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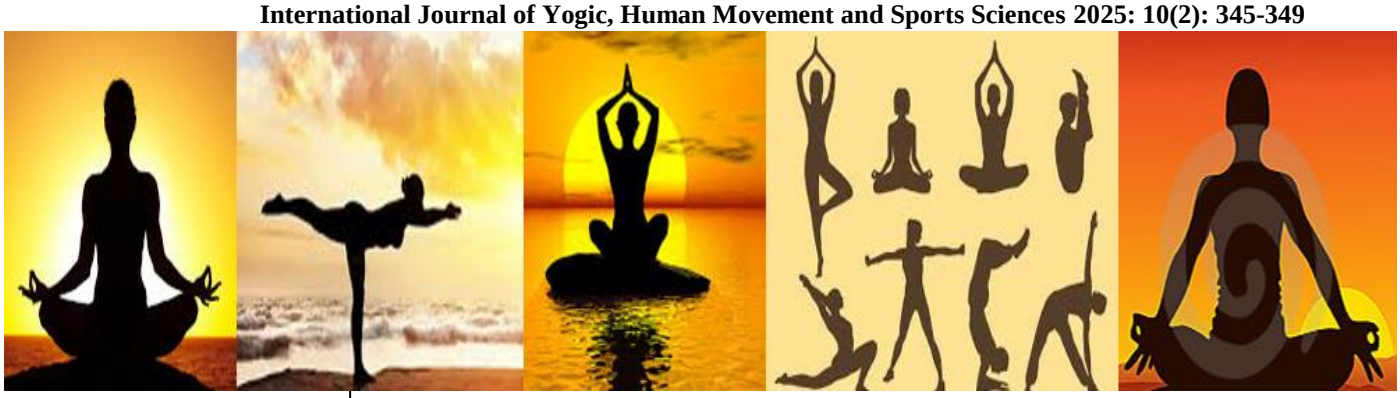

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Chronobiology and Organ Function: A Research Perspective on the Traditional Chinese Medicine Organ Clock

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Abstract
The concept of time-dependent organ activity is central to Traditional Chinese Medicine (TCM), where each organ system is believed to have a two-hour peak of functional dominance within a 24-hour circadian cycle. This framework, often termed the "organ clock," has gained renewed interest in modern chronobiology and integrative medicine. According to this model, the lungs are most active from 3:00-5:00 AM, the large intestine from 5:00-7:00 AM, the stomach from 7:00-9:00 AM, the spleen from 9:00-11:00 AM, the heart from 11:00 AM-1:00 PM, the small intestine from 1:00-3:00 PM, the urinary bladder from 3:00-5:00 PM, the kidneys from 5:00-7:00 PM, the liver from 1:00-3:00 AM, and the gallbladder from 11:00 PM-1:00 AM.
This manuscript examines the organ clock from both traditional and scientific perspectives. First, we analyze historical foundations within TCM and the philosophical underpinnings that link organ activity to Qi flow, meridians, and holistic health. Next, we explore correlations with modern physiology, including circadian rhythms, hormonal cycles, autonomic nervous system regulation, and digestive-metabolic processes. We highlight parallels between TCM organ timing and evidence-based biological rhythms such as cortisol peaks, melatonin secretion, gastrointestinal motility, and renal filtration. Finally, we discuss clinical implications for lifestyle modification, chronotherapy, disease prevention, and personalized medicine.
By bridging TCM insights with contemporary chronobiology, this research underscores the relevance of temporal patterns in organ function and health management. The organ clock may provide a useful framework for optimizing therapeutic interventions, aligning lifestyle behaviors with natural body rhythms, and fostering integrative approaches in modern healthcare.

Keywords: Organ clock, Traditional Chinese Medicine, circadian rhythm, chronobiology, Qi flow, chronotherapy, integrative medicine

Introduction
Time has long been recognized as a critical dimension of health and disease. Across diverse medical traditions, rhythms of nature have been associated with human physiology, behavior, and well-being [1]. Traditional Chinese Medicine (TCM) offers one of the most detailed frameworks of temporal health regulation through the concept of the organ clock, a 24-hour cycle in which specific organs are believed to exhibit peak activity within designated two-hour intervals. In this model, organ systems are not only anatomical structures but also functional networks connected by the flow of *Qi* (vital energy) and blood through meridians. Each period of dominance is thought to reflect an optimal window for repair, detoxification, digestion, elimination, or circulation [2]. The organ clock begins with the lungs between 3:00 and 5:00 AM, a time associated with respiration, oxygenation, and preparation for the upcoming day. The large intestine follows from 5:00 to 7:00 AM, symbolizing elimination and cleansing [3]. Digestive energy then shifts to the stomach (7:00-9:00 AM) and spleen (9:00-11:00 AM), supporting nutrient assimilation. Around midday, the heart (11:00 AM-1:00 PM) governs circulation and emotional vitality, followed by the small intestine (1:00-3:00 PM), which finalizes nutrient absorption [4]. In the afternoon, the urinary bladder (3:00-5:00 PM) and kidneys (5:00-7:00 PM) regulate water metabolism and energy conservation.

The night hours highlight detoxification and restoration, with the gallbladder (11:00 PM-1:00 AM) and liver (1:00-3:00 AM) preparing the body for cellular repair and metabolic balance [5].

While these associations originate from classical Chinese medical texts dating back more than two millennia, recent advances in chronobiology and circadian science have drawn intriguing parallels. Modern physiology demonstrates that nearly every organ system exhibits rhythmic activity coordinated by central and peripheral clocks [6]. For example, cortisol secretion peaks in the early morning, gastric acid secretion follows predictable patterns, renal filtration varies across day and night, and hepatic metabolism is strongly linked to circadian regulation. These findings suggest that the organ clock, though framed in the language of TCM, may reflect empirical observations of biological rhythms long before the discovery of molecular circadian genes [7].

Understanding these time-dependent variations is not merely of historical interest. Contemporary medicine increasingly acknowledges the value of chronotherapy, where drug administration, nutritional intake, and physical activity are timed according to circadian physiology to maximize efficacy and minimize side effects [8]. Similarly, lifestyle interventions such as sleep hygiene, fasting schedules, and exercise timing are now recognized as determinants of metabolic health. The TCM organ clock provides an integrative lens through which these modern practices can be contextualized and potentially optimized [9].

This manuscript aims to critically examine the organ clock by bridging traditional perspectives with modern evidence. We explore the historical foundations of the concept, compare it with current knowledge of circadian biology, and evaluate its potential clinical applications in preventive medicine, therapeutics, and holistic health care. By doing so, we seek to highlight the continuing relevance of ancient medical insights in an era increasingly defined by precision medicine and integrative approaches [10].

Historical and Philosophical Foundations

Origin of the organ clock in classical Chinese medical texts

The idea that physiological functions and flow with the time of day is deeply rooted in Chinese medical thought. Classical sources compiled over two millennia ago—most notably the *Huan di Neijing* (Yellow Emperor's Inner Canon) and its major commentaries—articulated an organized scheme in which vital activity moves cyclically through the body's organ systems [11]. These foundational texts do not present the organ clock as an isolated curiosity; rather, they locate it within a comprehensive theory of health that links cosmology, seasonal change, and human conduct. Over successive centuries, later medical writings and clinical commentaries refined how particular two-hour periods were associated with specific organs, meridians, and therapeutic priorities. The organ clock therefore emerged as both a theoretical map and a practical tool for diagnosis and treatment in the classical TCM corpus [12].

Role of Qi, meridians, and yin-yang balance

At the heart of the organ-clock model lie three interrelated philosophical constructs: *Qi*, meridians, and yin-yang. *Qi* is conceived as a dynamic, functional energy that underlies physiological processes; it circulates through channels—meridians—that connect organ networks and surface points on the body [13]. The organ clock describes when *Qi* is most relatively concentrated or functionally dominant in each organ system, producing windows of heightened activity and receptivity. Yin and yang provide the overarching rhythm: yang qualities (activation, warmth, outward function) predominate during the daylight hours, while yin qualities (rest, repair, inward consolidation) are associated with night [14]. The temporal alternation of yin and yang is thereby mapped onto organ function so that the timing of peak *Qi* corresponds to broader patterns of activity and rest. This triad—*Qi*, meridians, and yin-yang—supplies both a metaphysical explanation and a clinical rationale for observing and acting upon daily bodily rhythms [15].

Traditional interpretations of organ activity in daily life

In TCM practice the organ clock is not merely an abstract diagram; it is used to interpret everyday symptoms, behaviors, and the optimal timing of routine activities. Each two-hour interval is associated with characteristic physiological tasks: early-morning lung time (3:00-5:00) is linked to respiration and the initiation of daily energy; the stomach and spleen periods (7:00-11:00) are regarded as prime windows for digestion and nutrient assimilation; midday heart time (11:00-13:00) coincides with circulation and emotional vivacity; and night hours such as liver time (1:00-3:00) are reserved for detoxification and internal restoration [16]. Traditional texts and practitioners extend these associations to interpret patterns such as recurring nocturnal awakenings, time-specific pain, or changes in bowel or urinary habits as signposts pointing toward particular organ imbalances. Emotions are likewise connected to organ rhythms—grief and the lungs, joy and the heart, anger and the liver—and these affective qualities are woven into diagnostic reasoning about when symptoms surface or worsen [17].

Early clinical applications in TCM practice

From antiquity, clinicians translated the organ-clock framework into therapeutic choices. Treatment timing could influence the selection of acupuncture points, the scheduling of moxibustion or cupping sessions, and the timing or formulation of herbal prescriptions [18]. Practitioners often recommended aligning meals, rest, and activity with the organ clock—for example, emphasizing nourishment during stomach time and rest during the liver's nocturnal interval—to support physiological processes deemed most active at those moments. In diagnosis, the temporal patterning of symptoms served as an additional axis of information: a complaint that intensifies consistently during a specific two-hour block might direct the clinician to focus treatment on the corresponding meridian or organ network. Over time these time-aware practices became embedded in a broader clinical culture that treated daily rhythms as actionable and therapeutically meaningful [18].

Description of the Organ Clock Cycle

The organ clock describes a repeating 24-hour rhythm in which each organ system reaches its energetic or functional peak during a specific two-hour window. This section outlines the traditional interpretations of each phase alongside modern scientific parallels that may provide a physiological basis for these ancient observations [19].

3:00-5:00 AM - Lungs (Respiration, Oxygenation, Grief)

In TCM, the lung period is considered the beginning of the daily cycle. It symbolizes the intake of fresh energy through respiration and the renewal of vital *Qi*. Emotionally, the lungs

are linked with grief and letting go, which aligns with the cleansing and preparatory role of early morning breathing practices in traditional health regimens [20].

Modern correlation: Pulmonary function tests reveal circadian variations in airway caliber, with early morning narrowing often observed in asthmatic patients. Cortisol levels rise just before dawn, promoting increased alertness and influencing lung function. This period also coincides with the highest incidence of asthma attacks, offering a clinical link to lung activity rhythms.

5:00-7:00 AM - Large Intestine (Elimination, Detoxification)

According to TCM, this is the optimal time for bowel movements, as the large intestine is believed to be most active in clearing waste from the body. A regular morning elimination routine is thought to promote both physical and mental clarity for the day [21].

Modern correlation: Gastrointestinal motility follows a circadian pattern, with morning hours showing heightened peristaltic activity and rectal sensitivity. Hormonal influences such as increased cortisol and waking-induced colonic motor activity support this observation, lending biological plausibility to the TCM view [22].

7:00-9:00 AM - Stomach (Digestion, Energy Intake)

The stomach's energetic peak is described as the ideal time for the first substantial meal of the day. Digestion and nutrient breakdown are considered most efficient in this window.

Modern correlation: Studies on chrononutrition suggest that insulin sensitivity and digestive efficiency are greater in the morning than later in the day. Gastric acid secretion and enzyme activity also peak during morning hours, supporting enhanced food breakdown and nutrient absorption [23].

9:00-11:00 AM - Spleen (Nutrient Assimilation, Immunity)

In TCM, the spleen governs the transformation of food into *Qi* and blood, making this a crucial phase for sustaining energy and strengthening immunity. The spleen period represents integration of nourishment into body systems.

Modern correlation: In modern physiology, the small intestine continues active nutrient absorption during this period. Moreover, immune cell trafficking follows circadian rhythms, with morning hours favoring immune surveillance, which aligns with the TCM association of the spleen with immunity [24].

11:00 AM-1:00 PM - Heart (Circulation, Emotional Regulation)

This phase emphasizes cardiovascular vitality and emotional well-being. The heart in TCM is also considered the seat of consciousness (*Shen*), linking circulation with mental clarity and emotional balance.

Modern correlation: Cardiovascular studies show a mid-day peak in blood flow, body temperature, and alertness. Interestingly, heart attack incidence often peaks in late morning to midday, correlating with increased sympathetic activity and blood pressure variability during this time [25].

1:00-3:00 PM - Small Intestine (Absorption, Clarity of Judgment)

In TCM, the small intestine is responsible for separating "pure" from "impure," not only in terms of nutrient absorption but also in decision-making and clarity. This time is believed to support mental discrimination and digestion [25, 26].

Modern correlation: Nutrient absorption continues actively in this window. Cognitive performance studies show an early afternoon dip in vigilance, though decision-making tasks often benefit from post-meal glucose availability, linking gut and brain functions [27].

3:00-5:00 PM - Urinary Bladder (Excretion, Water Metabolism)

The urinary bladder's peak is thought to involve the regulation of fluid balance and elimination of metabolic by-products. TCM also associates this time with drive and ambition.

Modern correlation: Renal plasma flow and urine output display circadian rhythms, with afternoon hours often associated with increased clearance rates. Hydration status and hormonal influences such as vasopressin secretion support variations in urinary activity [28].

5:00-7:00 PM - Kidneys (Vitality, Endocrine Balance)

Kidneys in TCM are considered the "root of life," storing essence (*Jing*) and governing growth, reproduction, and longevity. This period emphasizes energy consolidation and balance of endocrine functions [29].

Modern correlation: Renal physiology is strongly circadian, with electrolyte handling and blood pressure regulation showing evening shifts. Moreover, endocrine functions—including melatonin release preparations for sleep—begin adjusting during this period, paralleling TCM's emphasis on vitality and systemic regulation [30].

11:00 PM-1:00 AM - Gall Bladder (Decision-Making, Bile Secretion)

This phase is associated with decisiveness, courage, and the secretion of bile for fat digestion. The gall bladder's energetic strength is linked not only to digestion but also to determination and judgment.

Modern correlation: Bile acid metabolism follows circadian rhythms, with secretion patterns influenced by feeding-fasting cycles. Sleep studies also suggest that late-night hours influence cognitive processing and emotional stability, echoing the TCM connection between gall bladder activity and decisiveness [31].

1:00-3:00 AM - Liver (Detoxification, Glycogen Storage)

In TCM, the liver governs the smooth flow of *Qi* and blood. Its nightly peak is believed to support detoxification, emotional regulation (especially anger), and preparation for a new cycle of energy.

Modern correlation: Hepatic metabolism and detoxification enzymes display circadian regulation, with peak activity during nocturnal hours. Glycogen storage and lipid metabolism also follow night-dominant rhythms. This aligns with modern understanding that liver detoxification and metabolic resetting occur predominantly during sleep [32].

Clinical Implications

The recognition that organ function follows predictable rhythms has important clinical applications in both traditional and modern medicine. In TCM, the organ clock is used to guide lifestyle choices, with recommendations to eat, sleep, work, and rest in harmony with the body's energetic cycles. Modern chronobiology provides a parallel framework, showing that timing strongly influences physiology,

pharmacology, and disease expression. Together, these perspectives suggest that aligning daily routines with biological rhythms may enhance health outcomes and prevent disease progression [33].

One major implication of this framework is chronotherapy, or the timed administration of treatment. Research in cardiovascular medicine shows that blood pressure follows a circadian rhythm, peaking in the early morning and falling at night. Administering antihypertensive drugs in the evening has been shown to blunt the morning surge in blood pressure and reduce the risk of myocardial infarction, which often occurs during mid-morning hours corresponding to the heart's TCM activity period. Similarly, chemotherapy, when delivered at times aligned with tumor cell cycles and host organ tolerance, produces fewer side effects and better efficacy. These findings mirror the TCM belief that treatment is most effective when targeted during an organ's peak period of energy and function [34].

Lifestyle modification is another area where the organ clock offers guidance. TCM advises consuming the largest meal in the morning during the stomach's active period, as digestion is most efficient at this time. Modern studies on chrononutrition confirm that morning meals are associated with better glycemic control, higher energy expenditure, and improved metabolic health compared to late-night eating. Sleep is also emphasized in both systems. In TCM, the liver and gall bladder hours (11:00 PM-3:00 AM) are critical for detoxification and repair, making early sleep essential for optimal restoration. This aligns with modern findings that deep sleep stages occurring in early night hours are associated with enhanced growth hormone release, tissue repair, and hepatic metabolic resetting [35].

Integrative medicine also benefits from applying organ-clock principles. For example, individuals with irritable bowel syndrome often report symptom fluctuations that peak at certain times of day. Mapping these symptoms to TCM organ timings can guide dietary scheduling, stress management practices, and acupuncture therapy. Likewise, patients with insomnia may find that repeated awakening during the same time window reflects imbalance in the corresponding organ, such as waking between 1:00 and 3:00 AM being linked to liver stress in TCM. Such temporal patterns can complement modern diagnostic approaches by offering additional insights into patient care [36].

In preventive medicine, the organ clock encourages individuals to view health not only in terms of what they do, but also when they do it. Exercise scheduled during late afternoon and early evening, corresponding to kidney and urinary bladder time, is considered optimal for strength and endurance in TCM. Scientific studies confirm that muscle performance, coordination, and oxygen uptake are greatest during this period. Stress management practices such as meditation or breathing exercises scheduled in the lung period (early morning) may enhance both mental clarity and pulmonary function.

Conclusion

The Traditional Chinese Medicine organ clock represents one of the earliest systematic attempts to link human physiology with the passage of time. Rooted in the principles of Qi circulation, meridians, and the balance of yin and yang, it has guided clinical practice and lifestyle recommendations for centuries. While originally articulated within a philosophical and symbolic framework, many of its observations have found striking parallels in modern chronobiology. Contemporary research demonstrates that organ systems, hormones, and metabolic pathways follow circadian rhythms that strongly influence health, disease expression, and therapeutic outcomes.

By comparing the TCM organ clock with current scientific evidence, it becomes clear that both traditions converge on the same fundamental insight: the body is not static, but dynamically regulated by temporal cycles. This recognition opens new opportunities for integrative health care, where ancient wisdom and modern science can inform each other. Chronotherapy, chrononutrition, and lifestyle interventions aligned with biological rhythms demonstrate that timing is as critical as dosage, diet, or discipline.

At the same time, it is important to acknowledge limitations. The organ clock cannot be directly equated with molecular circadian mechanisms, and many of its emotional or energetic associations lack empirical validation in Western medicine. Nevertheless, its value lies in providing a holistic framework that encourages practitioners and patients to observe patterns in daily life and align health practices with natural rhythms.

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