancement and urbanization. Modern living exposes individuals to artificial lighting, extended screen time, irregular sleep–wake patterns, erratic eating habits and psychological stress. These factors disrupt the natural synchrony between internal biological clocks and environmental cues, a phenomenon recognized

as circadian misalignment. Circadian disruption affects hormonal regulation, metabolic processes and reproductive health, contributing to lifestyle disorders.

Ayurveda anticipated the consequences of such behavioral and environmental deviations through concepts such as *Pragyaparadha* and *Asatmya Indriyarthasamyoga*, which disturb *Dosha* and natural physiological processes.

Polycystic ovary syndrome (PCOS) exemplifies the impact of circadian dysregulation on women's health. PCOS is characterized by irregular ovulation, hyperandrogenism, insulin resistance, and

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metabolic disturbances. Chronobiological studies indicate that disruption of sleep–wake cycles, meal timing, and exposure to artificial light alter the hypothalamic–pituitary–ovarian (HPO) axis, insulin secretion, and cortisol levels. *Ayurveda* correlates these changes with *Vata–Kapha* aggravation, impaired *Agni*, and obstruction in *Artavavaha Srotas*, leading to menstrual irregularities, cyst formation, and infertility.

1.2. Aims and Objectives

1.2.1. Aim

To study the impact of circadian misalignment on PCOS through *Ayurvedic* and modern perspectives.

1.2.2. Objectives

- To understand the circadian rhythm in reproductive health
- To correlate PCOS with lifestyle disturbances
- To explain *Ayurvedic* concepts such as *Kala*, *Agni*, and *Artava*
- To evaluate integrative management approaches.

2. MATERIALS AND METHODS

This study is based on a review of classical *Ayurvedic* texts such as *Charaka Samhita*, *Sushruta Samhita*, and *Ashtanga Hridaya*, along with modern research articles on PCOS and circadian rhythm. The methodology includes a literary review, conceptual analysis, and correlation of *Ayurvedic* principles with modern scientific concepts to develop an integrative understanding.

3. DISCUSSION

3.1. Deeper *Ayurvedic* Framework of Time Biology and Its Role in Female Reproductive Health^[1]

Ayurveda views time (*Kala*) as a fundamental determinant of physiological processes, disease manifestation, and therapeutic outcomes. Unlike a purely chronological concept, time in *Ayurveda* is biological, cyclical, and dynamic, governing the rhythmic functioning of the body at multiple levels. This concept closely parallels modern chronobiology, which emphasizes the importance of internal biological clocks in maintaining health.

In the context of female reproductive health, particularly conditions such as PCOS, understanding this *Ayurvedic* framework of time biology is essential.

3.1.1. *Kala Chakra (cycle of time) as a regulator of physiology*^[2]

In *Ayurveda*, *Kala* (time) is not merely a chronological measurement but a fundamental determinant of physiological and pathological processes. Time is cyclical and dynamic, influencing the fluctuations of *Dosha*, the metabolism of *Dhatu* (tissues), and hormonal activity throughout the day. Each *Dosha* exhibits dominance during specific periods, which governs the optimal timing of bodily functions such as digestion, circulation, and excretion. Time is divided into cyclic phases where each *Dosha* predominates at specific intervals, regulating bodily functions:

Kapha Kala (6–10 AM/PM)

- Promotes growth, stability, and tissue nourishment
- Supports follicular development in the reproductive cycle.

Pitta Kala (10–2 AM/PM)

- Governs metabolism, transformation, and hormonal activity
- Corresponds to enzymatic activity and endocrine function.

Vata Kala (2–6 AM/PM)

- Controls movement, neural signaling, and elimination
- Regulates ovulation and menstrual flow through *Apana Vata*

This cyclical dominance reflects the body's intrinsic timing system, similar to circadian hormonal fluctuations.

3.1.1.1. Modern chronobiology identifies similar temporal frameworks

3.1.1.1.1. Circadian rhythms (approximately 24-h cycles)

- Regulates sleep, digestion, and hormone secretion
- Corresponds to *Dinacharya*.

3.1.1.1.2. Reproductive relevance

- Proper sleep regulates melatonin secretion, which significantly influences ovarian function, follicular maturation, and reproductive health^[3]
- Timely intake of food maintains proper *Agni*, ensuring adequate nourishment of *Rasa Dhatu* and proper formation of *Artava*
- Adequate sleep and regulated dietary habits help maintain hormonal secretion, circadian rhythm, and metabolic homeostasis.^[4]

3.1.1.1.3. Ultradian rhythms (shorter cycles of 90–120 min)

- Repeated biological cycles within a day, such as digestion, hormonal pulsations, and circadian rhythmicity, regulate physiological homeostasis^[5]
- These rhythmic physiological activities are reflected in the periodic dominance of *Dosha* and metabolic cycles described in *Ayurveda*.

3.1.1.1.4. Reproductive relevance

- Hormonal pulsatility, particularly of GnRH and LH, plays a crucial role in the regulation of ovulation and female reproductive physiology^[1]
- Energy metabolism and circadian energy cycles significantly influence ovarian function, follicular development, and reproductive health.^[6]

3.1.1.1.5. Infradian rhythms (longer than 24 h)

- Infradian rhythms, which extend beyond 24 h, regulate cyclic reproductive events and physiological periodicity in females and dictate ovarian activity, ovulation, and cyclical endometrial changes during the menstrual cycle.^[7]

This alignment highlights a remarkable convergence between *Ayurvedic* time biology and contemporary circadian science, emphasizing that reproductive health depends on the synchronization of internal rhythms with natural environmental cues.

3.1.2. *Dhatu formation and chronobiology*

In *Ayurveda*, the body is sustained by seven primary tissues (*Dhatu*), which are formed sequentially through the process of *Dhatu Poshana Nyaya*. *Dhatu* formation in *Ayurveda* is a sequential and time-dependent process governed by *Agni* (metabolism), where nutrients are transformed from *Rasa* to subsequent *Dhatu*.^[8] Importantly, *Artava* is an *Upadhatu* of *Rasa Dhatu*, meaning its formation directly depends on the quality of *Rasa* rather than being the final *Dhatu*. This process is closely linked with chronobiology, as proper digestion, metabolism, and tissue nourishment follow natural biological rhythms like the circadian cycle. When lifestyle factors such as irregular sleep, improper diet, and stress disturb these rhythms, *Agni* becomes impaired, leading to *Rasa Dushti*, which in turn affects the proper formation of *Artava*.

This results in menstrual irregularities, anovulation, and conditions such as PCOS. Thus, maintaining alignment with natural rhythms is essential for healthy *Dhatu* formation and optimal female reproductive function.

3.1.3. Oja and immuno-endocrine balance

Oja represents vitality, immunity, and subtle energy that sustains physiological resilience.^[9] Its maintenance requires proper sleep, regulated activity, and alignment with natural rhythms. Circadian misalignment through late-night activity, exposure to artificial light, or stress leads to depletion of *Oja*.

3.1.3.1. Modern correlations include

- Chronic low-grade inflammation
- Oxidative stress
- Hormonal dysregulation (e.g., cortisol, melatonin, reproductive hormones).

Hence, *Ayurveda's* concept of *Oja* closely parallels the modern understanding of immune-endocrine homeostasis, linking reproductive competence to rhythm regulation.

3.2. Advanced Pathophysiology of PCOS: An Integrative View

3.2.1. Neuroendocrine axis disturbance

Ayurveda: *Vata* governs neural communication and hormonal regulation. When aggravated, it disrupts the delicate coordination required for ovulation and menstruation.

Modern science: Circadian misalignment disrupts the HPO axis, altering GnRH pulsatility and leading to anovulation and menstrual irregularity.^[6]

3.2.2. Metabolic-endocrine loop

Ayurveda: Impaired digestion (*Mandagni*) leads to the accumulation of toxins (*Ama*) and derangement of *Meda Dhatu* (fat tissue), creating metabolic imbalance.

Modern science: This manifests as insulin resistance, hyperinsulinemia, and androgen excess, establishing a self-perpetuating cycle of reproductive and metabolic dysfunction.

3.2.3. Inflammatory component

Ayurveda: *Ama* acts as an inflammatory toxin, disrupting bodily channels (*Srotas*).

Modern research: Chronic low-grade inflammation contributes to insulin resistance, hyperandrogenism, and endothelial dysfunction.

Role of spices/herbs: Many *Ayurvedic* herbs and kitchen spices (turmeric, cinnamon, fennel) possess anti-inflammatory and antioxidant properties, bridging traditional wisdom, and modern pharmacology.

3.3. Chrono therapeutics and Ayurveda

Chronotherapy, the timing of interventions according to biological rhythms, finds its parallel in *Ayurveda*:

Treatments and medications are administered based on *Dosha* dominance.

- Meals and herbal therapies are scheduled to align with digestive peak times
- Seasonal detoxification (*Ritucharya*-based *Panchakarma*) restores internal rhythm and prepares the body for optimal reproductive function.

Example:

Digestive tonics are administered during the *Pitta* phase (midday) when metabolism is highest. Sleep-promoting therapies are recommended during the *Kapha* phase (evening) to enhance restorative processes.

3.4. Reproductive Cycle as a Biological Rhythm

The female reproductive cycle is a classic example of a biological (infradian) rhythm, occurring over a monthly period and regulated by coordinated hormonal fluctuations. In modern science, this cycle is controlled by the HPO axis, which governs ovulation, menstruation, and endometrial changes.^[10] *Ayurveda* correlates this rhythmic process with the cyclical dominance of *Dosha* and the proper functioning of *Artava* (*Upadhatu of Rasa*).

Kapha supports follicular growth, *Pitta* regulates hormonal transformation and metabolism, while *Vata* (especially *Apana Vata*) governs ovulation and menstrual flow. Any disruption in daily or circadian rhythms, such as irregular sleep, stress, or improper diet, can disturb this natural cycle, leading to *Artava Dushti* and resulting in menstrual irregularities, anovulation, and disorders like PCOS. Thus, the reproductive cycle reflects the body's dependence on synchronized biological rhythms for maintaining reproductive health.

3.5. Gut–Brain–Ovary Axis

The Gut–Brain–Ovary Axis represents the interconnected relationship between digestive health, neural regulation, and reproductive function. In modern science, the gut microbiota influences hormone metabolism (especially estrogen), insulin sensitivity, and inflammation, while the brain regulates reproductive hormones through the HPO axis. *Ayurveda* parallels this through the central role of *Agni* (digestive fire), which governs not only digestion but also mental clarity and hormonal balance. Disturbance in *Agni* leads to *Ama* formation, which affects both the mind (*Manas*) and reproductive tissue (*Artava*, the *Upadhatu of Rasa*). Stress, poor diet, and circadian disruption impair this axis, resulting in hormonal imbalance, irregular ovulation, and conditions like PCOS. Thus, maintaining gut health, mental balance, and proper daily rhythm is essential for optimal reproductive function.

3.6. Epigenetics and Prakriti

The concept of Epigenetics and *Prakriti* highlights how genetic expression and individual constitution influence health and disease. Modern science explains that epigenetics involves changes in gene expression triggered by lifestyle factors such as diet, stress, sleep, and circadian rhythm, without altering the DNA itself. Similarly, in *Ayurveda*, *Prakriti* (individual constitution) determines a person's physical, physiological and psychological traits, as well as their susceptibility to diseases. When lifestyle factors such as irregular routines, poor diet, and stress disturb natural rhythms, they can activate or suppress certain genes, leading to disorders such as PCOS in predisposed individuals.^[11] *Ayurveda* explains this as an imbalance of *Dosha* according to one's *Prakriti*. Thus, both systems emphasize that while genetic predisposition exists, proper lifestyle and rhythm alignment can prevent disease manifestation and maintain reproductive health.

3.7. Public Health and Societal Relevance

3.7.1. Urban lifestyle and women's health

It refers to how modern habits such as late nights, excessive screen time, irregular meals, stress, and sedentary living disturb circadian rhythm.

This leads to hormonal imbalance, affecting the reproductive system and contributing to conditions like PCOS.^[12] In *Ayurveda*, it causes *Vata–Kapha* imbalance, weak *Agni*, and disturbed *Artava* (*Upadhatu of Rasa*), ultimately impairing menstrual health and fertility.

3.7.2. Adolescents at risk

Early digital exposure, irregular sleep patterns, and unhealthy diets predispose young girls to hormonal disturbances and early onset of reproductive dysfunction.^[13]

3.7.3. Economic and healthcare burden

Economic and healthcare burden refers to the long-term impact of PCOS and circadian disruption on both individuals and society. Women with PCOS often require ongoing medical care for menstrual irregularities, infertility treatments, and management of associated conditions such as obesity, diabetes, and cardiovascular disorders, increasing healthcare costs. In addition, reduced productivity, absenteeism, and psychological stress further add to the economic burden.^[14] From an *Ayurvedic* perspective, these conditions arise due to prolonged *Dosha* imbalance, impaired *Agni*, and disturbed *Artava*, emphasizing the need for preventive lifestyle measures to reduce both disease prevalence and financial strain.

3.8. Expanded Integrative Management

3.8.1. Chrono-lifestyle design

- Fixed sleep–wake cycle aligned with natural light–dark cycles
- Regular physical activity to balance *Vata* and *Kapha Dosha*.

3.8.2. Chrono nutrition

- Daytime calorie consumption during the digestive peak
- Avoid late-night meals
- Seasonal dietary adjustments to balance *Dosha*.

3.8.3. Mind–body synchronization

- Yoga, especially *Surya Namaskara*, to regulate the circadian rhythm
- Meditation and *Pranayama* for stress reduction.

3.8.4. Herbal and dietary support

Herbal and Dietary Support in *Ayurveda* focuses on improving *Agni*, reducing *Ama*, balancing *Kapha–Vata Dosha*, and supporting healthy *Artava* (*Upadhatu of Rasa*) in PCOS. Classical texts emphasize the use of *Deepana–Pachana* herbs and *Pathya Ahara* to correct metabolism and clear *Srotas*. Commonly used herbs and kitchen spices such as *Hariadra* (turmeric), *Twak* (cinnamon), *Methi* (fenugreek), and *Jeeraka* (cumin) help in enhancing digestion, reducing inflammation, and improving insulin sensitivity. Dietary support includes *Laghu*, *Ushna*, and *Kapha*-reducing foods such as barley, green gram, and bitter vegetables, which aid in *Meda* reduction and proper *Dhatu* nourishment. Regular use of such herbs and diet helps restore metabolic and hormonal balance, thereby improving menstrual regularity and reproductive function in PCOS.

3.8.5. Panchakarma and detoxification

Panchakarma and Detoxification in *Ayurveda* aim to eliminate *Ama* (metabolic toxins), restore *Agni*, and balance *Dosha*, which are central in the pathogenesis of PCOS. According to classical texts, accumulation of *Ama* and *Srotorodha* (channel obstruction), especially in *Artavavaha Srotas*, leads to menstrual irregularities and cyst formation. *Panchakarma* therapies such as *Vamana* (therapeutic emesis) help reduce excess *Kapha*, *Virechana* (purgation) corrects *Pitta* and metabolism, and *Basti* (medicated enema) is particularly effective

in balancing *Vata*, especially *Apana Vata*, which governs menstruation and ovulation. These procedures purify the body, improve tissue nourishment, and enhance hormonal balance. When combined with proper diet and lifestyle, *Panchakarma* helps restore physiological rhythm, supports healthy *Artava* formation, and plays a vital role in the management of PCOS.

4. CONCLUSION

Circadian misalignment plays a crucial role in the development and progression of PCOS by disturbing hormonal regulation, metabolic processes, and ovarian function. Irregular sleep patterns, poor diet, and stress disrupt the natural biological rhythm, leading to insulin resistance, hyperandrogenism, and menstrual irregularities. *Ayurveda* explains this condition through the imbalance of *Vata* and *Kapha Dosha*, impaired *Agni* (metabolism), and vitiation of *Artava* (*Upadhatu of Rasa*). These disturbances result in improper nourishment of reproductive tissues and obstruction of *Artavavaha Srotas*, contributing to cyst formation and infertility. An integrative approach that includes proper *Dinacharya* (daily routine), balanced diet, yoga, stress management, herbal support, and *Panchakarma* therapies helps in restoring circadian rhythm and *Dosha* balance. Thus, aligning lifestyle with natural biological cycles not only manages PCOS effectively but also promotes overall health and long-term reproductive well-being.

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10. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

11. DISCLAIMER/VIEW AND OPINIONS

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