RESEARCH PAPER

A Mechanistic Integrative Review Exploring Dinacharya As A Behavioral Chronomedicine Framework Influencing Gut–Brain Axis Regulation

Dr. Yogeshwar Pandey [1], Dr. Dharampal Singh Thakur[2]

[1]Associate Professor and Head of Department, Department of Kriya Sharir,
[2]Associate Professor Department of Rachana Sharir Rajiv Lochan Ayurved Medical College, Durg, C.G., India, PIN-491001

Abstract-The gut–brain axis is a complex bidirectional communication network involving neural, endocrine, immune, and microbial pathways. Recent advances in chronobiology and microbiome research have demonstrated that circadian rhythm significantly influences gastrointestinal physiology, microbial oscillation, neuroendocrine regulation, and metabolic homeostasis. Ayurveda describes a time-regulated behavioral framework through *Dinacharya*, which emphasizes synchronization of daily activities with natural biological cycles for maintenance of health and prevention of disease. **Objective:**To critically examine the scientific correlation between Ayurveda chronobiology and the gut–brain axis with special reference to Dinacharya, circadian rhythm, and gut microbiome regulation. **Methods:**A narrative integrative review approach was adopted using evidence from microbiome research, circadian biology, neurogastroenterology, lifestyle medicine, and classical Ayurvedic literature. Relevant concepts related to gut microbial dynamics, neuroendocrine signaling, chrononutrition, stress physiology, and Ayurvedic behavioral regulation were analyzed and interpreted through a translational perspective. **Results:** Available evidence suggests that circadian rhythm plays an important role in regulating gut microbiome composition, intestinal permeability, immune signaling, metabolic activity, and neuro-gastrointestinal function. Behavioral factors including sleep timing, meal regularity, stress regulation, and physical activity significantly influence these pathways. Several principles described under Dinacharya, including early awakening, timely food intake, sleep regulation, and maintenance of digestive balance, demonstrate conceptual and mechanistic overlap with contemporary chronobiology and lifestyle medicine. Ayurvedic concepts such as *Agni*, *Ama*, and *Nidra* may also show functional parallels with digestive metabolism, inflammatory regulation, intestinal homeostasis, and restorative physiology. **Conclusion:** Dinacharya may represent a traditional behavioral chronobiological framework capable of influencing the gut–brain axis through circadian synchronization, microbiome regulation, and neuroendocrine balance. Although direct mechanistic evidence remains limited, integration of Ayurveda chronobiology with contemporary microbiome and circadian science may provide important insights for preventive, lifestyle-based, and integrative healthcare approaches.

Keywords-*Gut–brain axis, Dinacharya, Ayurveda chronobiology, Circadian rhythm, Gut microbiome, Chrononutrition, Agni, Ama, Neuro-gastrointestinal health, Lifestyle medicine, Microbial oscillation, Integrative medicine*
How to cite this article: Pandey Y, Thakur DS. A Mechanistic Integrative Review Exploring Dinacharya As A Behavioral Chronomedicine Framework Influencing Gut–Brain Axis Regulation. Int J Drug Deliv Technol. 2026;16(55s): 1174-1183. DOI: 10.25258/ijddt.16.55s.113

Introduction

The gut–brain axis has emerged as one of the most important research domains in contemporary biomedical science because of its extensive role in regulating gastrointestinal physiology, metabolism, immune responses, and neurobehavioral function.(1,2) Rather than functioning as isolated systems, the gut and brain communicate continuously through neural, endocrine, immune, and metabolic pathways.(1) In recent years, growing attention has been directed toward the role of gut microbiota in this bidirectional communication network, particularly in relation to stress physiology, mood regulation, inflammatory signaling, and metabolic homeostasis.(2,3) Alterations in gut microbial composition and intestinal barrier integrity have been associated with several chronic disorders, including irritable bowel syndrome, obesity, anxiety, depression, metabolic syndrome, and neuroinflammatory diseases.(1,4)

At the same time, chronobiology research has increasingly demonstrated that many physiological processes involved in gut– brain communication are strongly influenced by circadian rhythm.(5,6) Gastrointestinal motility, hormone secretion, immune activity, sleep physiology, and microbial metabolism all exhibit circadian oscillations regulated by central and peripheral biological clocks.(5) Disturbance of these rhythms through irregular sleep, altered meal timing, chronic stress, night-shift work, or circadian misalignment has been shown to affect microbial diversity, intestinal permeability, metabolic regulation, and neuroendocrine balance.(6,7) Emerging evidence further suggests that gut microbial communities themselves follow diurnal rhythmic patterns influenced by feeding behavior and host circadian signaling.(7,8)

The concept of aligning daily behavior with biological rhythms has been described in Ayurveda for centuries through *Dinacharya* (daily regimen).(9,10) Classical Ayurvedic literature emphasizes that maintenance of health depends upon synchronization between bodily

*Author for Correspondence: routfunny5@gmail.com

functions, environmental cycles, dietary behavior, sleep, and mental discipline.(9) Texts such as Charaka Samhita and Ashtanga Hridaya describe time-specific behavioral practices related to waking, food intake, physical activity, bowel evacuation, and sleep regulation as essential components of disease prevention and physiological balance.(9,10) The cyclical predominance of *Vata*, *Pitta*, and *Kapha* during different phases of the day reflects a temporal physiological model that appears conceptually comparable to modern circadian regulation.(11) One of the classical Ayurvedic recommendations states: "A healthy individual should awaken during Brahma Muhurta for the preservation of health and longevity."(10)

From a contemporary scientific perspective, such recommendations may have relevance in relation to circadian entrainment, autonomic regulation, endocrine rhythmicity, and metabolic synchronization.(5,6) Likewise, Ayurvedic concepts including *Agni*, *Ama*, and *Nidra* may offer broader physiological interpretations associated with digestion, inflammatory dysregulation, intestinal homeostasis, and restorative biological rhythms.(11,12)

Although the gut–brain axis, microbiome science, and circadian medicine have expanded rapidly over the past decade, the possible mechanistic relationship between Ayurveda chronobiology and these emerging biomedical frameworks has been insufficiently explored. Existing literature is largely fragmented, with limited attempts to integrate Dinacharya-based behavioral regulation with gut microbial oscillation, neuroendocrine signaling, and circadian physiology in a translational manner.(11,13)

Therefore, the present review aims to critically examine the scientific correlation between Ayurveda chronobiology and the gut–brain axis, with particular emphasis on Dinacharya, circadian rhythm regulation, microbiome dynamics, and neuro- gastrointestinal health. By integrating evidence from these diverse fields, this review seeks to develop a mechanistic and translational perspective that may contribute to future preventive and integrative healthcare strategies.

Research Gap

Although circadian rhythm and gut microbiome regulation are increasingly recognized as major determinants of neuro- gastrointestinal health, their correlation with Ayurveda chronobiology remains insufficiently explored.(1,6) Existing literature discussing Dinacharya is largely descriptive, with limited mechanistic interpretation linking Ayurvedic concepts with circadian regulation, microbial oscillation, neuroimmune signaling, and gut–brain axis physiology.(11,13) Furthermore, translational studies evaluating the influence of Dinacharya on microbiome dynamics and circadian homeostasis remain scarce.(12,13)

Rationale of the Study

Recent advances in chronobiology and microbiome research have highlighted the importance of behavioral synchronization in maintaining neuro-gastrointestinal and metabolic health.(5,7) Since Dinacharya emphasizes time-regulated daily practices for preservation of physiological balance, exploring its possible correlation with circadian rhythm and gut–brain axis regulation may provide an integrative perspective for preventive and lifestyle-based healthcare approaches.(10,12)

Hypothesis

Dinacharya may function as a behavioral chronobiological model capable of modulating the gut–brain axis through circadian synchronization, gut microbiome regulation, neuroendocrine balance, and immune homeostasis.(1,5) Disruption of these temporal behavioral patterns may contribute to dysbiosis, circadian misalignment, and neuro-gastrointestinal dysfunction.(1,7)

Objectives Primary Objective

To critically analyze the scientific correlation between Ayurveda chronobiology and the gut–brain axis with special reference to Dinacharya, circadian rhythm, and gut microbiome regulation.

Secondary Objectives

- To examine the role of circadian rhythm in neuro-gastrointestinal physiology and microbial oscillation.
- To correlate Ayurvedic concepts such as Dinacharya, Agni, Ama, and Nidra with contemporary chronobiology and gut–brain axis mechanisms.
- To explore the potential translational relevance of Dinacharya in preventive and lifestyle-based healthcare approaches.

Gut–Brain Axis: Contemporary Scientific Perspective

The gut–brain axis is a bidirectional communication network that connects the gastrointestinal tract with the central nervous system through neural, endocrine, immune, and metabolic pathways.(1,2) This interaction primarily involves the enteric nervous system, autonomic nervous system, hypothalamic–pituitary–adrenal (HPA) axis, intestinal microbiota, and various neuroactive mediators.(1) Recent advances in neurogastroenterology and microbiome research have demonstrated that the gut plays a significant role not only in digestion and metabolism, but also in emotional regulation, stress responses, cognition, and immune homeostasis.(2,3)

Among the major components of this axis, the gut microbiota has emerged as an important regulator of host physiology. Intestinal microorganisms participate in nutrient metabolism, maintenance of intestinal barrier integrity, immune modulation, and synthesis of several bioactive compounds including short-chain fatty acids (SCFAs), serotonin precursors, and gamma-aminobutyric acid (GABA)-related metabolites.(1,14) These microbial products influence gastrointestinal

motility, inflammatory pathways, autonomic activity, and neuroendocrine signaling.(2,4)

Communication between the gut and brain occurs through multiple interconnected mechanisms. Neural signaling is mediated predominantly through the vagus nerve, while endocrine communication involves cortisol and other stress-related hormones regulated by the HPA axis.(3,15) In addition, immune mediators such as cytokines and microbial metabolites contribute to bidirectional signaling between intestinal and central systems. (1,14) Disturbance of these pathways has been associated with several chronic disorders including irritable bowel syndrome, inflammatory bowel disease, obesity, anxiety, depression, and metabolic syndrome. (2,4)

Emerging evidence further suggests that the gut–brain axis is strongly influenced by circadian rhythm. Gastrointestinal motility, microbial activity, hormone secretion, feeding behavior, and immune responses exhibit diurnal oscillations regulated by biological clocks.(5,6) Consequently, circadian disruption caused by irregular sleep, altered eating patterns, chronic stress, and lifestyle imbalance may contribute to dysbiosis, neuroendocrine dysfunction, systemic inflammation, and impaired neuro-gastrointestinal health.(6,7)

Circadian Rhythm and Gut Microbiome Regulation

Circadian rhythm is an endogenous biological timing system that regulates physiological, metabolic, endocrine, and behavioral processes in approximately 24-hour cycles.(5) These rhythms are coordinated primarily by the suprachiasmatic nucleus of the hypothalamus and are influenced by external cues such as light exposure, feeding behavior, sleep-wake patterns, and physical activity.(5,16) In addition to the central clock, peripheral circadian clocks are present in multiple organs including the liver, intestine, pancreas, and immune tissues.(16)

Recent studies have shown that gut microbial communities also exhibit circadian oscillations.(7,8) The composition, diversity, and metabolic activity of intestinal microbiota fluctuate according to feeding cycles, fasting duration, hormone secretion, and host behavioral rhythms. (7,8) Microbial metabolites such as short-chain fatty acids, bile acid derivatives, and tryptophan metabolites demonstrate time-dependent variation and influence intestinal integrity, immune regulation, and neuroendocrine signaling. (7,17)

Circadian disruption caused by sleep deprivation, irregular eating habits, night-shift work, chronic stress, and altered lifestyle patterns has been associated with microbial dysbiosis, impaired intestinal barrier function, metabolic inflammation, and neuro-gastrointestinal dysfunction.(6,17) Experimental studies further suggest that disturbance of microbial rhythmicity may affect glucose metabolism, immune homeostasis, stress physiology, and behavioral regulation.(7,13)

These findings have increased scientific interest in chrononutrition and lifestyle-based circadian interventions aimed at restoring microbial and metabolic homeostasis.(6,18) In this context, traditional behavioral frameworks emphasizing time-regulated daily activities may possess significant relevance in maintaining gut microbial balance and circadian synchronization.(12,18)

Ayurveda Chronobiology and Dinacharya

Ayurveda describes health as a dynamic equilibrium maintained through appropriate interaction between the body, mind, environment, diet, and time.(9) Among its preventive healthcare principles, *Dinacharya* represents a structured daily behavioral regimen designed to preserve physiological balance and reduce susceptibility to disease.(9,10) Classical Ayurvedic texts emphasize that improper timing of sleep, food intake, physical activity, and behavioral habits may disturb bodily equilibrium and contribute to disease progression. (9)

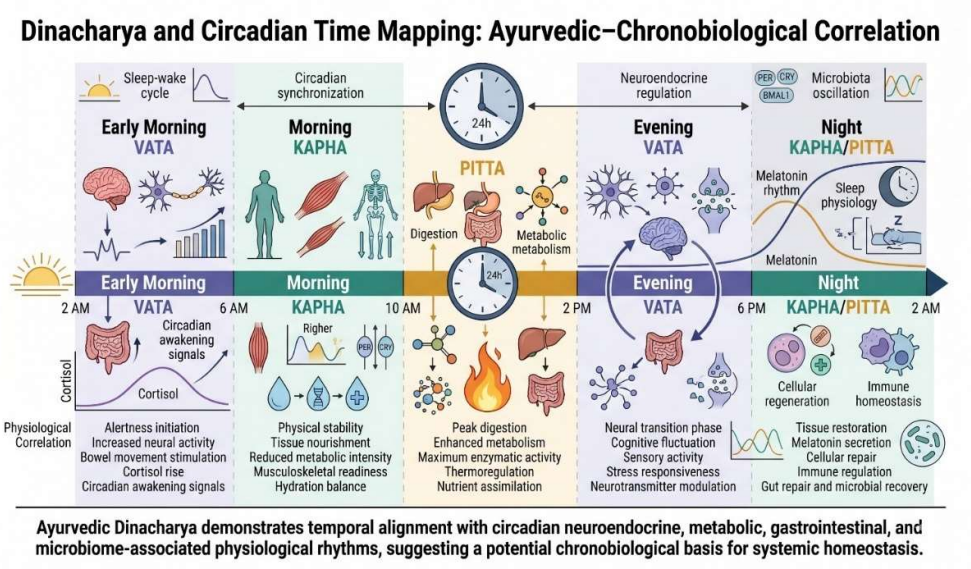
The concept of Ayurveda chronobiology is reflected in the cyclical predominance of *Kapha*, *Pitta*, and *Vata* during different phases of the day.(10,19) According to Ayurvedic physiology, these temporal cycles influence digestion, metabolism, physical activity, mental function, and sleep regulation.(19) Such observations indicate an early recognition of biological rhythmicity and physiological variation across time.(10,11)

Classical texts particularly stress the importance of awakening during *Brahma Muhurta*, maintaining regular bowel habits, consuming meals at appropriate times, engaging in physical activity, and ensuring timely sleep.(9,10) These practices are believed to support proper functioning of *Agni* (digestive and metabolic activity), maintain doshic balance, and preserve physical and mental well-being.(9) "A healthy individual should awaken during Brahma Muhurta for the protection and preservation of health."(10) From a contemporary perspective, these recommendations may correlate with circadian entrainment, metabolic synchronization, autonomic regulation, and maintenance of neuro-gastrointestinal homeostasis.(5,11) The emphasis placed on behavioral regularity in Dinacharya also appears consistent with modern evidence linking lifestyle rhythms with gut microbiome stability and circadian physiology.(5,17)

Table 1. Correlation Between Dinacharya and Circadian Physiology

Dinacharya Principle	Possible Modern Correlation	Physiological Relevance
Brahma Muhurta awakening	Circadian entrainment	Hormonal synchronization
Timely meals	Chrononutrition	Metabolic regulation
Regular sleep	Circadian rhythm maintenance	Neuroendocrine balance
Physical activity	Metabolic activation	Insulin sensitivity

Regular bowel habits	Gastrointestinal rhythmicity	Gut motility regulation
Mental discipline	Stress modulation	Autonomic balance



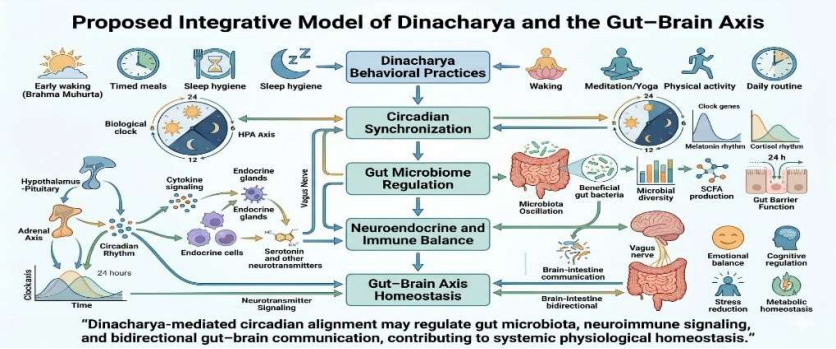
Mechanistic Correlation Between Dinacharya, Circadian Rhythm, and the Gut–Brain Axis

Emerging evidence suggests that behavioral timing plays an important role in regulating circadian physiology, gut microbial dynamics, neuroendocrine balance, and gastrointestinal function.(5,17) In this context, several principles described under Dinacharya appear mechanistically relevant to contemporary understanding of the gut–brain axis and circadian biology.(10,11)

Regular sleep-wake patterns are essential for maintaining synchronization between central and peripheral biological clocks. Ayurveda emphasizes early awakening and timely sleep, practices that may support circadian entrainment, hormonal rhythmicity, autonomic balance, and metabolic regulation. Disturbance of these rhythms has been associated with altered cortisol secretion, impaired melatonin signaling, microbial dysbiosis, and systemic inflammation.(5–7)

Similarly, timed food intake is increasingly recognized as an important regulator of gut microbial oscillation and metabolic homeostasis. Modern chrononutrition research suggests that meal timing influences glucose metabolism, intestinal permeability, microbial metabolite production, and circadian gene expression.(7,18) Ayurveda places significant emphasis on appropriate timing of meals and maintenance of *Agni*, indicating a possible correlation between digestive rhythmicity and metabolic regulation.(10,11)

The gut microbiota also contributes to bidirectional gut–brain communication through production of short-chain fatty acids, neurotransmitter precursors, bile acid metabolites, and immune mediators. Circadian disruption may alter these microbial activities and contribute to neuro-gastrointestinal dysfunction.(1,5) From an Ayurvedic perspective, impaired digestion and accumulation of *Ama* are considered major contributors to disease development, which may conceptually parallel inflammatory dysregulation, endotoxemia, and intestinal barrier dysfunction described in modern biomedical science.(11,12) Furthermore, behavioral practices included in Dinacharya such as physical activity, mental discipline, and sleep regulation may influence vagal tone, stress physiology, and neuroimmune signaling.(1,15) These observations suggest that Dinacharya may function as a behavioral framework capable of supporting circadian synchronization and gut–brain axis homeostasis through integrated neuroendocrine, metabolic, microbial, and immunological pathways.(5,6,18)



Agni, Ama, and Gut Microbiome Dynamics

In Ayurveda, *Agni* is considered the fundamental principle responsible for digestion, metabolism, transformation, and maintenance of physiological balance. Proper functioning of Agni is believed to support nourishment, vitality, immunity, and mental well-being, whereas impaired Agni contributes to incomplete digestion and formation of *Ama*, a pathological state associated with metabolic and systemic imbalance.(9,12)

Although these concepts are described in traditional physiological terminology, they may demonstrate functional parallels with several mechanisms identified in modern gastrointestinal and microbiome research. Contemporary studies indicate that digestive efficiency, microbial metabolism, intestinal barrier integrity, and host immune responses are closely interconnected. Disturbance of these processes may result in dysbiosis, altered microbial metabolite production, intestinal inflammation, and increased permeability of the gut barrier.(1,17)

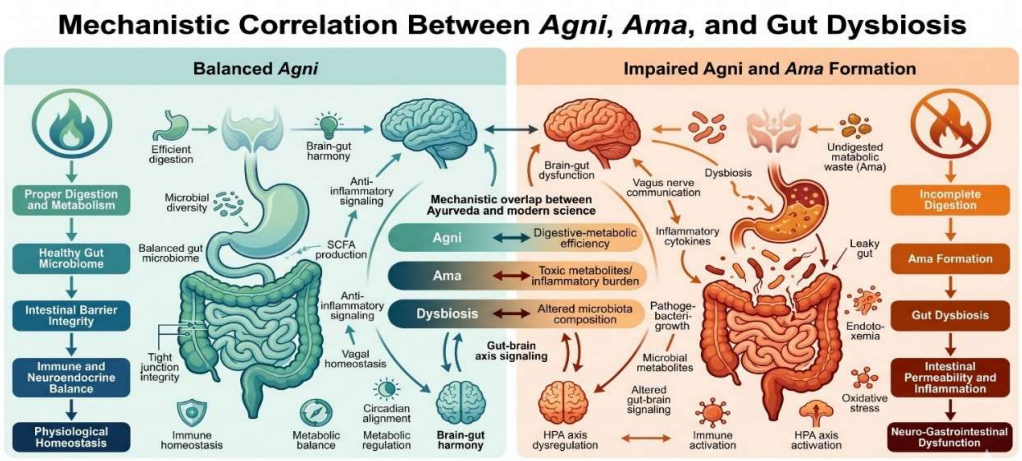
The Ayurvedic concept of Ama may conceptually correspond to pathological metabolic byproducts, inflammatory mediators, endotoxemia, and impaired intestinal homeostasis associated with dysbiosis and metabolic dysfunction. Similarly, balanced Agni may reflect optimal digestive metabolism, microbial equilibrium, nutrient assimilation, and maintenance of intestinal integrity.(12,20)

Recent microbiome research has also demonstrated that dietary timing, sleep patterns, stress physiology, and circadian rhythm significantly influence microbial composition and metabolic activity.(17,18) Since Dinacharya emphasizes regular eating habits, behavioral discipline, sleep regulation, and maintenance of digestive balance, these practices may contribute to preservation of gut microbial stability and neuro-gastrointestinal homeostasis.(9,18)

Thus, the relationship between Agni, Ama, and gut microbiome dynamics may provide an important translational framework for interpreting Ayurveda physiology within the context of modern microbiome and circadian science.

Table 2. Ayurvedic Concepts and Possible Biomedical Correlation

Ayurvedic Concept	Possible Biomedical Interpretation
Agni	Digestive and metabolic efficiency
Ama	Inflammatory/metabolic dysregulation
Nidra	Restorative circadian physiology
Dinacharya	Behavioral chronomedicine
Ayurvedic Concept	Possible Biomedical Interpretation
Agni	Digestive and metabolic efficiency
Ama	Inflammatory/metabolic dysregulation
Nidra	Restorative circadian physiology
Dinacharya	Behavioral chronomedicine
Doshic rhythmicity	Biological temporal variation
Grahani dysfunction	Gut dysregulation/dysbiosis



Balanced Agni may support microbial homeostasis, intestinal integrity, and neuroimmune balance, whereas impaired Agni and Ama formation may contribute to gut dysbiosis, systemic inflammation, and gut–brain axis dysfunction.

Nidra, Stress Physiology, and Neuroendocrine Regulation

Nidra (sleep) is regarded in Ayurveda as one of the essential pillars of health and is considered necessary for maintenance of physical strength, mental stability, metabolic balance, and longevity. Classical Ayurvedic literature describes disturbed or inadequate sleep as a contributing factor in fatigue, impaired cognition, digestive dysfunction, emotional imbalance, and disease susceptibility.(9,10)

Modern neuroscience and chronobiology similarly recognize sleep as a fundamental regulator of neuroendocrine, metabolic, immune, and gastrointestinal function. Sleep-wake cycles are closely controlled by circadian rhythm and influence hormonal secretion, autonomic activity, inflammatory signaling, and gut microbial behavior. Experimental studies have shown that sleep deprivation and circadian disruption may alter microbial diversity, intestinal permeability, cortisol rhythm, glucose metabolism, and systemic inflammatory responses.(5,21)

Stress physiology also plays a significant role in gut–brain axis regulation. Activation of the hypothalamic–pituitary–adrenal (HPA) axis during chronic stress increases cortisol secretion, affects intestinal barrier integrity, alters gut motility, and contributes to microbial dysbiosis. These changes may further influence neuroinflammation, emotional regulation, and gastrointestinal health.(1,15)

Ayurveda emphasizes behavioral discipline, mental regulation, proper sleep, and balanced daily routines as important measures for preservation of psychological and physiological equilibrium. In this context, Dinacharya-based regulation of sleep and daily activities may possess relevance in maintaining neuroendocrine stability, autonomic balance, and gut–brain axis homeostasis.(5,15)

Vagus Nerve, Neuroimmune Signaling, and Gut–Brain Communication

The vagus nerve serves as one of the principal communication pathways between the gastrointestinal tract and the central nervous system. Through afferent and efferent signaling, it regulates gastrointestinal motility, immune responses, stress adaptation, inflammatory activity, and autonomic balance. Increasing evidence suggests that vagal pathways play a central role in bidirectional gut–brain communication and contribute significantly to neuro-gastrointestinal homeostasis.(1,15)

Gut microbiota and their metabolites influence vagal signaling through interaction with enteroendocrine cells, immune mediators, and neurotransmitter pathways. Short-chain fatty acids, serotonin-related metabolites, and inflammatory cytokines can modulate neural communication between the gut and brain. Alteration of these pathways has been associated with anxiety, depression, inflammatory bowel disorders, metabolic dysfunction, and stress-related gastrointestinal diseases.(1,2) Neuroimmune signaling also represents an important component of the gut–brain axis. Chronic inflammation, intestinal permeability, microbial dysbiosis, and stress-induced immune activation may contribute to altered cytokine production and neuroinflammatory responses. These mechanisms are increasingly recognized in the pathophysiology of several metabolic, psychiatric, and gastrointestinal disorders.(2,22)

From an Ayurvedic perspective, maintenance of physiological equilibrium depends upon balanced interaction between body, mind, digestion, and behavior. Practices included within Dinacharya, such as regular physical activity, sleep regulation, mental discipline, and proper dietary habits, may indirectly support autonomic balance and neuroimmune stability.(9,10) Although direct mechanistic evidence remains limited, these observations suggest a possible integrative relationship between Ayurvedic behavioral regulation and contemporary gut–brain axis physiology.

Chrononutrition and Meal Timing in Ayurveda and Modern Science

Chrononutrition refers to the interaction between meal timing, circadian rhythm, metabolism, and physiological regulation. Recent research has demonstrated that the timing of food intake significantly influences glucose metabolism, insulin sensitivity, gastrointestinal function, hormonal secretion, microbial oscillation, and energy homeostasis.(5,18) Irregular eating patterns and late-night food consumption have been associated with obesity, metabolic dysfunction, circadian disruption, and inflammatory imbalance.(5,17)

The gut microbiome also responds dynamically to feeding-fasting cycles. Meal timing influences microbial diversity, metabolite production, bile acid metabolism, and circadian gene expression. Experimental studies suggest that disruption of feeding rhythm may impair microbial oscillation and contribute to dysbiosis, intestinal inflammation, and metabolic instability.(7,17)

Ayurveda has long emphasized the importance of appropriate dietary timing and digestive regulation. Dinacharya recommends consumption of meals according to digestive capacity and biological timing, with particular importance given to the midday meal when *Agni* is considered strongest.(9,10) Irregular eating habits, overeating, untimely food intake, and incompatible dietary practices are described as important contributors to impaired digestion and disease development.(10) From a modern perspective, these principles may correspond with circadian variation in digestive enzyme activity, metabolic efficiency, gastrointestinal motility, and hormonal regulation.(5,18) The Ayurvedic emphasis on mindful eating, meal regularity, and digestive balance appears conceptually aligned with contemporary chrononutrition and lifestyle medicine approaches aimed at maintaining metabolic and gut microbial homeostasis.(7,10)

Discussion

Recent advances in microbiome science, neurogastroenterology, and circadian biology have substantially expanded understanding of the bidirectional relationship between behavioral rhythms and physiological regulation.(1,6) The present review suggests that several principles described in Ayurveda under Dinacharya demonstrate conceptual and mechanistic overlap with contemporary knowledge of circadian rhythm, gut microbiome dynamics, neuroendocrine regulation, and gut– brain axis physiology.(1,10)

Modern biomedical research increasingly recognizes that behavioral factors such as sleep timing, meal regularity, stress regulation, and physical activity significantly influence microbial composition, intestinal permeability, immune signaling, metabolic homeostasis, and neuro-gastrointestinal function.(6,23) In parallel, Ayurveda describes health maintenance through synchronized regulation of diet, sleep, bowel habits, physical activity, and mental discipline according to natural temporal cycles.(10) This similarity indicates that Dinacharya may represent an early behavioral chronobiological framework aimed at preserving systemic homeostasis.

Particularly noteworthy is the potential correlation between Ayurvedic concepts such as *Agni*, *Ama*, and *Nidra* with modern mechanisms involving digestive metabolism, inflammatory dysregulation, intestinal barrier function, circadian synchronization, and restorative physiology.(12,24) Likewise, the temporal predominance of *Vata*, *Pitta*, and *Kapha* may reflect observations related to fluctuations in metabolic, autonomic, and neuroendocrine activity across the day.(10) However, despite these conceptual parallels, direct mechanistic evidence linking Dinacharya with microbiome regulation and circadian physiology remains limited. Most currently available integrative studies are descriptive and lack molecular, microbiological, or translational validation.(12,13) Furthermore, Ayurvedic physiological concepts are traditionally qualitative and individualized, which presents challenges in standardization and experimental interpretation within modern biomedical frameworks.

Nevertheless, the growing interest in chronomedicine, lifestyle interventions, and microbiome-targeted therapies provides an important opportunity for interdisciplinary research integrating Ayurveda with contemporary systems biology. Future studies involving microbiome sequencing, inflammatory biomarkers, circadian gene expression, autonomic parameters, and clinical outcome measures may help establish stronger scientific evidence regarding the influence of Dinacharya on gut–brain axis regulation and neuro-gastrointestinal health.(1,13)

Clinical Implications and Translational Relevance

The growing prevalence of metabolic disorders, stress-related illnesses, gastrointestinal dysfunction, sleep disturbances, and neuropsychiatric conditions has increased interest in non-pharmacological and lifestyle-based therapeutic strategies.(1,5) In this context, Dinacharya may possess potential clinical relevance as a behavioral approach aimed at improving circadian synchronization, digestive regulation, stress adaptation, and gut–brain axis homeostasis.(10)

Several practices described under Dinacharya, including regular sleep patterns, timely food intake, physical activity, and behavioral discipline, appear consistent with contemporary recommendations in chronomedicine, lifestyle medicine, and chrononutrition.(5,18) These interventions may potentially support gut microbial balance, autonomic regulation, metabolic stability, and neuroendocrine function.(1,18)

From a translational perspective, integration of Dinacharya-based behavioral regulation with modern preventive healthcare approaches may provide supportive benefits in conditions associated with circadian disruption and dysbiosis, including irritable bowel syndrome, obesity, metabolic syndrome, stress-related disorders, and sleep dysfunction.(1,13) However, well- designed clinical and mechanistic studies remain necessary before definitive therapeutic conclusions can be established.

The integration of Ayurveda chronobiology with microbiome and circadian research may also contribute to the development of personalized and preventive healthcare models emphasizing behavioral synchronization and long-term physiological regulation.(10,13)

Conclusion

The present review highlights a possible scientific correlation between Ayurveda chronobiology and contemporary understanding of the gut–brain axis, circadian rhythm, and gut microbiome regulation. Emerging evidence from chronobiology, neurogastroenterology, and microbiome research indicates that behavioral rhythms significantly influence gastrointestinal physiology, neuroendocrine signaling, immune homeostasis, and metabolic balance. In this context, the Ayurvedic concept of Dinacharya appears to provide a structured behavioral framework aimed at maintaining physiological synchronization with natural biological cycles.

Several principles described in Dinacharya, including regulation of sleep, meal timing, physical activity, bowel habits, and daily behavioral discipline, demonstrate conceptual parallels with modern approaches related to chrononutrition, circadian alignment, and lifestyle-based preventive medicine. Ayurvedic concepts such as *Agni*, *Ama*, and *Nidra* may also possess functional relevance in relation to digestive metabolism, inflammatory regulation, intestinal integrity, and restorative physiological processes.

Although current evidence supporting direct mechanistic integration remains limited, the available literature suggests that Ayurveda chronobiology may offer a valuable systems-oriented perspective for

understanding behavioral regulation of the gut–brain axis. Further interdisciplinary research integrating microbiome analysis, circadian biomarkers, neurophysiology, and Ayurvedic lifestyle interventions is necessary to establish stronger translational and clinical evidence.

Overall, the integration of Dinacharya with contemporary circadian and microbiome science may contribute to the development of preventive, lifestyle-based, and integrative healthcare strategies for improving neuro-gastrointestinal and metabolic health.

Future Perspectives and Research Directions

Future research should focus on generating translational and mechanistic evidence examining the relationship between Dinacharya, circadian regulation, and gut microbiome dynamics.(1,13) Interdisciplinary studies integrating Ayurveda, microbiome science, chronobiology, neurogastroenterology, and systems biology may help clarify the physiological relevance of Ayurvedic behavioral principles in modern healthcare.(13,24)

Prospective clinical studies may evaluate the influence of Dinacharya-based interventions on:

- gut microbial diversity,
- circadian biomarkers,
- inflammatory mediators,
- autonomic regulation,
- sleep quality,
- metabolic parameters,
- and neuro-gastrointestinal outcomes.

Advanced methodologies including metagenomic sequencing, metabolomics, circadian gene expression analysis, and neurophysiological assessment may further improve understanding of the gut–brain axis from an integrative perspective.(1,5) In addition, development of standardized assessment models for Ayurvedic chronobiological practices may support reproducibility and scientific validation.(24)

Future investigation of Dinacharya as a behavioral chronomedicine approach may also contribute to preventive and lifestyle- based management strategies for metabolic disorders, stress-related conditions, sleep disturbances, and gastrointestinal dysfunction.(5,13)

Limitations

The present review is primarily conceptual and interpretative in nature and is based on integration of evidence from microbiome research, circadian biology, neurogastroenterology, and classical Ayurvedic literature. Direct experimental and clinical evidence correlating Dinacharya with gut microbiome oscillation, circadian biomarkers, and neuro-gastrointestinal regulation remains limited.

Several Ayurvedic concepts such as *Agni*, *Ama*, and doshic rhythmicity are traditionally qualitative and individualized, making standardization and mechanistic interpretation within contemporary biomedical frameworks challenging. In addition, most currently available integrative studies are descriptive, with limited molecular validation and insufficient longitudinal or interventional data.

The review also acknowledges that conceptual similarities between Ayurveda and modern biomedical science do not necessarily indicate complete equivalence. Therefore, further translational, experimental, and clinical studies are required before definitive mechanistic conclusions can be established.

References

1. Cryan JF, O'riordan KJ, Cowan CSM, Sandhu K V., Bastiaanssen TFS, Boehme M, et al. The microbiota-gut-brain axis. Physiol Rev. 2019;99(4):1877–2013. doi:10.1152/physrev.00018.2018 PubMed PMID: 31460832.
2. Foster JA, McVey Neufeld KA. Gut-brain axis: How the microbiome influences anxiety and depression. Trends Neurosci. 2013 May;36(5):305–12. doi:10.1016/j.tins.2013.01.005 PubMed PMID: 23384445.
3. Mayer EA, Knight R, Mazmanian SK, Cryan JF, Tillisch K. Gut microbes and the brain: Paradigm shift in neuroscience. Journal of Neuroscience. 2014 Nov 12;34(46):15490–6. doi:10.1523/JNEUROSCI.3299-14.2014 PubMed PMID: 25392516.
4. Dinan TG, Cryan JF. Gut microbiota: a missing link in psychiatry. World Psychiatry. 2020 Feb 1;19(1):111–2. doi:10.1002/WPS.20726
5. Panda S. Circadian physiology of metabolism. Science (1979). 2016 Nov 25;354(6315):1008–15. doi:10.1126/SCIENCE.AAH4967 PubMed PMID: 27885007.
6. Voigt RM, Forsyth CB, Keshavarzian A. Circadian rhythms: a regulator of gastrointestinal health and dysfunction. Expert Rev Gastroenterol Hepatol. 2019 May 4;13(5):411–24. doi:10.1080/17474124.2019.1595588 PubMed PMID: 30874451.
7. Thaiss CA, Zeevi D, Levy M, Zilberman-Schapira G, Suez J, Tengeler AC, et al. Transkingdom control of microbiota diurnal oscillations promotes metabolic homeostasis. Cell. 2014 Oct 23;159(3):514–29. doi:10.1016/j.cell.2014.09.048 PubMed PMID: 25417104.
8. Liang X, Bushman FD, FitzGerald GA. Rhythmicity of the intestinal microbiota is regulated by gender and the host circadian clock. Proc Natl Acad Sci U S A. 2015 Aug 18;112(33):10479–84. doi:10.1073/PNAS.1501305112 PubMed PMID: 26240359.
9. Śarmā R, Dash Bhagwan. Agniveśa's Caraka saṃhitā : text with English translation & critical exposition based on (Cakrapāṇi Datta's Āyurveda dīpikā). 2014th ed. Vol I–VI. Varanasi: Chowkhamba Sanskrit Series Office : Also can be had from Chowkhamba Krishnadas Academy; 2015.
10. Prof. K. R. Srikantha Murthy. Vagbhata's Astanga

Hrdayam. 2000th ed. Vol I–III. Varanasi: Chowkhamba Krishnadas Academy ; 2000.
11. Gayathri BI, Vinodkumar M V. Chronobiology and its Ayurvedic Understanding. International Journal of Ayurveda and Pharma Research. 2023 Dec 31;72–7. doi:10.47070/ijapr.v11i12.3042
12. Wallace RK. The Microbiome in Health and Disease from the Perspective of Modern Medicine and Ayurveda. Medicina (Kaunas). 2020 Sep 1;56(9):1–12. doi:10.3390/MEDICINA56090462 PubMed PMID: 32932766.
13. Cheng WY, Ho YS, Chang RCC. Linking circadian rhythms to microbiome-gut-brain axis in aging-associated neurodegenerative diseases. Ageing Res Rev. 2022 Jun 1;78:101620. doi:10.1016/J.ARR.2022.101620 PubMed PMID: 35405323.
14. Carabotti M, Scirocco A, Antonietta Maselli M, Severi C. The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems [Internet]. Vol. 28. 2015. Available from: www.annalsgastro.gr
15. Bonaz B, Bazin T, Pellissier S. The Vagus Nerve at the Interface of the Microbiota-Gut-Brain Axis. Front Neurosci. 2018 Feb 7;12. doi:10.3389/fnins.2018.00049
16. Tahara Y, Shibata S. Circadian rhythms of liver physiology and disease: Experimental and clinical evidence. Nat Rev Gastroenterol Hepatol. 2016 Apr 1;13(4):217–26. doi:10.1038/NRGASTRO.2016.8 PubMed PMID: 26907879.
17. Bishehsari F, Voigt RM, Keshavarzian A. Circadian rhythms and the gut microbiota: from the metabolic syndrome to cancer. Nat Rev Endocrinol. 2020 Dec 1;16(12):731–9. doi:10.1038/S41574-020-00427-4 PubMed PMID: 33106657.
18. Zarrinpar A, Chaix A, Panda S. Daily Eating Patterns and Their Impact on Health and Disease. Trends in Endocrinology and Metabolism. 2016 Feb 1;27(2):69–83. doi:10.1016/j.tem.2015.11.007 PubMed PMID: 26706567.
19. Verma D, Agrawal S, Gehlot S. Ayurveda Perspectives on Chronobiological concerns in Human Biology. Journal of Research and Education in Indian Medicine (Est1982). 2017;20(3–4):1. doi:10.5455/JREIM.82-1506402458
20. Rinninella E, Raoul P, Cintoni M, Franceschi F, Miggiano GAD, Gasbarrini A, et al. What is the healthy gut microbiota composition? A changing ecosystem across age, environment, diet, and diseases. Microorganisms. 2019 Jan 1;7(1). doi:10.3390/MICROORGANISMS7010014 PubMed PMID: 30634578.
21. Smith RP, Easson C, Lyle SM, Kapoor R, Donnelly CP, Davidson EJ, et al. Gut microbiome diversity is associated with sleep physiology in humans. PLoS One. 2019 Oct 7;14(10):e0222394. doi:10.1371/journal.pone.0222394
22. Mayer EA, Knight R, Mazmanian SK, Cryan JF, Tillisch K. Gut microbes and the brain: Paradigm shift in neuroscience. Journal of Neuroscience. 2014 Nov 12;34(46):15490–6. doi:10.1523/JNEUROSCI.3299-14.2014 PubMed PMID: 25392516.
23. Cryan JF, O KJ, M Cowan CS, Sandhu K V, S Bastiaanssen TF, Boehme M, et al. The Microbiota-Gut-Brain Axis. Physiol Rev. 2019;99:1877–2013. doi:10.1152/physrev.00018.2018.-The
24. Gayathri BI, Vinodkumar M V. Chronobiology and its Ayurvedic Understanding. International Journal of Ayurveda and Pharma Research. 2023 Dec 31;72–7. doi:10.47070/ijapr.v11i12.3042