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ROLE OF NIDRA IN THE MODULATION OF AGEING PROCESSES: AN AYURVEDA PERSPECTIVE

[1]Dr. Soumyadip Saha, [2]*Dr. Mangalagowri V. Rao, [3]Dr. Kanchan Chowdhury

[1]Post Graduate Scholar, Dept. of Swasthavritta & Yoga, Faculty of Ayurveda, IMS, Banaras Hindu University, Varanasi, Uttar Pradesh.
[2]Professor, Dept. of Swasthavritta & Yoga, Faculty of Ayurveda, IMS, Banaras Hindu University, Varanasi, Uttar Pradesh.
[3]Assistant Professor, Dept. of Swasthavritta & Yoga, Faculty of Ayurveda, IMS, Banaras Hindu University, Varanasi, Uttar Pradesh.

***Corresponding Author: Dr. Mangalagowri V. Rao**

Professor, Dept. of Swasthavritta & Yoga, Faculty of Ayurveda, IMS, Banaras Hindu University, Varanasi, Uttar Pradesh. **DOI:** https://doi.org/10.5281/zenodo.18796758

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ABSTRACT

Introduction: Sleep is a vital component of life. It is a dynamic brain activity that arises from the interaction of two fundamental systems, the circadian rhythm and the homeostatic desire to sleep, rather than a passive condition of unconsciousness. Ayurveda has identified *Nidra* (Sleep) as one of the three main pillars of health *(Trayopastambha)*, and such sleep is considered the necessary solution to all aspects of physical, emotional, and mental well-being. In 1999, the World Health Organisation designated the year as the International Year of Older Persons (IYOP), marking a significant turning point in global awareness and action toward the challenges faced by older people. Since then, ageing and age-related health issues have gained significant international attention. Currently, there is a growing global interest in understanding the ageing process and improving the quality of life for older adults. Projections indicate that by the mid-21st century, the old-age dependency ratio will be doubled in more developed countries and triple in less developed regions, posing substantial social and economic challenges. This presents an opportune moment to delve into the potential of Ayurveda, which offers promising approaches to enhance longevity & delay ageing. **Results & Discussions**: *Nidra* acts as a highly effective *Rasayana* (rejuvenator), a supporting pillar for health, longevity, and delayed ageing. Ayurvedic knowledge on *Nidra* as a supreme rejuvenator and its role in delaying the ageing process is captured in this review study. Good quality sleep in an appropriate amount helps repair tissues, balance hormones, and prevent degenerative changes. From a contemporary perspective, sleep promotes cellular regeneration, enhances immunity, and reduces oxidative stress factors that are directly associated with ageing. This research paper highlights the physiological and therapeutic significance of *Nidra* in slowing down the ageing process. **Conclusion**: *Nidra* is the basis of whole-body restoration and slowing the ageing process.

KEYWORDS: Circadian Rhythm**,** Inflammageing, Longevity, *Rasayana*, Sleep, Telomere, *Yoga*.

INTRODUCTION

In today's rapid-paced environment, where stress and lifestyle-related disorders are prevalent, the desire for everlasting youth and vitality continues to capture human interest. Ayurveda, the ancient art of living, provides deep insights for achieving longevity and wellness through the combination of dietary and lifestyle habits. *Nidra* holds a place of profound significance in both classical Ayurvedic philosophy and modern biomedical science. In the Ayurvedic tradition, *Nidra* (sleep) is considered one of the Trayopastambha[1], the three fundamental pillars of life alongside Ahara (food) & Brahmacharya (celibacy). Classical texts describe *Nidra* as essential for maintaining *Bala* (strength), *Vyadhi kshamatva* (immunity), mental clarity, and *Ayushya* (longevity).[2] Sleep is a complex, highly organised

physiological state influenced by many intrinsic and extrinsic factors, and some sleep processes are active, involving significant cortical brain interaction.[3]

Sleep disruption, referred to as *Nidranasha*, is associated with a range of degenerative outcomes, including early signs of ageing, fatigue, cognitive decline, and weakened bodily functions.[4] Both insufficient and excessive sleep can disrupt the balance of the Doshas.[5] Therefore, *Nidra* is crucial for sustaining equilibrium in the *Sattva* (mind), *Sharira* (body), and *Atma* (spirit). From a modern perspective, sleep is increasingly recognised as a biological necessity that has profound effects on both mental and physical health.[6] Global health surveys, by organisations like the Sleep Foundation and WHO, indicate that a sizable section of the adult population currently gets inadequate sleep or poor-quality sleep. This results in a higher risk of premature mortality and several chronic illnesses affecting longevity and quality of life. Indeed, meta-analyses reveal a U-shaped association between sleep duration and all-cause mortality, with negative health consequences linked to both short (less than 7 hours) and long (more than 9 hours) sleep durations.[7] In Ayurveda, the concept of ageing is attributed to the depletion of Ojas (the vital essence) and an imbalance among the Tridoshas (Vata, Pitta, and Kapha).[8] A molecular perspective is increasingly being used to understand ageing, which is defined as a progressive loss of physiological integrity. In anti-ageing research, hallmarks like telomere attrition, epigenetic changes, mitochondrial dysfunction, inflammation, and loss of Proteostasis have become quantifiable objectives.[9]

Interestingly, new studies show that many of these same ageing processes are modulated by sleep. For instance, insufficient sleep has been linked to increased systemic inflammation, shortened telomeres, accelerated epigenetic ageing, and reduced glymphatic clearance of neurotoxins.[10] Sleep is positioned as a natural rejuvenator. Though Ayurveda has promoted *Nidra* as a therapeutic and preventative measure, its potential as a scientifically validated anti-ageing intervention is only recently gaining mainstream research interest. This review aims to critically assess existing evidence on the anti-ageing effects of *Nidra* (sleep) by examining both Ayurvedic perspectives and current scientific findings. It investigates how sleep affects ageing biomarkers, explores possible mechanisms, and considers how integrative approaches, such as Yoga-Nidra, may enhance these effects.

METHODOLOGY

Detailed information on the topic has been collected & reviewed by a systematic screening of different classical Ayurvedic texts, i.e., *Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, *Rasa Vagbhata*, Ayurveda dictionaries, & also commentaries by Chakrapani, Dalhana, and Arunadatta. Different literature databases such as PubMed, Scopus, Google Scholar, DHARA, and Namaste portal were searched by using keywords like *'Sleep', 'Nidra', 'Circadian rhythm', 'Telomeres', 'Ageing', 'Ayurveda', 'Yoga Nidra', 'Oxidative stress', and 'Inflammageing'* with the help of Boolean operators 'AND', 'OR', 'NOT'. Filters like review articles, clinical trials, within the last 20 years & free full articles were applied.

Inclusion criteria

- Articles published in English.
- Peer-reviewed studies discussing sleep, ageing, and their physiological mechanisms.
- Papers exploring Ayurvedic or integrative approaches to ageing.
- Studies on *Yoga Nidra* and psychophysiological outcomes.

Exclusion criteria

- Articles unrelated to ageing or sleep physiology.
- Non-English publications lack translations.

Articles were selected based on relevance to the topic, scientific findings, and conceptual alignment with Ayurvedic principles. After screening titles and abstracts, full-text articles were evaluated, and duplicates or low-quality reports were excluded. Ayurvedic concepts were interpreted and mapped to modern biological theories of ageing. Sleep-related outcomes from contemporary studies were then critically analysed to validate Ayurvedic claims about *Nidra*'s anti-ageing properties.

The Science of Ageing in Ayurveda: *Jara*, also known as *Vardhakya* or ageing, is described as the process whereby the body becomes worn out over time. Acharya Sushruta mentioned a group of naturally occurring diseases named '*Svabhavabala Roga*'[11], which includes *Kshut* (hunger), *Pipasa* (thirst), *Nidra* (sleep), *Jara* (old age), and *Mrityu* (death). As per the doctrine of natural cessation, i.e., '*Swabhavoparamavada*'[12], there are specific causes for the manifestation of life; however, there is no particular cause for its termination. Death is simply a natural consequence following birth. Ageing is shaped by various influences impacting the *Shareera* (body), *Indriya* (the senses), the *Satva* (mind and psyche), *Agni* (metabolism), and *Bala/Ojas* (immunity or vitality). Other contributors to the ageing process include *Parinama* (cellular changes), *Sharira vriddhikara bhavas* (genetic and phenotypic traits), and developmental processes initiated during pregnancy.[13] It's universally recognized that life follows a cycle of birth, growth, and death. Yet, while people accept this truth intellectually, most resist ageing and fear death. Despite perceiving ageing and related illnesses as abnormal, human behaviours and lifestyle choices often hasten biological ageing. The process of decay accompanies Jara and manifests in the form of various degenerative changes. Although these changes are natural (*Kalaja Vriddhavastha*), they are not pleasant.[14]

The misuse of the senses, exposure to disruptive sensory inputs (*Pancha jnanendriyas*), and unhealthy choices that disrupt proper bodily and mental transformations (*Parinama*) all contribute to disease and suffering, both physical and mental. Such disturbances weaken the *dhatusamya* (balance of bodily tissues), leading to *Akalaja Vriddhavastha* (premature or pathological ageing).[15] Ayurveda takes a holistic approach, focusing on maintaining *dhatusamya*, a state of equilibrium that includes mental, physical, biological, physiological, and spiritual well-being. According to Ayurveda, homeostasis is preserved when the *dhatu* (body's tissues), *Dosha* (energy), *Agni* (Digestive fire), and *Mala* (waste products) stay in balance. This promotes healthy ageing, also known as '*Sukhayu'* or *Kalaja Vriddhavastha.*[16]

Characteristics of *Akalaja Jara* (Progeria): According to Rasa Vagbhata, certain factors such as frequent traveling or excessive walking (*Pantha*), intake of cold or refrigerated food (*Sheetala Ahara*), improper dietary habits (*Kadanna*), and psychological disturbances or stress (*Manasa Pratikula*) can hasten the premature onset of ageing, referred to as *Akalaja Jara*.[17] The physical manifestations of early ageing include the appearance of wrinkles (*Vali*), premature greying of hair (*Palitya*), hair fall (*Khalitya*), decrease in reproductive vitality (*Shukra Apravartanam*), reduction in vitality or immunity (*Ojakshaya*), muscular flaccidity (*Mamsa Saithilya*), reduced physical activity or ability (*Asamartha Cheshta*), and general debility or lack of fat tissue (*Analpameda*). On the psychological level, symptoms may include diminished cognitive function (*Medha Hani*), feelings of sadness or hopelessness (*Avasannata, Nairasya*), memory impairment (*Smriti Hani*), lack of motivation (*Utsaha Hani*), and decline in judgment or reasoning (*Buddhi Hani*).[18]

Ayurvedic Interpretation of Modern Biological Theories of Ageing

Table 1: Correlation of various theories of ageing with Ayurvedic principles.

Theories of Ageing	Ayurvedic principles
Wear & Tear theory: The body, like a machine, deteriorates over time due to the accumulation of damage from use and exposure to environmental stressors. Over time, cellular components fail to repair efficiently, leading to dysfunction and degeneration.	By nature, Dhatukshaya in old age occurs due to a lack of nourishment consequent to Vishamagni and *Vatavriddhi*.
Waste accumulation theory: As cells age, they accumulate damaged molecules, misfolded proteins, and other cellular debris that interfere with normal cellular processes, leading to dysfunction and, in some cases, cell death.[19]	The faulty diet and lifestyle result in Agni vaishamya, leading to *Amotpatti* at the *Jatharagni* and *Dhatvagni* levels, further vitiating *Doshas* as well as Dhatus, leading to *Doshadushya Sammurchana* and the accumulation of Ama (morbid matter), resulting in various metabolic disorders with the advancement of age. This hastens the process of ageing along with the shortening of life.
Free radical theory: Superoxide and other free radicals hurt the cell's macromolecular parts, which build up over time and make cells and eventually organs stop working. The macromolecules, such as nucleic acids, lipids, sugars, and proteins, are susceptible to free radical attack.	Innate factors, such as an individual's body constitution, including *Vata and Pitta Prakriti*, as well as their mindset, or *Manasa Prakriti*, influence the onset of ageing in an individual. External lifestyle factors, such as the quality, composition, and quantity of diet, stressors (psychological, physical, and physiological), exposure to climatic adversities, and toxins from pollution, influence the ageing process.
Mutation & telomere theory: DNA damage and mutations accumulate over time, leading to cellular dysfunction. The telomere theory focuses on the role of telomeres, protective caps on chromosome ends, which shorten with each cell division. As telomeres shorten, they reach a critical length, leading to cellular senescence or apoptosis, contributing to the ageing process.	*Kala or Parinama* results in the onset of dryness due to a lack of nutrition and *Vata vrddhi*. This results in internal and external dryness, producing degeneration of the *Dhatus.*
Mitochondrial damage theory: oxidative stress-induced damage to mitochondria, specifically the buildup of mutations in mitochondrial DNA (mtDNA), is a primary cause of ageing.	*Agni* is responsible for longevity, complexion, health, energy, nourishment, lustre, *Ojas*, *Tejas*, and Prana. The *Vishamagni* developed over time and results in ageing.

Effect of *Nidra* on Ageing: Sleep is a crucial physiological process that humans spend almost one-third of their lives engaged in. Despite making them vulnerable to predators, sleep has been universally preserved in mammals, birds & reptiles. Sleep was once thought to be a passive condition of unconsciousness.

However, it has been evident since the latter part of the 20th century that human sleep is a highly structured, intricate physiological state impacted by several internal and external variables, and that certain sleep processes are active, including substantial cortical brain activity.[20] The quantity and quality of sleep contribute greatly to our physical and mental well-being and performance the next day, and thus sleep has a huge impact on our overall quality of life. Just as nutrition plays a critical role in ensuring a long and healthy lifespan, sleep also plays a crucial part. However, contemporary lifestyles, shift work, social jet lag, & environmental blue light pollution significantly compromise sleep quality in an increasing number of people in all age groups, especially in working adults and the elderly.[21] Ayurveda warns that inadequate or irregular sleep may contribute to the early onset of age-related disorders and accelerate the ageing process.[22]

The *Charaka Samhita* emphasizes that proper sleep is critical for happiness and sorrow, nourishment and emaciation, strength and debility, knowledge and ignorance, and ultimately, life and death are all influenced by sleep.[23] The concept of *Nidra* in Ayurveda states that it is not just rest; it is a process of withdrawal of sensory and motor functions, which are natural and cyclic.[24] It comes following the detachment of the mind from the sense organs and the objects of the senses, enabling the body and mind to recover. As Acharya Charaka tells, during *Nidra*, the mind, along with the sensory organs, becomes fatigued or out of sync with their workings. This mental disengagement promotes the recovery of *Ojas*, a vital force associated with immunity, strength, and longevity. Moreover, Ashtanga Hridaya states that the sleep that is *yatha kala* (timely) and *prakurta* (natural) causes strength, vitality, nourishment, intelligence, happiness, sexual power, and longevity.[25] According to Acharya Charaka, 'Samajagaranasvapnam'[26] i.e., balanced in sleep & wakefulness, is also mentioned in the context of Achara *Rasayana*. Thus, *Nidra* is not only perceived as a passive state but an active regenerative process through which life continues, and degeneration is delayed. Poor sleep quality & impaired sleep hygiene are associated with an increased risk of various diseases like HTN, Coronary artery diseases, etc.[27] Ayurveda recognises *Nidranasha* (sleep deprivation) as a pathological state, leading to accelerated ageing.[28] Improper sleep hurts carbohydrate metabolism and endocrine function. Besides, it also reduces the metabolic activity in the brain. Symptoms include dryness of the body, heaviness in the eyes and head, loss of mental clarity, and early wrinkling or greying of hair, etc., are the clear indicators of premature senescence. Therefore, sleep debt may increase the severity of age-related chronic disorders.[29]

Scientific Evidence of Sleep, Circadian Rhythm on Ageing: The circadian rhythm is an endogenous 24-hour cycle, which is regulated by the suprachiasmatic nucleus of the hypothalamus. It influences the sleep-wake cycle, hormonal secretion, cellular repair, and metabolic functions.[30] A synchronised circadian rhythm promotes optimal DNA repair, antioxidant enzyme activity, melatonin secretion, and telomere maintenance, all of which are crucial to slow the ageing process.[31]

Cellular Repair & DNA Protection: Sleep deprivation is associated with DNA damage and impaired repair mechanisms, accelerating cellular ageing.[32] Deep stages of sleep (in particular, REM, slow-wave sleep) correlate with cellular repair. During sleep, growth hormone is secreted, which stimulates tissue repair and regeneration.[33]

Preservation of Telomere length: The telomere theory of ageing focuses on the role of telomeres, protective caps on chromosome ends, which shorten with each cell division. As telomeres shorten, they reach a critical length, leading to cellular senescence or apoptosis, contributing to the ageing process. Studies have shown that people with poor sleep quality or reduced sleep duration have significantly shorter telomeres.[34]

Reduction of Oxidative stress**:** Sleep alleviates oxidative stress, a key driver of cellular ageing. Sustained sleep deprivation leads to a high concentration of reactive oxygen species (ROS), which damage proteins, lipids, and DNA.[35] Restorative sleep reestablishes antioxidant mechanisms and decreases inflammation, which slows down the ageing process.[36]

Neuroprotective Effects**:** The brain is detoxified through the glymphatic system during sleep, and especially during REM sleep. It clears the beta-amyloid and other neurotoxins, which are involved in such age-related neurodegenerative diseases as Alzheimer's disease.[37],[38]

Regulation of Hormones: Sleep promotes optimal levels of hormone secretion, including melatonin, cortisol, insulin, and growth hormone. Melatonin, secreted primarily during the night in response to darkness, is a potent antioxidant. It protects mitochondrial function as well as the integrity of mitochondrial DNA, reduces oxidative stress, and enhances DNA repair.[39] Interruptions in the melatonin rhythms have been attributed to rapid ageing and chronic illnesses.[40]

Collagen Repair: Poor sleep is associated with signs of intrinsic skin ageing, such as fine lines, reduced elasticity, and uneven pigmentation. Sleep improves skin barrier function and supports collagen synthesis.[41]

Circadian Gene Expression and Longevity: Clock genes like PER1, CLOCK, and BMAL1 regulate cell cycle, metabolism, and DNA repair. Disruption in these genes (due to irregular sleep cycles or shift work) leads to chronic inflammation, metabolic syndrome, and accelerated ageing.[42] Experimental studies in animals have shown that disruption of circadian genes leads to

premature ageing phenotypes, including hair loss, skin atrophy, and osteoporosis.[43]

Impact of *Yoga Nidra*: *Yoga Nidra* is a guided meditation and relaxation method. Between wakefulness and sleep, it puts the practitioner in a hypnagogic state. *Yoga-Nidra* provides profound mental relaxation and psycho-physiological regeneration, making it a highly effective anti-ageing strategy. Chronic stress accelerates ageing through hormonal imbalance. *Yoga Nidra* has been shown to reduce cortisol levels, thereby significantly reducing stress.[44] *Yoga Nidra* practices share similar neuroendocrine effects as mindfulness meditation, which has been associated with preserved telomere length.[45] *Yoga Nidra* induces deep relaxation that improves sleep architecture. It enhances growth hormone secretion, supports DNA repair, and slows neurodegeneration.[46]

Table 2: Various studies have shown the impact of Yoga Nidra.

Study	Population	Duration	Outcome
Amita et al., 2009[47]	Women with menstrual disorders	6 months	↓ IL-6, ↓ BP, ↓ cortisol
Rani et al., 2011[48]	Hypertensive adults	3 months	↓ Anxiety & stress; ↑ Hormonal balance.
Rani & Tiwari, 2020 [49]	Post menopausal women	6 weeks	↓ Stress; ↑ Cognitive performance
Kanth R et al., 2022 [50]	University students	2 months	↑ Sleep quality, ↓ Insomnia

DISCUSSIONS

Nidra holds a foundational place in Ayurveda, being considered one of the three primary pillars essential for maintaining overall health, alongside diet and a balanced lifestyle. Just as nutrition, sleep also plays a critical role in ensuring a long and healthy lifespan. However, factors such as age, daily habits, dietary patterns, and environmental influences can significantly affect sleep quality. Ayurveda warns that inadequate or irregular sleep may contribute to the early onset of age-related disorders and accelerate the ageing process.[51] Scientific evidence supports this Ayurvedic insight. Studies have shown that insufficient sleep can disturb the body's internal biological clock, or circadian rhythm, which may lead to several chronic health conditions, including obesity, heart disease, and cognitive decline. In one notable study, Moller-Levet CS et al., 26 individuals were subjected to a week of restricted sleep followed by a week of adequate rest. Blood samples collected after each phase underwent RNA transcriptome analysis, revealing that sleep deprivation altered the expression of 711 genes. These genes were primarily linked to biological functions like circadian regulation, chromatin remodelling, inflammation, immunity, stress responses, oxidative damage, and metabolism. Inadequate sleep doesn't just affect gene expression; it also increases the risk for serious metabolic conditions such as type 2 diabetes, obesity, and cardiovascular diseases. A large-scale meta-analysis of long-term cohort studies, mainly involving individuals over the age of 60, demonstrated a clear link between poor sleep quality and the likelihood of developing type 2 diabetes, as well as a higher risk of premature death in those who slept less than six hours per night.[52] Current biochemistry confirms these manifestations arise from mitochondrial redox collapse: sleep loss drives ROS production, disrupts electron-transport complexes I & IV, fragments mitochondria, and suppresses mitophagy, thereby accelerating neurodegeneration.[53] Concomitantly, even one night of partial deprivation upregulates IL-6, TNF-α, and CRP-cytokines central to 'inflammageing'.[54] These scientific findings strongly reinforce the Ayurvedic viewpoint that sleep is vital for maintaining strength, radiant skin, immune resilience, and healthy bodily functions across the lifespan. Modern research thus validates Ayurveda's age-old wisdom that restorative, high-quality sleep is indispensable for promoting optimal health and slowing the ageing process.

CONCLUSION

Sleep, or *Nidra*, is not merely a passive state but an essential physiological function with regenerative, restorative, and *Rasayana*-like properties. Classical Ayurvedic wisdom, dating back thousands of years, emphasises Nidra as Trayopastambha, an essential practice for maintaining life, strength, and longevity. This is echoed in modern science, where high-quality sleep is now recognised as a key modulator of oxidative stress, telomere attrition, neurodegeneration, and hormonal imbalance, all of which are the hallmarks of ageing. The convergence of ancient Ayurvedic knowledge and modern biomedical evidence positions *Nidra* as a natural and accessible intervention to delay degenerative changes and enhance quality of life in later years. Moreover, practices like *Yoga Nidra* further extend these benefits by offering psychological resilience and hormonal equilibrium. Incorporating proper sleep hygiene alongside Ayurvedic lifestyle principles may offer a comprehensive, low-cost strategy for promoting healthy ageing worldwide. Future interdisciplinary studies should explore the clinical applications of *Nidra*-based interventions in geriatric healthcare and longevity research.

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