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Chronobiology And Circadian Rhythm-Based Daily Regimen In Ayurveda - A Comparative Analysis

Dr. Sadhna Kumar[1], Dr. Siddhi Ratnakar Nachankar[2], Dr. Vaishali Kuchewar[3], Dr. Bhairavi Bhimrao Nimbarte[4], Dr. Rupali Suresh Bhanare[5]

[1]Diet Research Expert, LiveYourBestLife Healthcare & PhD (Scholar), Department of Swasthavritta and Yoga, Mahatma Gandhi Ayurved Medical College, Hospital and Research Centre, DMIHER, Wardha, Maharashtra, India, 442001.

[2]PhD (Scholar), Assistant Professor, Department of Swasthavritta, R.A.Podar Ayurveda Medical College, Mumbai, India, 400088.

[3]Chief Medical Officer, Mahatma Gandhi Ayurved Medical College, Hospital and Research Centre, DMIHER, Wardha, Maharashtra, India, 442001.

[4]Associate Professor, Department of Kayachikitsa, Bhausaheb Mulak Ayurved Mahavidyalaya, Nandanvan, Nagpur, India, 440024.

[5]Assistant Professor, Department of Swasthavritta and Yoga, Bhausaheb Mulak Ayurved Mahavidyalaya, Nandanvan, Nagpur, India, 440024.

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ABSTRACT

Chronobiology has been documented in ancient systems of medicine, including Ayurveda, several millennia ago, albeit in a different language and with different terminology. The ancient texts of Ayurveda highlight the simple living inspired by the rhythms of the natural world, where life and daily activities were designed in sync with the rise of the sun, moon, and the diurnal changes. The core belief Ayurveda is that as much as a person lives in sync with nature's rhythms, that much more health will be maintained. Dinacharya - the daily regimen described in Ayurveda, embodies the principles of chronobiology. The master clock, which is housed in the hypothalamic suprachiasmatic nuclei, regulates the circadian cycle of sleep and wakefulness. In Ayurveda, the fundamental concept of Dosha Kala delineates the dominance of Kapha, Pitta and Vata bioenergies at various times of the day and closely matches the circadian rhythms in hormone release, metabolism, chrononutrition, cognition and a host of other biological processes. Dinacharya practices, including the timing of waking, of meals, of exercise, and sleep, are in harmony with the recent discoveries of chrononutrition and neuroendocrine regulation, clearly indicating that these practices will assist in health promotion, disease prevention, and maintaining a good level of psychophysiological balance. The concept of Aushadha Sevana Kala – the time of administration of the drugs also reflects chronopharmacology, which evidences that action of drugs results from the circadian changes in the absorption and metabolism of drugs. Chronodisruption by not following Dinacharya including late-night eating, sleeping patterns and light exposure, has been associated with chronic conditions like obesity, diabetes and depression. This review presents an integrative exploration of Ayurvedic physiology in relation to modern chronobiology, revisiting the parallels between Ayurvedic ideology and modern science. It encourages further interdisciplinary research to refine and personalise medical practices based on individual rhythms.

Keywords: *Chronobiology, Daily Regimen, Dinacharya, Ayurveda, Circadian rhythm, Dosha Kala*

1. INTRODUCTION

Chronobiology is the scientific study of biological rhythms which illustrates the profound influence of the circadian clock on physiological processes, including human metabolism, immune regulation, cognitive function, and hormonal secretion. Governed by the suprachiasmatic nucleus (SCN) in the hypothalamus, the circadian rhythm orchestrates systemic homeostasis through synchronized peripheral clocks, ensuring optimal physiological functioning.(1) Ayurveda has long recognized the impact of diurnal; variations on health and disease. One of the fundamental theories of Ayurveda is the Tridosha theory – the Dosha are the bioenergies – the physiological entities or bio-energetic principles that govern all physiological processes of the body and mind. Each has its own function and areas that it dominates in.(2) The Doshas form

the basis of Ayurvedic medicine, therapies, lifestyle prescriptions and diet counselling. The doctrine of Dosha Kala, which explains the diurnal pattern of how Kapha, Pitta, and Vata (the three Doshas) change within the 24-hour cycle, each governing specific biological processes syncing with natural biorhythms.(3)

When in equilibrium, the doshas support health, growth and vitality; when they are out of balance, they disrupt body tissues (dhatus), making a person more susceptible to disease (Vyadhi). The balanced state of doshas is a core determinant of health, as emphasized in classical Ayurvedic texts as Samadosha – balanced Dosha. Analogous to macrocosmic forces, Kapha, Pitta, and Vata correspond to the stabilizing influence of the Moon (Soma), the transformative energy of the Sun (Surya), and the dynamic movement of Air (Anila), respectively—reflecting their essential role in maintaining homeostasis within the microcosm of the body.(4)

The Ayurvedic treatises emphasize the significance of Dinacharya (daily regimen) as a pivotal determinant of health and well-being. The prescribed practices, including waking during Brahma Muhurta (predawn), structured dietary intake based on Dosha-mediated metabolic activity, and adherence to natural sleep-wake cycles, are in concordance with contemporary findings in chrononutrition, neuroendocrine regulation, and metabolic homeostasis. Furthermore, Aushadha Sevana Kala (time-specific administration of therapeutics) in Ayurveda aligns with the principles of chronopharmacology, which elucidates the diurnal variations in drug metabolism, absorption, and efficacy. (5)

This review presents a comparative analysis of Ayurvedic circadian physiology and modern chronobiology, substantiating the correlations between Dosha Kala and circadian hormonal rhythms, metabolic transitions, and neurophysiological states. Chronobiological fundamentals of Dinacharya, its influence on hormonal balance, digestive efficiency, psycho-physiological well-being, and the therapeutic significance of aligning pharmacological and dietary interventions with natural biorhythms are discussed. Drawing these parallels not only helps future research in this space but encourages formulating measures to increase the adoption of Dinacharya and other aspects of daily and seasonal regimen in the public health arena. Lifestyle medicine gaining more traction in recent years indicates the growing movement towards preventive methods, epigenetics, lifestyle and diet modifications to improve health outcomes by addressing the root causes. The applications of circadian rhythm based lifestyle and from that research into avenues to further its implementation is the need of the hour. This study explores the relevance of time-based health optimization, offering a holistic framework for preventive and therapeutic interventions in lifestyle medicine.

2. MATERIAL AND METHODS

This review adopts a comparative analytical approach, integrating classical Ayurvedic principles with contemporary chronobiological research. It included a comprehensive search of scientific evidence in literature to draw parallels from contemporary research with the conclusions of classical sources.

Search Strategy

A structured literature search was carried out in order to explore relevant literature from both Ayurvedic classical texts and modern scientific evidence on Dinacharya and circadian rhythm. The Ayurvedic literature of historical context was analyzed with relevant sections being extracted from the primary Ayurvedic classical scriptures. Important Sanskrit keywords Dosha Kala, Dinacharya, Aushadha Sevana Kala were used to identify relevant verses. In order to gain an understanding of these practices, secondary Ayurvedic literature and commentaries called Tika were also explored. The search was conducted using keywords including Daily regimen, Dinacharya, Aushadha Sevana Kala, Circadian, Rhythm, Chronobiology, Chrononutrition, Dosha Kala, Ayurveda, Circadian biology and Chronopharmacology in online databases. PubMed, EMBASE, MEDLINE, Google Scholar, and Scopus were utilized to source peer-reviewed articles on circadian biology, neuroendocrine rhythms, metabolic cycles, and chronopharmacology. Studies published in English within the last two decades were prioritized, with additional references from earlier landmark studies in circadian science. The studies included randomized controlled trials (RCTs), clinical trials, systematic reviews, narrative reviews, meta-analyses, and relevant case reports. Unpublished results, anecdotal testimonials, opinion pieces, brief communications and promotional pieces were excluded in favor of peer-reviewed evidence. In addition, excluded articles included those which were not available in full text or not written in the English Language.

3. RESULTS

Dosha Kala and Circadian Rhythms

Modern chronobiology has established that biological functions fluctuate predictably within a 24-hour period, controlled by the central circadian clock in the suprachiasmatic nucleus (SCN) and peripheral clocks in different organs. These fluctuations regulate hormone secretion, metabolism, immune responses, and cognitive function.(6)

Ayurveda describes three distinct Dosha phases within a 24-hour period, each governing specific physiological processes.

Time of Day[7]	**Circadian Science Findings**[8]	**Ayurvedic Dosha Kala**	**Physiological Correlations**[9]	**Sleep, Stress, and HPA Axis Associations**[10]
Morning (6–10 AM)	Cortisol levels peak (~9 AM), HPA axis activation highest, cognitive function improves	Kapha Kala (Kapha dominance: stability, lubrication, slow digestion)	Morning cortisol promotes wakefulness, but metabolism remains sluggish, aligning with Kapha's heaviness and steadiness.	Cortisol reaches its highest concentration in the morning (9 AM), stimulating alertness and metabolic activity. Melatonin secretion ceases due to light exposure, reinforcing wakefulness. Chronic stress may lead to dysregulated HPA-axis activity, causing mood imbalances and metabolic issues.
Midday (10 AM–2 PM)	Peak digestion, metabolic efficiency, optimal cognitive function, gradual decline in cortisol levels	Pitta Kala (Pitta dominance: strong digestion, metabolism)	Enzymatic activity and gastric acid secretion peak, supporting Ayurveda's recommendation for making lunch the largest meal of the day.	Cortisol levels start declining from their morning peak, reducing stress-induced hyperactivation. Optimal cognitive function and productivity align with Pitta's governance over transformation and metabolism. Sleepiness is lowest at this time due to high alertness.
Afternoon (2–6 PM)	Cortisol continues declining, gradual onset of melatonin production (~6 PM)	Vata Kala (Vata dominance: creativity, movement)	Increased neurotransmitter activity supports learning and problem-solving, aligning with Vata's qualities of mobility and cognition.	Cortisol decline allows parasympathetic activation, reducing stress responses. Melatonin synthesis begins around sunset (~6 PM), signalling preparation for sleep. Vata's association with cognition matches peak mental creativity.
Evening (6–10 PM)	Melatonin secretion increases (~8 PM), cortisol reaches lowest point, relaxation begins	Pitta Kala (Pitta facilitates metabolic transitions)	Ayurveda recognizes Pitta resurfacing in the evening for digestive processes and energy conversion before sleep.	Melatonin secretion rises sharply, promoting sleepiness. Cortisol levels reach their nadir near midnight. Stress resilience is reduced in the evening, making this an essential time for relaxation and recovery.
Night (10 PM–2 AM)	Deep sleep (slow-wave sleep, SWS), peak growth hormone secretion (~12 AM), lowest metabolic activity	Kapha Kala (Kapha facilitates repair and immune strengthening)	Deep sleep enhances cellular repair, immune function, and detoxification, which Ayurveda attributes to Kapha dominance.	Growth hormone (GH) is secreted at its peak around midnight, supporting cellular repair and tissue regeneration. Melatonin remains high, reinforcing sleep architecture. Sleep deprivation at this time

				disrupts metabolism and increases stress hormone levels.
Pre-dawn (2–6 AM)	Cortisol levels start rising (~4 AM), REM sleep dominates, increased sleep fragmentation	Vata Kala (Vata promotes movement and mental clarity)	Vata's light and mobile nature helps transition from deep sleep to wakefulness, supporting Ayurveda's recommendation of waking up before sunrise (Brahma Muhurta).	Cortisol begins its pre-dawn rise (~4 AM), preparing the body for wakefulness. REM sleep dominates, supporting memory consolidation. Sleep disruption at this phase increases stress sensitivity during the day.

Scientific Research Evidence Supporting Dosha Kala

1. **Morning (Kapha Kala) and Cortisol Peak**

- A study conducted in 2015 (Hirotsu C) tested that Cortisol secretion peaks at 9 AM, reinforcing Ayurveda's association of Kapha with alertness, structure, and metabolic stability.[11]
- An Ayurvedic study by Bharadwaj S (2025) suggested Melatonin suppression due to light exposure enhances wakefulness, validating Ayurveda's recommendation to wake up early to align with natural rhythms.[12]
- Chronic stress leads to overactivation of the HPA axis, contributing to anxiety, metabolic disorders, and mood imbalances.[13]

2. **Midday (Pitta Kala) and Stress Modulation**

- Cortisol declines from its morning peak, improving cognitive focus and productivity.[7]
- As per a study by Lopez-Minguez, in 2019, concluded that metabolic efficiency is highest, making midday the best time for digestion and nutrient absorption.[14]
- Ayurveda prescribes the noon meal at this time to maximize digestive fire (Agni), supporting hormonal stability.[15]

3. **Afternoon (Vata Kala) and Mental Performance**

- Cortisol continues to decline, allowing better stress recovery and parasympathetic activation.[7]
- Melatonin synthesis starts around sunset (6 PM), reinforcing Ayurveda's advice to slow down and reduce stimulation in the evening.[8]
- Mental creativity peaks, aligning with Vata's governance over cognition and nervous system activity, suggests a study conducted in 2019 (Dermot B.)[9]

4. **Evening (Pitta Kala) and Sleep Preparation**

- Melatonin levels begin rising (8 PM), promoting relaxation and sleepiness.[8]
- Cortisol reaches its lowest level near midnight, facilitating sleep depth.[7]
- Ayurveda recommends avoiding overstimulation and heavy meals after sunset to prevent digestive and sleep disturbances.[17]

5. **Night (Kapha Kala) and Growth Hormone Secretion**

- Slow-wave sleep (SWS) and growth hormone secretion peak at midnight, promoting cellular repair, immune function, and muscle regeneration (Van Cauter E, Plat).[18]
- Sleep deprivation at this time disrupts metabolism and increases cortisol, reinforcing Ayurveda's emphasis on early bedtime.

6. **Pre-Dawn (Vata Kala) and Cortisol Awakening Response**

- Cortisol begins to rise (~4 AM), helping the body transition to wakefulness.[7]
- As per Charilaos C (2013), REM sleep dominates, playing a critical role in learning and memory consolidation.[19]

- Ayurveda's recommendation to wake up before sunrise (Brahma Muhurta) aligns with the body's natural hormonal priming for the day.

Dinacharya and Circadian Optimization[20]

For the promotion of health and longevity, classical Ayurvedic texts prescribe adherence to a structured daily routine (Dinacharya). The daily regimen encompasses a series of practices aimed at maintaining the functional integrity of various organs and systems of the body. It emphasizes regularity in waking, eating, occupational engagement, and sleeping habits to uphold internal physiological balance. Moreover, the systematic observance of these practices and ethical guidelines contributes to the preservation of mental and spiritual well-being.

In addition to promoting general health, these procedures offer ancillary benefits such as enhancement of physical appearance, deceleration of aging processes, and support for longevity. When appropriately implemented, the daily regimen serves as a preventive strategy against numerous lifestyle-related disorders and holds potential for significantly reducing the global burden of disease.

Modern science recognizes the importance of consistent daily routines in maintaining circadian stability. While Exploring the Role of Circadian Rhythms in Sleep and Recovery, Desai et al (2024) concluded that the disruptions in sleep-wake cycles, irregular eating patterns, and night-time light exposure have been linked to metabolic disorders, mood disturbances, and neurodegeneration.[21]

Neglecting Dinacharya disrupts immunity, metabolism, and mental equilibrium, increasing susceptibility to chronic diseases. Modern research on circadian rhythms, chrononutrition, and stress physiology supports the time-specific health benefits of Dinacharya.

It nurtures the mind, sensory organs, digestion, Doshas (bodily humors), Dhatus (tissues), and Malas (waste elimination), ensuring overall well-being. Ayurveda emphasizes that disrupting this natural rhythm contributes to modern ailments like hypertension, diabetes, and metabolic disorders.

Key Elements of Dinacharya:[15]

- Brahma Muhurta (Pre-Dawn Waking): Aligns with the cortisol awakening response, enhancing immunity, metabolism, and stress resilience.
- Shoucha Vidhi – Early morning bowel movements and clearing of the bladder in the morning is aided by the active Vata energy which has a natural downward movement.
- Dantadhavana (Oral Hygiene) and Jihva Nirlekhan (Tongue Scraping): Removes toxins (Ama), reduces oral plaque, and improves gut health.
- Nasya (Nasal Therapy): Strengthens respiratory immunity and enhances oxygen intake.
- Kavala (Oil Pulling): Promotes oral and gut microbiome balance, reducing dental plaque and inflammation.
- Abhyanga (Oil Massage): Regulates circadian rhythm, improves sleep quality, and enhances circulation.
- Vyayama (Exercise): Boosts cardiovascular health, cognitive function, and metabolic activity.
- Sadvritta (Moral and Ethical Code): Encourages mental clarity, emotional stability, and a disciplined lifestyle.
- Hita Mita Ahara (mindful eating: eating healthy, in the right quantity): Supports digestive efficiency, metabolic health, and Dosha balance.

Dinacharya Aligned with Circadian Rhythms

1. Early Rising (Brahma Muhurta, 4:30–5:30 AM) and Cortisol Awakening Response.

Studies confirm that cortisol levels naturally rise before dawn, promoting wakefulness.[7]Ayurveda prescribes waking before sunrise, aligning with the cortisol awakening response, which optimizes energy levels.

2. Morning Bowel movement and Frequency:

A study in 2020 on Bowel Movement Frequency (BMF) showed that it is a basic sign of a healthy colon and it may indicate a healthy lifestyle, a well-established routine, nutrition, physical activity as well as personal criteria such as a individual's gut microbiome. Monitoring BMF may assist the early identification and prevention of disease.[22]

3. Meal Timing and Chrononutrition

Research confirms that digestive enzyme activity is highest at midday, validating Ayurveda's prescription to eat the largest meal during Pitta Kala (10 AM–2 PM).[23]Late-night eating disrupts circadian glucose metabolism, increasing the risk of obesity and diabetes.[24]The Charaka Samhita advises light dinners before sunset to prevent metabolic overload.[25]

4. Exercise and Circadian Physiology

Study Conducted in 2022 (Arciero PJ show that morning exercise enhances metabolic function, while evening workouts improve strength.[26]Ayurveda prescribes morning exercise during Kapha Kala (6–10 AM).[27]

5. Sleep and Melatonin Regulation

Modern sleep science confirms that melatonin production begins around 6–7 PM, reaching peak levels by midnight.[8]According to Kaiyadeva Nighantu, the ideal time for sleep is after the first two Yamas (approximately six hours) following sunset. For a healthy individual, sleep typically occurs at the same time each night and lasts for a consistent duration, a phenomenon Ayurveda refers to as Ratrisvabhava Prabhava (the natural influence of night on sleep regulation).[20]Additionally, it is recommended to avoid sleeping during the first and last parts of the night and to wake up before sunrise, aligning with the body's circadian rhythm and the principles of Brahma Muhurta (pre-dawn wakefulness).[28]

Circadian Rhythm Disruptions and Health Consequences

Chronodisruption is the term for disconnecting from circadian rhythms. Numerous medical conditions are associated with it, including as cognitive impairment, mood and sleep issues, metabolic diseases, hormonal imbalance, increased drowsiness during the day, heart conditions, headaches, eating disorders, obesity, poor academic performance, decreased productivity, substance abuse, and even certain types of cancer. Chronodisruption isn't just about

- Shift work and late-night screen exposure suppress melatonin, leading to sleep disturbances, weight gain, and mood disorders.[8]
- A study by Mirghani H (2021) suggests skipping breakfast and eating late at night disrupt insulin sensitivity, increasing the risk of diabetes and cardiovascular diseases.[29]
- Ayurveda's Dinacharya provides time-based solutions to prevent these disruptions, supporting circadian stability.

Chronopharmacology, Chronotherapeutics and Ayurveda's Aushadha Sevana Kala

Chronopharmacology studies conducted in Jan 2025 (Kaşkal M) show that drug efficacy varies based on administration timing.[30] Ayurvedic chronotherapeutics, which focuses on scheduling treatments to coincide with the body's natural biological rhythms, is an intriguing fusion of traditional knowledge and contemporary science. The Aushadha Sevan Kala principle, which Ayurveda has long acknowledged, states that the efficacy of medicine depends not only on what is given but also on when it is administered. This idea stems from the knowledge that the three Doshas, Pitta, Kapha, and Vata, and the physiological functions of the body change with the seasons, the time of day, and even the phases of digestion. Similar to the contemporary practice of chronotherapy, which synchronizes medication with circadian rhythms to enhance efficacy and reduce side effects, Ayurveda seeks to restore balance and maximize therapeutic outcomes by customizing treatments to these rhythms. This Aushadha Sevana Kala (time-based medication intake) which is also called Bheshaja Kala, aligns with modern findings.

- Chourpiliadis C (2023), in their study, suggested that glucocorticoids are most effective in the morning (when cortisol is naturally high).[31]
- A study conducted in 2017 (Awad K) concludes that Statins work best at night (when cholesterol synthesis peaks).[32]

For effective metabolism of Aushadha (medicine) and Ahara (food), a well-functioning Agni (digestive fire) is essential. Ayurveda emphasizes timing (Aushadha Sevana Kala) in drug administration to enhance absorption, efficacy, and therapeutic action based on Dosha cycles and circadian rhythms.

Key Drug Administration Timings in Ayurveda:[33]

- Abhakta Kala (Empty Stomach): Enhances potency and absorption, ideal for excretory, reproductive, and metabolic disorders.
- Praagbhakta Kala (Before Meals): Ensures immediate digestion, suitable for quick-acting treatments.
- Madhyabhakta Kala (Mid-Meal): Localized action, best for digestive and metabolic disorders.
- Adhobhakta Kala (After Meals): Targets circulatory and respiratory issues, ensuring systemic distribution.
- Sabhakta Kala (With Food): Enhances digestive strength, used in chronic conditions affecting the whole body.
- Antarabhakta Kala (Between Meals): Optimizes midday metabolism, effective for circulatory and muscular disorders.
- Muhurmuhu Kala (Frequent Dosing): Maintains steady drug levels, ideal for respiratory and chronic diseases.
- Grasa Kala (With Every Morsel): Stimulates digestive and nervous systems, effective for Prana Vayu (a sub type

of the Vata Dosha bioenergy) disorders.

- Nishi Kala (Night-time): Prolonged action, useful for neurological and head-related diseases

Circadian rhythms influence drug metabolism and therapeutic outcomes, validating Ayurveda's time-based treatment approach. Aligning drug administration with Agni cycles (the peaks and falls of digestive activity) and Dosha activity enhances efficacy and personalized healing.

4. DISCUSSION

This study highlights the profound alignment between Ayurvedic chronobiology and modern circadian science, exploring the relevance of Dosha Kala, Dinacharya, and Aushadha Sevana Kala in contemporary health management. In today's era of circadian disruption due to late-night screen exposure, irregular meal timings, and chronic stress, the Ayurvedic emphasis on biological rhythms offers a holistic and time-conscious approach to disease prevention and health optimisation.

The Ayurvedic classification of Kapha, Pitta, and Vata Kaala mirrors modern findings on hormonal fluctuations, metabolic cycles, and neurophysiological states. The cortisol awakening response aligns with Brahma Muhurta (pre-dawn wakefulness), while the Pitta-mediated peak digestive fire (Agni) at midday corresponds with optimal metabolic efficiency. Late-night food consumption and irregular sleep, which Ayurveda discourages, are now linked to metabolic disorders and neuroendocrine imbalance, reinforcing the need for adherence to circadian-aligned lifestyle practices.

Aushadha Sevana Kala (time-specific drug administration) is validated by modern chronopharmacology, which recognises that drug efficacy varies with circadian rhythms. The alignment of glucocorticoid administration with the morning cortisol peak and night-time statin use for cholesterol regulation reflects Ayurveda's time-based approach to medication efficacy and bioavailability.

5. CONCLUSION

This analysis affirms that Ayurveda's circadian principles that is the Dosha Kala, Dinacharya, and Aushadha Sevana Kala and other aspects of chronotherapeutics align with modern circadian science and chronopharmacology. However, the ancient principles of Ayurveda hold even more importance in personal well-being and public health in the current era, due to the growing disconnect from natural rhythms in the modern lifestyles. Respecting natural biorhythms through structured routines and time-specific therapies is vital in maintaining physiological balance, preventing chronic diseases, and promoting well-being.

Future research should validate these interventions through clinical trials, paving the way for a holistic, time-conscious healthcare paradigm that prioritizes preventive medicine and optimal physiological function. Another important direction for future research is the innovation and implementation of daily regimen like Dinacharya or seasonal regimen like Ritucharya using digital health solutions to match the tech-driven healthcare landscape of today.

Declaration of competing interest

No conflicts of interest.

Credit authorship contribution statement

Sadhna Kumar: writing and editing of original draft from conceptualization to data curation; Siddhi Nachankar: writing, review, and editing; Vaishali Kuchewar: writing, review, and editing; Bhairavi Nimbarte: review, editing and proofreading: Rupali Bhanare: review, proofreading and formatting.

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