

THE PHYSIOLOGICAL APPROACH TO AGEING: A COMPARATIVE ANALYSIS OF AYURVEDIC AND MODERN PERSPECTIVES - A NARRATIVE REVIEW

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ABSTRACT

Introduction: The aging of the global population poses significant medical and social challenges. While aging is a natural process marked by a gradual decline in physiological functions, this article will explore it from Ayurvedic and modern scientific perspectives. By examining these approaches, we aim to highlight how ancient wisdom and contemporary science can work together to promote healthy aging and longevity. This comparative analysis will provide insights into the physiological understanding of aging from both viewpoints. **Methods:** A comprehensive review of Ayurvedic texts, modern medical literature and online articles on aging was conducted. The physiological approaches to aging in both perspectives were analysed and compared. **Results:** The analysis revealed that both Ayurvedic and modern perspectives acknowledge the importance of maintaining physiological homeostasis and promoting healthy lifestyle habits to mitigate the effects of aging. However, distinct differences were observed in the underlying philosophies and approaches to aging, with Ayurveda emphasizing individualized interventions and modern medicine focusing on pharmacological and technological interventions. **Discussion:** This comparative analysis highlights the value of integrating Ayurveda and modern perspectives to promote healthy aging. The findings suggest that a holistic approach, combining the strengths of Ayurvedic and modern perspectives, may provide a more comprehensive understanding of the aging process and inform the development of effective interventions to promote healthy aging.

KEYWORDS: Ageing, Ayurveda, Modern and Physiology.

INTRODUCTION

The aging of the global population is one of the most significant medical and social demographic challenges worldwide. Aging is an inevitable and natural process that all living organisms undergo, characterized by the gradual decline of physiological functions. The number and proportion of people aged 60 years and older in the population are increasing. In 2019, the number of people aged 60 years and older was 1 billion. This number will increase to 1.4 billion by 2030 and 2.1 billion by 2050.^[1] As the global population ages, understanding the physiological mechanisms of aging is crucial for developing effective interventions to promote healthy aging.^[2] The World Health Organization (WHO) defines the healthy aging process as maintaining functional ability to enable well-being in older age.^[3]

From the perspective of modern science, aging is often viewed as the accumulation of cellular damage, metabolic slowdown, and the loss of the body's ability to repair itself. This process is intricately linked to genetic factors, environmental influences, and lifestyle choices, leading to various age-related diseases and conditions.^[4] However, in Ayurveda, aging is understood through a holistic framework that considers not just the physical changes but also the mental, emotional, and spiritual aspects of life. Ayurveda, the ancient system of medicine from India, presents a unique and integrated approach to aging, focusing on the balance of bodily energies (*Doshas*) and the prevention of disease through natural means including diet, herbs, lifestyle practices, and mindfulness.^[5]

This article will explore the physiology of aging from both Ayurveda and Modern scientific perspectives. By examining how each system perceives and addresses the aging process, we aim to provide a deeper understanding of how ancient wisdom and modern science can complement one another in promoting healthy aging and longevity. This exploration seeks to bridge the gap between two perspectives one rooted in ancient traditions and the other grounded in contemporary biological science, offering a comprehensive approach to aging and wellness.

AIMS AND OBJECTIVES

1. To explore and discuss Ayurvedic concepts and principles related to aging.
2. To understand the health-related problems of the elderly, recognizing aging as a natural yet palliative disease that serves as a risk factor for many other health conditions.
3. To compare and contrast the Ayurvedic and modern perspectives on aging and its management.

MATERIALS AND METHODS

This article is based on a comprehensive review of both ancient Ayurvedic texts and modern scientific literature related to aging. Ayurveda texts including *Charak Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, and various commentaries were analysed to understand the traditional Indian perspective on aging. Modern scientific literature, including studies on cellular and molecular mechanisms of aging, was reviewed to provide a contemporary understanding of the aging process and age-associated diseases. A systematic search of electronic databases including PubMed, Scopus, and Web of Science was conducted using keywords such as “aging,” “Ayurveda” “Modern Medicine,” and “physiological mechanisms.”

Concept of Aging in Ayurveda

Aging, or *Jara*, is an unavoidable life process that is deeply integrated into Ayurvedic philosophy. Ayurveda offers a holistic and profound understanding of aging, recognizing it as a natural progression rather than a process to be feared or resisted. According to Ayurveda, the way age is influenced by the constitution (*Prakriti*), lifestyle, diet,

environment, and most importantly, the balance of the three *Doshas Vata, Pitta, and Kapha*. Ayurvedic classics have detailed explanations of specific ways for *Rogi Pareeksha*. *Vaya Pareeksha* included one of the *Dasavidha Pareeksha* in which the chronological age and the longevity are the subjects.^[6]

In Ayurveda, aging is primarily associated with the predominance of *Vata Dosha*^[7], the force that governs movement, dryness, and degeneration. The Ayurvedic perspective of aging encompasses not only the physical degeneration of the body but also the mental, emotional, and spiritual aspects of aging.

The Stages of Life

Vaya is considered as the period from birth to the present of a living person. Ayurveda divides human life into several distinct stages based on age, each governed by different *Doshas*. The three main categories the *Brahatrayi* used to categorise *Vaya* are *Baalayavastha* (During this phase, *Kapha Dosha* predominates, promoting growth, vitality, and immunity. *Madhyamavastha* (*Pitta Dosha* governs this period, marked by energy, productivity, and transformation) and *Jeernavastha* (*Vata Dosha* becomes dominant, leading to the gradual decline of strength, metabolism, and bodily functions) and there are some changes over the age ranges used to define each category. This division of life stages is important in Ayurveda because it underscores the need for tailored care and treatment for each stage, acknowledging the body's changing requirements over time.

Table 01: Vaya classification according to different Acharyas.

| S. I | Acharya | Bala | Madhyama | Vridhdha |
|------|-----------------------------------|------------|-------------|---------------|
| 1. | Charaka ^[8] | Upto 30yrs | 30 to 60yrs | 60yrs onwards |
| 2. | Susrutha ^[9] | Upto 16yrs | 16 to 70yrs | 70yrs onwards |
| 3. | Ashtanga Hrdaya ^[10] | Upto 16yrs | 16- 60yrs | 60yrs onwards |
| 4. | Ashtanga Sangraha ^[11] | Upto 16yrs | 16-70yrs | 70yrs onwards |

Aging and Doshas^[12]

In Ayurveda, the *Doshas* are considered the fundamental energies that govern all bodily functions. Their interaction with the body, mind, and environment shapes the process of aging. *Vata*, the primary *Dosha* responsible for movement, dryness, and the nervous system, becomes increasingly dominant as age. *Vata* is associated with qualities like coldness, dryness, lightness, and roughness qualities that contribute to the physical manifestations of aging. As *Vata* increases with age, it causes a gradual depletion of *Ojas*, the vital essence that sustains life force and immunity. The depletion of *Ojas* leads to symptoms such as dry skin, thinning hair, stiffness in joints, memory loss, and a reduction in overall vitality. *Vata*'s increasing influence also affects the digestive fire (*Agni*), which slows down with age, leading to weakened digestion and the accumulation of *Ama* (toxins). As a result, older adults often experience reduced energy, slower recovery from illness, and overall frailty. In youth and middle age, *Pitta* predominates, representing metabolism, transformation, and energy. During this phase, the body is at its most active and productive. However, as the individual ages and *Pitta* diminishes, there is a decline in metabolic fire, which can result in slower digestion, reduced appetite, and less efficient absorption of nutrients. The decrease in *Pitta* influence can also lead to a decline in cognitive function, as mental sharpness and memory, which are *Pitta* domains, start to fade with age. Additionally, the cooling and soothing characteristics of *Pitta* may diminish, which can lead to a general sense of dryness and a decrease in moisture levels throughout the body. In the developmental stage of childhood, *Kapha* predominates, providing essential stability, structure, and nourishment. As people age, *Kapha* gradually diminishes, and the body loses its resilience and capacity for regeneration. This reduction in the qualities of *Kapha* can lead to the weakening of the bones, muscles, and

joints, contributing to the frailty and loss of physical endurance often seen in older age. Interestingly, though reduction in *Kapha* is linked to aging, some of its stabilizing qualities may help maintain mental clarity and emotional balance in old age, as *Kapha* governs steadiness and calmness in the mind.

In Ayurveda, aging is divided into two distinct categories *Kalaja Jara* (Natural Aging) and *Akalaja Jara*.^[13] This refers to the natural aging process that occurs over time. *Kalaja Jara* is associated with the gradual increase of *Vata Dosha* and is a natural part of life. The process begins after the age of 60, marked by the gradual loss of vitality, strength, and flexibility. The body undergoes natural degeneration, and the senses become less sharp. Memory and cognition also start to decline, as the body's tissues lose moisture and elasticity. *Akalaja Jara* refers to premature aging, which occurs due to imbalances in lifestyle, diet, and environment. External factors such as stress, poor eating habits, lack of sleep, and exposure to toxins can accelerate the aging process and cause early degeneration of tissues. In Ayurveda, *Akalaja Jara* is seen as an imbalance of the *Doshas*, primarily aggravated *Vata*, which leads to symptoms such as early wrinkles, grey hair, physical frailty, and mental decline.

Ayurveda approach to manage ageing

Ayurveda offers numerous solutions to address both *Kalaja* and *Akalaja Jara*. The key lies in balancing the *Doshas*, nourishing the body, and rejuvenating the mind.

Diet and Nutrition: Aging is marked by reduced digestive capacity, and Ayurveda emphasizes the importance of eating warm, nourishing, and easily digestible foods. Foods that are heavy, oily, and rich in *Ojas* (vitality) are recommended to counterbalance the dryness and roughness of aging.

Rasayana: Ayurveda recommends specific herbs for rejuvenation, known as *Rasayana* therapies. These herbs help slow down the aging process, rejuvenate the body's tissues, and enhance longevity.

Panchakarma therapy: It helps to cleanse the body of accumulated toxins (*Ama*), balance the *Doshas*, and restore vitality. Procedures such as *Abhyanga*, *Shirodhara*, and *Nasya* are used to promote longevity and slow down the degenerative effects of aging.

Mental and Spiritual Well-being: Ayurveda recognizes that mental and emotional health plays a crucial role in the aging process. Practices such as meditation, yoga, and mindfulness help reduce stress and enhance emotional balance, which in turn slows the aging process. Emotional health is vital to prevent early degeneration of both body and mind.

The Concept of Aging in Modern Science

Aging is an inevitable biological process that every living organism experiences. In modern science, aging is generally understood as the gradual deterioration of cellular and physiological functions over time, leading to a decline in the body's ability to maintain homeostasis and repair itself. While aging is universal, the mechanisms that drive it are complex, involving genetic, environmental, and lifestyle factors. This article will analyse the effects of aging on various physiological systems and will also discuss prominent theories that seek to elucidate the biological foundations of aging.

The Effects of Aging on Each System^[14]

The aging of the nervous system is associated with a decline in cognitive functions, including memory, learning, and problem-solving abilities. This process involves significant structural changes within the brain, notably a reduction in brain volume, particularly in the hippocampus, which is essential for memory formation. Furthermore, there is a decrease in both the number of neurons and synapses, accompanied by diminished levels of neurotransmitters such as dopamine and acetylcholine.^[15] These alterations can adversely impact mood, memory, and motor functions. Consequently, neurodegenerative diseases, including Alzheimer's and Parkinson's disease, are more prevalent among the elderly population as a result of these neurological changes.

As individuals age, the heart's capacity to effectively pump blood diminishes, while the blood vessels lose their elasticity, resulting in increased stiffness. This deterioration contributes to the development of hypertension and elevates the risk of cardiovascular diseases, including atherosclerosis, myocardial infarction, and stroke. The build-up of plaque within the arteries restricts blood flow, and changes in the electrical conduction system of the heart may lead to arrhythmias. As the years advance, the heart's once robust ability to pump blood becomes increasingly less efficient, resembling a tyre worn from countless journeys. The blood vessels, which should possess the flexibility of a well-tuned instrument, gradually lose their elasticity, becoming stiffer and more resistant. This transformation fosters an environment ripe for hypertension, laying the groundwork for a greater likelihood of cardiovascular afflictions such as atherosclerosis, heart attacks, and strokes. The stealthy accumulation of plaque within the arteries constricts the vital flow of blood, while the heart may also be plagued by arrhythmias, a direct consequence of disruptions in its intricate electrical conduction system.

The musculoskeletal system undergoes significant changes with advancing age, resulting in a decline in strength, flexibility, and mobility. The reduction in calcium absorption leads to decreased bone density, contributing to conditions such as osteopenia and osteoporosis, which render bones more fragile and susceptible to fractures. Furthermore, there is a notable decrease in muscle mass, commonly referred to as sarcopenia, accompanied by alterations in muscle fibres that diminish overall muscle strength and endurance. Additionally, the joints may exhibit increased stiffness and reduced lubrication, resulting in disorders such as osteoarthritis, which can cause pain and restrict the range of motion.^[16]

The aging process significantly impacts the endocrine system, a complex network of glands that secrete hormones vital for numerous bodily functions. One of the notable changes is the decline in growth hormone production as individuals age. This reduction can hinder the body's ability to repair tissues and regenerate cells, which can contribute to slower recovery from injuries and an increase in body fat, particularly around the abdomen. In terms of sexual health, aging causes a gradual decrease in sex hormones, with women experiencing a notable drop in estrogen levels during menopause. This hormonal shift can lead to a range of symptoms, including hot flashes, mood swings, and vaginal dryness. For men, testosterone levels also decline with age, which can manifest as reduced libido, fatigue, and even challenges with muscle maintenance. Furthermore, the function of the thyroid gland, which plays a crucial role in regulating metabolism and energy expenditure, often becomes less efficient with age. This can lead to a slower metabolic rate, making it more challenging for older adults to maintain a healthy body weight. As a result, many may experience fluctuations in energy levels, contributing to feelings of fatigue or lethargy throughout the day. Overall,

these hormonal changes can have a profound impact on physical health, emotional well-being, and the overall quality of life in aging individuals.

As individuals age, the efficiency of the immune system declines, a process referred to as immunosenescence. This decline is characterized by a decrease in the production of immune cells, resulting in a diminished capacity to respond to new infections and vaccines. Consequently, older adults experience increased susceptibility to infections and longer recovery times from illnesses. These factors may lead to the development of chronic conditions, including autoimmune disorders and a heightened risk of cancer. Additionally, inflammation often becomes more pronounced in the elderly, further contributing to the prevalence of age-related diseases such as arthritis and cardiovascular conditions.^[17]

The skin displays the most prominent signs of aging. Over time, the degradation of collagen and elastin fibers within the dermis leads to the development of wrinkles, sagging, and decreased skin elasticity. Furthermore, the skin becomes thinner and more susceptible to bruising, while sebaceous glands produce diminished amounts of oil, resulting in dryness. The reduction in melanin production contributes to the emergence of age spots and uneven pigmentation. Additionally, hair follicles exhibit a slowdown in hair production, leading to thinning and greying of hair. Nails may also become brittle and prone to splitting.

With age, the lungs lose elasticity, and the chest wall becomes stiffer. This reduces the efficiency of gas exchange and lung capacity. The respiratory muscles weaken, and the cilia in the respiratory tract become less effective at clearing out mucus and pathogens. As a result, older individuals may experience difficulty breathing, reduced stamina, and a higher susceptibility to respiratory infections like pneumonia.

Theories of Aging^[18]

Programmed Theories of Aging: Programmed theories suggest that aging is a result of genetically programmed processes. According to this view, the body follows an internal biological clock that determines the rate and timing of aging. Key theories in this category include:

Genetic Program Theory: This theory proposes that aging is controlled by specific genes that regulate the life span. These genes may be responsible for regulating cell growth, repair, and death.

Telomere Shortening Theory: Telomeres are repetitive DNA sequences at the ends of chromosomes that protect them from damage during cell division. Over time, telomeres shorten with each cell division, eventually leading to cellular senescence (when a cell no longer divides). The shortening of telomeres has been linked to aging and age-related diseases.

Damage or Error Theories of Aging: Damage or error theories suggest that aging is caused by the accumulation of cellular damage over time. This damage can be caused by internal factors (such as metabolic processes) or external factors (such as environmental stressors). Key theories in this category include:

Free Radical Theory: Free radicals are unstable molecules that can damage cells, proteins, and DNA by stealing electrons from other molecules. This oxidative damage accumulates over time, leading to cellular dysfunction and aging. Antioxidants are thought to help combat free radical damage, but their effectiveness in slowing aging is still debated.

Mitochondrial Theory of Aging: Mitochondria, the energy-producing organelles in cells, generate energy but also produce free radicals as a by-product. Over time, mitochondrial DNA accumulates mutations due to this oxidative stress, leading to reduced cellular energy production and contributing to aging-related degeneration.

Theories of Aging Based on Inflammation: Chronic inflammation, often referred to as inflammation, is increasingly recognized as a major factor in the aging process. As we age, the body experiences a low-level, persistent inflammatory response that can contribute to many age-related diseases, such as cardiovascular disease, Alzheimer's disease, and arthritis. This theory posits that the immune system's overactive response to tissue damage and pathogens accelerates aging.

Disposable Soma Theory: This theory posits that organisms allocate resources between reproduction and maintenance of the body (soma). Since the body is expendable after reproduction, the body prioritizes energy towards reproductive success, leading to the accumulation of damage in non-reproductive cells over time. This explains why aging is more pronounced in non-reproductive cells, while germ cells (sperm and eggs) are maintained for reproductive purposes.

Hormesis Theory: The hormesis theory suggests that exposure to mild stressors, such as physical exercise, caloric restriction, and certain environmental toxins, can stimulate adaptive responses that enhance the body's resilience to aging. Essentially, low levels of stress can trigger repair mechanisms that promote longevity and improve health. The concept of hormesis has led to research on interventions like intermittent fasting and exercise as potential ways to slow aging.

Modern approach to manage the Aging

Modern approaches to managing aging encompass a range of medical, lifestyle, technological, integrative strategies. Medical approaches include hormone replacement therapy, senolytic therapy, stem therapy, and gene therapy to promote healthy aging and prevent related diseases. Lifestyle approaches focus on exercise, nutrition, stress management, and sleep to maintain physical and mental well-being.^[19] Technological advancements such as artificial intelligence, machine learning and telemedicine enable personalized health monitoring and interventions. By combining these modern approaches, individuals can optimize their aging process and improve overall health and well-being.

DISCUSSION

Aging is a complex phenomenon that is examined through distinct lenses in Ayurveda and modern science. Modern science primarily attributes the aging process to biological mechanisms such as cellular senescence, oxidative stress, and the progressive decline in organ functionality over time. Key theories, including the free radical theory of aging, telomere shortening, and mitochondrial dysfunction, suggest that aging arises from the accumulation of cellular damage and genetic factors. These processes tend to accelerate due to a combination of environmental influences, lifestyle choices, and genetic predispositions. In contemporary medicine, interventions such as antioxidants, anti-aging medications, and regenerative therapies aim to mitigate or reverse the molecular and cellular damage associated with aging. Research on age-related diseases, such as Alzheimer's disease, cardiovascular conditions, and diabetes, focuses on elucidating these molecular alterations and identifying pharmaceutical or technological solutions to address them. Although advancements in biotechnology and genetic engineering present promising opportunities, modern science

often places greater emphasis on symptom management and disease prevention rather than on comprehensive rejuvenation strategies.

Ayurveda, the ancient system of Indian medicine, offers a more holistic view of aging. Aging, is a natural process that occurs as a result of an imbalance in the body's energies or *Doshas* (*Vata*, *Pitta*, and *Kapha*), with *Vata* being the primary *Dosha* associated with aging. Ayurveda sees the aging process not just as a biological phenomenon but as one influenced by mental, emotional, and spiritual factors. It emphasizes the importance of maintaining balance through proper diet, lifestyle, and the use of rejuvenative therapies known as *Rasayana*. Ayurveda focuses on preventing the premature aging process by harmonizing the doshas, detoxifying the body (Panchakarma), and restoring vitality through herbs like *Ashwagandha* and *Amalaki*, which help preserve the body's life force, *Ojas*. Unlike modern science, Ayurveda does not seek to fight aging through external interventions but rather promotes a balanced lifestyle to maintain health and longevity. While modern science targets aging at the cellular level, Ayurveda integrates physical, mental, and spiritual health as essential components of aging gracefully. Both systems, although differing in their approach, provide valuable insights into how aging can be understood and managed, highlighting the importance of balance, prevention, and personalized care.

While there are various steps to manage the aging process, the modern medicine approach is different from the Ayurvedic approach. While neither approach is superior or inferior, the paramount difference lies in how both these sciences address the aging process. A subset of researcher considers aging itself to be a disease because, aging is associated with an accumulation of cellular and molecular changes that impair normal physiology, impairment of normal physiological functioning of cells, tissue, organs and bodily systems, in turn triggers age-associated diseases, and aging itself is a risk factor for other diseases. Anti-aging approaches would therefore require an ideal disease-free physiological state at a certain age and a "to-do" list of drug interventions to keep the individual as close to that ideal state as possible. If aging is viewed as a disease as some researchers do, then the most logical approach would be to overcome the aging process with drugs like metformin, resveratrol, masoprocol, rapamycin and others. However, a drug approach de-emphasizes the enormous potential of disease prevention through lifestyle changes as the entire aging process is viewed in mechanistic and reductionistic terms that involve manipulating a specific pathway or molecules with powerful drugs. In contrast, a systems approach is designed to address multiple pathogenic mechanisms and optimizing the therapeutics for each of those targets. The past few decades of genetic and biochemical research have revealed an extensive network of molecular interactions involved in the aging process, suggesting that a systems approach or a network-based therapeutics approach, rather than a single target-based approach, may be feasible and potentially more effective for delaying or reversing the aging process.

Ayurveda considers aging as a natural and inevitable process and offers time-tested therapies for healthy aging. Ayurveda professes the principles of harmonious living and being in tune with nature, universal consciousness, environment, and individual constitution. Healthy aging would therefore require for the individual to bring in harmonious impressions, incorporate healthy lifestyle practices and routines that promote good health and well-being, and encourage healthy transformation of the body and mind through harmonious choices and actions. Unfortunately, lack of systematic safety and efficacy studies or proof-of-concept trials have relegated these Ayurvedic concepts of aging to a conceptual model. Thus, it is imperative that these concepts are revisited and re-examined to generate best research evidence that support these underlying principles, addresses causality, and minimizes bias and chance effects.

An important application of the Ayurvedic program described above is that a multi-component lifestyle system may serve as a platform on which these anti-aging drugs targeted to the patient's risk factors and that is likely to fail as a monotherapeutic, may succeed as key components of a “whole” therapeutic system. Thus, a combinatorial approach incorporating the best of modern medicine and Ayurvedic principles will ensure adding life to years and years to life. Recent advancements in regenerative medicine, including stem cell therapy and gene-editing technologies like CRISPR, hold promise for reversing age-related damage and restoring tissue function. Additionally, personalized medicine and precision healthcare are becoming increasingly important, with genetic testing and biomarkers being used to tailor interventions for individual patients based on their unique genetic makeup and health status.

Table 2: Comparative Analysis of Ayurvedic and Modern Perspectives of aging.

| Aspect | Ayurveda | Modern Medicine |
|------------------|---|---|
| Concept of aging | Natural process, <i>Vata</i> dominance | Cellular /molecular changes, genetic factors |
| Key factors | <i>Dosha</i> imbalance, <i>Dhatu</i> degeneration | Oxidative stress, DNA damage, telomere shortening |
| Focus | Holistic balance (mind, body and spirit), disease prevention | Cellular health |
| Intervention | <i>Rasayana</i> therapy, life style modification, <i>Yoga</i> | Pharmacological agents, diet, exercise |
| Goal | Promote longevity, vitality and mental clarity | Delay age related diseases, enhance lifespan |

CONCLUSION

The aging process is a complex, highly individualized phenomenon, influenced by genetic, environmental, and lifestyle factors, which effects physical and mental health, functional capacity, and overall quality of life. Ayurveda the prevention and management of aging can be approached from a holistic perspective that emphasizes the importance of lifestyle choices, dietary habits, and rejuvenation therapies to slow the aging process. Conversely, modern medicine tends to adopt a more biological focus, addressing the molecular and cellular mechanisms associated with aging. Both methodologies offer significant contributions to the understanding of this complex phenomenon. A synergistic approach, which integrates Ayurvedic principles of prevention with contemporary therapeutic advancements, may enhance health span and alleviate the impacts of aging. Continued research in both arenas is essential to achieve a more comprehensive understanding of aging and its management.

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