



Review Article

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A REVIEW ON BREATH, GUT FLORA AND SLEEP QUALITY: UNRAVELLING THE TRIAD OF WELL-BEING

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ABSTRACT

The intricate relationship between Breath, Gut flora, and Sleep Quality significantly impacts overall well-being. This article explores how proper breathing techniques enhance relaxation and oxygenation, fostering better sleep. It also delves into the gut microbiome's role in serotonin production and circadian rhythm regulation. By understanding and optimizing these connections, we can improve sleep quality and consequently, our overall health. Proper breathing techniques, as recommended by Ayurveda, enhance prana (life force) and support mental calmness, aiding sleep. The gut, considered the seat of health (Agni), is crucial for maintaining balance. This relationship between breath, gut flora, and sleep quality is pivotal for overall health and well-being. This article explores how proper breathing positively influence gut health and sleep. The gut microbiome plays a crucial role in regulating neurotransmitters and inflammation, directly impacting sleep patterns. By understanding the synergy between breath, gut flora, and sleep, we can adopt holistic strategies to improve our nightly rest and daily vitality. Harmonizing breath and gut health through Ayurvedic practices like pranayama (mindful breathing practice), balanced diet, and daily routines (dinacharya) promotes good quality of sleep and overall vibrant growth, reflecting the profound synergy between these elements in achieving optimal health and harmony.

Keywords: circadian rhythms, gut brain axis, parasympathetic nervous system, sleep-wake cycles, gut microbiota, sleep quality

INTRODUCTION

Sleep, occupying nearly one-third of our daily routine¹, is fundamental to our health. Research has demonstrated that sleep is vital for various brain functions, such as cognitive performance, memory consolidation, and mood regulation². Additionally, sleep influences almost every system within the body, including the autonomic nervous system, cardiovascular system, immune system, and metabolism³. Sleep deprivation is a condition of not getting enough sleep or not getting good, quality sleep⁴. The effects of sleep deprivation can be wide-ranging and severe, impacting the body and mind which contributes to health problems such as cardiovascular, metabolic, endocrine diseases and poor immunity^{5,6}. There is occurrence of 50 million to 70 million adults in the U.S. that meet the medical criteria for poor quality of sleep at any point in time⁷. Therefore, gaining a deeper understanding of the link between Poor Quality of Sleep and human diseases, along with the underlying mechanisms, is critically important.

The connection between our body's systems is profound. It was thought that sleep regulation is the role of central nervous system (CNS)⁸, but presently it is proved that peripheral nervous system is also very crucial for its regulation. The gut harbours trillions of micro-organisms/bacteria in colon which influence the mood, behaviour, appetite, immunity and most important the Sleep. Healthier the variety of this gut flora healthier is the body. This gut microbiome communicate to brain via various pathways- like neurotransmitters produced by these micro-organisms, along with

through Vagus Nerve. Vagus nerve interns impacts on enteric nervous system and boosts proper digestion, absorption and elimination. The body's digestion tract works optimal in resting phase i.e. when the parasympathetic nervous system is activated, as the blood flow and oxygen is increased to gut. But Stress reverse this calming chain of rest, digest and good health. The stress initiate the body's sympathetic nervous system, which results in shallow breathing and poor digestion resulting in poor gut health. Which is the ultimate cause of various ill health condition including Poor Sleep Quality.

Recent researcher has highlighted the fascinating interplay between breath, gut flora, and sleep quality. Understanding these relationships can open doors to improving our overall well-being through seemingly simple adjustments in our lifestyle and habits. The Gut microbiota functions as an organ in its own, possessing extensive metabolic and functional capabilities⁹. In a healthy individual, it maintains a symbiotic relationship with the gut mucosa and performs significant metabolic, immunological, and gut-protective roles¹⁰. There is substantial evidence indicating that the gut microbiome influences not only digestive, metabolic, and immune functions but also regulates sleep and mental states. Numerous factors can interplay with the gut biome suggesting the bidirectional communication between gut flora and sleep wake regulation¹¹⁻¹³. The breathing also itself play crucial role on gut flora and sleep quality. This review examines the current understanding of how gut microbiota and breathing pattern influence the sleep quality. The current review further explains

the possible mechanisms of how gut microbiota and breathing impact sleep regulation along the brain-gut axis.

GUT-BRAIN AXIS

Among various major systems, the brain, as the central organ of the human body, is the first to be impacted by sleep. Research has shown that sleep is essential for brain functions, including cognitive performance, memory consolidation, and mood regulation¹⁴. Conversely, the effects of sleep loss on the brain are profound and detrimental².

The term "gut-brain axis" refers to the bidirectional signalling between the gastrointestinal (GI) tract and the central nervous system (CNS), encompassing the communication between gut microbiota and the brain¹⁵. Most GI physiological activities are regulated by the enteric nervous system (ENS), which connects the intestines to the spinal cord and brain via muscle sensorimotor and mucosal secretory pathways, using primary afferent and autonomic fibers^{16,17}. In addition to the independent regulation by the ENS, the CNS can also directly influence intestinal function. The most important communication is through the Vagus nerve, a vital and extensive nerve that regulates numerous internal functions. And the another communication involves various chemical messengers (such as neurotransmitters, hormones, and peptides) and through hypothalamic-pituitary-adrenal (HPA) axis¹⁸. The microbes in gut influence the HPA response to control stress being the bidirectional pathway¹⁹. Long term stress converts the body in flight and fight mode to combat that stressor, by releasing glucocorticoids. Circulating glucocorticoids exert an inhibitory effect on the stress response²⁰⁻²³. Stress increases the intestinal permeability and leads to increased susceptibility to gut inflammation resulting in more unwanted secretions from gut flora which disrupt the harmony of body and mind^{24,25}. The Figure 1 depicts the clinical manifestation inside body during healthy and diseased status of microbiome.

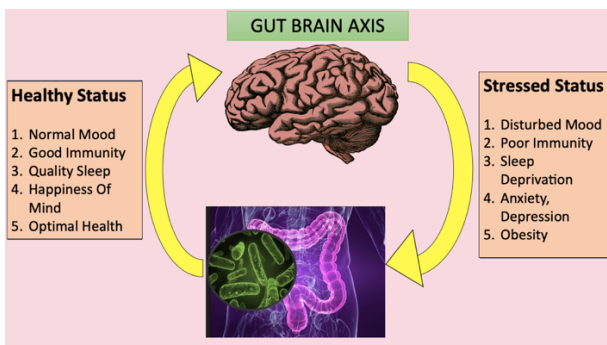


Figure 1: Gut Brain Axis

WHAT AYURVED SAYS

Ayurveda explains the functioning of the mind and body through three primary doshas-Vata, Pitta, and Kapha-which are the governing principles of our physiology²⁶. The Vata dosha encompasses functions related to movement throughout the body, waste elimination, and cognition. According to Ayurveda, its primary seat is in the Pakwa-ashya or colon, where a significant portion of the gut microbiome resides. The Pitta dosha is involved in work related to metabolism, digestion, hormonal balance, thermoregulation, and energy balance, centered in the Pachymana-ashya or mid-gut region. Kapha dosha oversees structural growth, nourishment of tissues and maintenance, primarily located in the urdha-amashaya or chest area^{27,28}. The

distribution of the three doshas at birth is called Prakruti. The researchers found that three main Prakriti types, Vata, Pitta, or Kapha, had a unique microbiome composition²⁹. There is distinct physiological difference among occurrence of gut flora, in individuals of Vata, Piita and Kapha Prakruti to protect them from nervous disorder, inflammatory disease and metabolic disorder respectively³⁰. Thus Ayurveda emphasizes the significance of a proper diet, digestion, exercise and overall lifestyle. Some researchers regard Ayurveda as an ancient science of epigenetics³¹. Epigenetics evolves over time, which can have both positive and negative effects. On the positive side, factors like nutritious food, exercise, and manageable stress can lead to epigenetic changes that promote health. Conversely, negative factors such as processed foods, smoking, and high levels of stress can cause epigenetic changes that harm health³². famous expression "All disease begins in the gut" is so relevant as it ultimately impact the gut health, which influences the sleep quality and other dimensions of human life. Ayurvedic practitioners recognize that each individual has a unique personalized psychophysiological constitution, influenced by diet, digestion, lifestyle including exercise and breathing pattern, stress management, and other environmental factors³³.

BIORHYTHMS AND GUT BACTERIA

Ayurveda distinctly identifies daily, seasonal, and lifetime rhythms. Each day is divided into specific periods governed by Vata, Pitta, or Kapha energies. In the morning there is Kapha period in morning, followed by a Pitta period in noon and then a Vata period in evening. Similarly in late evening, there's another Kapha period, followed by a Pitta period in night and finally a Vata period in early morning before sunrise³⁴. Almost all forms of life, from bacteria to humans, possess an internal "biological clock" that operates on roughly a 24-hour rhythm. When external light and dark signals are disrupted unnaturally, this can confuse the master clock, leading to various health issues³⁵. Gut bacteria also have biological rhythms. Recent research on the gut bacteria reveals not only the presence of a daily rhythm, but also seasonal biorhythms^{36,37}. The relationship between the circadian rhythms and gut microbiota appears to be bidirectional and may have important influences on health^{11,38}. Zeitgebers such as light, exercise, breathing and dietary habits etc. have important effects on the sleep-wake cycle³⁹.

EXPLORATION OF HOST-MICROBIAL MECHANISMS IN THE SLEEP CLOCK

The internal clock orchestrates a myriad of biological processes, from gene regulation to the intricate activation of metabolic pathways that trigger the release of hormones, digestive enzymes, and other metabolites in a coordinated manner⁴⁰. Various environmental factors such as weather changes, lifestyle choices, and dietary habits influence this circadian rhythm. Interestingly, this system not only synchronizes with external cues but also self-aligns with the 24-hour cycle⁴¹. The suprachiasmatic nucleus (SCN) in hypothalamus serves as the body's central circadian clock, governing the circadian rhythm across the entire organism⁴².

In addition to the central clock, peripheral organs can influence sleep-wake regulation. The hypothalamic-pituitary-adrenal (HPA) axis, activated during stress, critically regulates sleep. Moreover, bidirectional communication links microbial interactions in the gut with the enteric nervous system (ENS), immune system, and central nervous system (CNS) via the vagus afferent nerve, collectively defining the gut-brain axis⁴³.

THE STRESSOR IMPACTING GUT FLORA PRECIPITATED IN POOR QUALITY OF SLEEP

Despite the diverse nature of stressors, the biological stress response is mainly regulated by the hypothalamic-pituitary-adrenal (HPA) axis and the Sympathetic Nervous system (SNS). Activation of these systems due to stressors triggers the release of glucocorticoids, catecholamines, and other hormones⁴⁴. Specifically, catecholamines and other neuroendocrine hormones directly influence microbial growth⁴⁵. Activation of the HPA axis or administration of glucocorticoids can lead to arousal, sleeplessness and poor quality of sleep, inflammation, alter GI function and permeability, and modulate immune activity⁴⁶.

MODULATING THE PARASYMPATHETIC NERVOUS SYSTEM

The respiratory rhythm, controlled by our brainstem, affects the balance between the sympathetic and parasympathetic nervous systems⁴⁷. Breathing patterns directly impact the activation of these autonomic nervous system branches. Slow, deep breathing typically activates the parasympathetic nervous system, fostering calmness and relaxation. Conversely, rapid and shallow breathing tends to activate the sympathetic nervous system, resulting in increased arousal and heightened stress response⁴⁸. Stress-induced shallow breathing can disrupt gut flora balance, while a stressed gut can affect breathing patterns. Mindful breathing exercises can alleviate stress, benefiting both gut health and sleep quality. Proper breathing techniques can enhance oxygenation and circulation, promoting a balanced gut microbiome. A healthy gut, in turn, supports better sleep through its influence on neurotransmitter production and inflammation regulation.

The sympathetic nervous system (SNS) triggers the fight-or-flight response in organisms, increasing heart rate, blood pressure, and indirectly, respiration rate. It enhances immediate energy availability. Conversely, the parasympathetic nervous system (PNS) promotes the rest-and-digest state, reducing heart rate and respiration rate, and boosting digestion. The Vagus nerve (VN) serves as the primary mediator and effector of the PNS⁴⁹. These specific respiration style stimulates the vagal nerve. The vagal nerve, as a proponent of the parasympathetic nervous system (PNS), is the prime candidate in explaining the effects of contemplative practices on health, mental health and cognition⁵⁰. The Vagus Nerve provides a potential link between the gut microbiota and the brain. Regular moderate breathing practices brings about physiological adaptations that help maintain intestinal blood flow and correct gut dysfunction. Synergistic Effects of Deep breathing and healthy Gut Flora on Parasympathetic Activation contribute to improved quality of sleep.

The gut microbiota directly contributes to the production of various neurotransmitters, cytokines, and metabolites such as serotonin (5-HT), dopamine, gamma-aminobutyric acid (GABA), short-chain fatty acids (SCFAs), and melatonin. These substances interact with the enteric nervous system and the Vagus nerve, influencing central nervous system (CNS) activity⁵¹. Thus these gut microbiome helps regulate the body's circadian rhythms, the internal clock that governs sleep-wake cycles. Healthy Gut Flora is the Hidden Players in Sleep.

DISCUSSION

This paper highlights the significant interplay between proper breathing techniques, gut flora health, and sleep quality. Proper breathing, particularly deep and Abdominal breathing, stimulates the Vagus nerve, which plays a crucial role in activating the

parasympathetic nervous system⁵². This activation promotes relaxation and reduces stress, which are essential for initiating and maintaining quality sleep⁵³. Acharya Sharangdhar beautifully explained in a verse that through deep breathing, the life energy (Prana Vayu) from umbilicus (Nabhi) travels to heart and throat and then it comes out to external environment from there it takes the pure oxygen (Ambar Peeyush) to body to ignite the Metabolic fire (Agni) for longevity of a person⁵⁴. The gut, the mind and breathing combinedly have overall great impact to let a person sleep sound.

The findings suggest that deep breathing not only aids in stress reduction but also positively impacts gut health. The gut-brain axis, a bidirectional communication system between the central nervous system and the gastrointestinal tract, is influenced by breathing patterns. Proper breathing techniques can enhance vagal tone, which in turn supports a healthy and diverse gut microbiome. This symbiotic relationship is crucial as a balanced gut flora contributes to the production of neurotransmitters like serotonin, which regulate sleep cycles and mood⁵⁵.

Moreover, the improvement in gut health through proper breathing may lead to a reduction in gut-related issues such as inflammation and dysbiosis, which are known to disrupt sleep. By promoting a healthy gut environment, proper breathing indirectly fosters better sleep quality. Incorporating proper breathing techniques into daily routines can be a simple yet effective strategy to enhance gut health and improve sleep quality.

CONCLUSION

Good quality of Sleep is a fundamental physiological need, essential for the regeneration of both the body and mind. The relationship between breath, gut flora, and sleep quality is a testament to the interconnectedness of our body's systems. By paying attention to our breathing and gut health, we can significantly enhance our sleep quality, leading to better overall health and well-being. Embracing simple lifestyle changes can pave the way for restful nights and energized days, illustrating the profound impact of these often-overlooked aspects of our daily lives. A night of restful sleep is the silent architect of a vibrant day, crafting clarity and vitality from the depths of peaceful slumber enhancing quality of life. Future research should explore the long-term effects of sustained breathing practices on gut flora and sleep patterns, as well as the potential for integrating these practices into holistic health approaches for better overall well-being.

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