Review Article

Beyond the Mat: Exploring the Potential Clinical Benefits of Yoga on Epigenetics and Gene Expression: A Narrative Review of the Current Scientific Evidence

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Abstract

Yoga, an ancient practice rooted in Indian philosophy, has gained widespread popularity for its numerous physical and mental health benefits. In the recent years, there has been growing interest in understanding how yoga influences gene expression and epigenetic modifications. This narrative review investigates the molecular mechanisms, by which yoga influences gene expression, focusing on deoxyribonucleic acid (DNA) methylation, and histone modifications. Research literature was sourced from various databases to select randomized clinical trials and comparative cohort studies examining yoga's impact on gene expression and epigenetic changes. Our findings suggest that yoga could exert anti-inflammatory effects, as it downregulates pro-inflammatory cytokines, soluble interleukin IL-2 receptor gene expression, and transcription factors. Yoga also boosts the innate antiviral response and brain health by enhancing natural defense genes and microRNA-29c expression. Notably, it activates telomerase, linked with cellular longevity, and promotes nitric oxide synthetase and neuroprotective gene expression, implying benefits for ocular health. In addition, yoga fosters DNA repair and cellular integrity maintenance by increasing oxoguanine glycosylase one protein and p53 gene expression. However, the diversity of yoga interventions in these studies complicates direct comparisons and broader application. The current research primarily focuses on short-term outcomes, offering a limited understanding of yoga's long-term epigenetic impacts. Future research should address these gaps by studying the enduring effects of Yoga, personalizing interventions, and contrasting techniques.

Keywords: *Deoxyribonucleic acid methylation and histone modifications, epigenetics, gene expression, Yoga*

Introduction

Yoga, a practice that dates back over 5000 years, has evolved from its origins in ancient India to a globally recognized and embraced holistic approach to health and well-being. Conventionally, yoga encompassed physical postures (asanas), breath control techniques (pranayama), and meditation practices (dhyana). These components of yoga promote physical, mental, and spiritual harmony. In recent years, scientific research has uncovered the potential benefits of yoga in managing chronic medical conditions, reducing stress, and improving overall health.

Epigenetics, the study of heritable changes in gene expression that do not involve alterations in the deoxyribonucleic acid (DNA) sequence itself, has shed light on how lifestyle factors, including yoga, can influence disease onset and progression.[1] While DNA's genetic code provides the blueprint, epigenetic modifications layer a regulatory hierarchy dictating gene activation and repression. These modifications encompass DNA methylation, histone alterations, and noncoding RNA control, collectively governing gene expression. Epigenetic imprints impact transcription initiation alongside intricate processes such as alternative splicing and messenger RNA (mRNA) stability and sculpting mRNA synthesis.

History of Yoga

Yoga has a rich history that dates back thousands of years, rooted in ancient Indian philosophy. The term "Yoga" is derived from the Sanskrit word "Yuj," which means

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unity or integration, emphasizing its goal of achieving harmony between the body, mind, and spirit. Yoga is not merely a form of exercise but a spiritual discipline aimed at self-realization and ultimate liberation. Conventionally, the tenets of Yoga were passed down through oral traditions but were eventually documented in sacred scriptures such as the Vedas, Upanishads, and the Bhagavad Gita.[2]

Over time, Yoga evolved, giving rise to various schools and styles, each emphasizing different aspects of the practice. Hatha Yoga, which is prevalent in the Western societies, includes physical postures (asanas), breath control techniques (pranayama), and meditation practices (dhyana). Asanas promote relaxation, flexibility, and body awareness. Pranayama focuses on specialized breathing techniques to achieve mental tranquility. Dhyana, or meditation, fosters mental stability, emotional balance, and an improved quality of life.[3]

The popularity of Yoga has skyrocketed in the recent years, with millions of people around the world embracing it for its physical and mental health benefits. From stress reduction to enhanced flexibility and strength, Yoga has become a widely accepted practice for promoting overall well-being.

Epigenetics and Gene Expression

Epigenetics is a field of study that explores heritable changes in gene expression that do not involve alterations in the DNA sequence itself. It examines the dynamic structure of the epigenome, which includes DNA, histone proteins, and small RNA molecules. Epigenetic marks, such as DNA methylation and histone modifications, regulate gene activity by modulating DNA accessibility and protein interactions.[4] DNA methylation involves adding methyl groups to DNA, primarily at CpG islands and is often associated with gene silencing. Histone modifications, such as acetylation and methylation, influence the compactness of DNA, thereby affecting gene expression. Small RNA molecules, such as miRNAs and siRNAs, regulate genes through RNA interference.

Gene expression refers to the process of converting genetic information encoded in DNA into functional gene products, such as proteins. DNA methylation and histone modifications play crucial roles in regulating gene expression patterns.[5] Aberrations in these processes can silence genes or contribute to developing diseases such as cancer.[6] Understanding the relationship between gene expression and epigenetics is essential for unraveling the mechanisms underlying development, health, and disease.

Objective

The objective of this review is to examine the current evidence regarding the effects of Yoga on epigenetic regulation. By delving into the various components of Yoga, including physical postures, breath control techniques, and meditation practices, this review aims to elucidate the potential influence of yoga on gene expression and epigenetic modifications. By identifying existing research limitations and proposing future research directions, we hope to contribute to our understanding of the complex interplay between yoga and epigenetics and its potential to promote holistic well-being.

Methods

A literature search was performed across several databases, including PubMed, Cochrane, Scopus, and Web of Science. The aim was to identify randomized clinical trials or comparative cohort studies that investigated the impact of yoga on gene expression and epigenetic changes. The search strategy included a selection of relevant keywords to ensure the comprehensiveness of the research. The selected articles were analyzed and synthesized to extract the most relevant information regarding the effects of yoga on epigenetics and gene expression.

Epigenetic Regulation in Various Health Conditions

Epigenetic modifications influence gene expression, chromatin structure, and cellular responses. These alterations have significant implications for various health conditions. In the context of cancer, epigenetic modulation of genes, such as the Kisspeptin1 (KISS 1), can influence the downstream expression of other genes instrumental in cancer development and progression.[7] Stroke, another condition significantly impacted by epigenetic regulation, has been a focus of research to understand the pathogenesis of the disease.[8] Alzheimer’s disease, a prevalent neurodegenerative disorder, has also been associated with epigenetic patterns influenced by dietary factors.[9]

Epigenetic regulation also plays a crucial role in metabolic health, particularly in obesity and metabolic diseases’ onset. Aging processes and neurodegenerative disorders, such as Alzheimer’s disease, are also influenced by common epigenetic alterations.[10,11] In addition, epigenetic mechanisms have been implicated in addiction, offering potential therapeutic targets for intervention.[12] Gene expression and epigenetic regulation influence various biological processes and diseases. Understanding these relationships can lead to developing targeted therapies and disease prevention and management interventions.

Effects of Yoga on Health and Well-being

In recent years, research exploring the therapeutic effects of yoga has proliferated, highlighting its potential to improve physical, psychological, and cognitive well-being.[13,14] Numerous studies have investigated the effects of yoga on various conditions, including mental health disorders, cardiovascular and respiratory diseases, and cancer.

Furthermore, Yoga's potential role in managing the health impacts of COVID-19 has also been explored.

Yoga has positively affected psychological well-being, reducing anxiety, depression, and stress in various populations.[15] It has also been associated with improved physical health and quality of life, including enhanced physical well-being, energy levels, and reduced fatigue.[16] In addition, yoga practice has been shown to improve attention, verbal memory, and cognitive function in individuals with mild cognitive impairment and dementia.[17]

Regular yoga practice has been shown to improve various biomarkers and physiological indicators, including cholesterol levels, oxidative stress (OS) response, glucose tolerance, and blood pressure.[18] It may also impact neuroendocrine systems and reduce the physical effects of stress.[19]

Meditation, an integral part of yoga, has its own set of benefits, including the promotion of telomere maintenance through the reduction of cognitive stress, stress arousal, and the enhancement of positive mental states and relevant hormonal factors.[20]

Overall, existing evidence suggests that yoga can positively affect various aspects of health and well-being, including psychological well-being, physical health, cognitive functioning, stress reduction, and physiological indicators.

Mechanism of Action of Yoga

The therapeutic effects of yoga on the human body can be attributed to various mechanisms. One such mechanism is vagal stimulation, which enhances baroreflex sensitivity, reduces inflammatory cytokines, and lowers blood pressure and resting heart rate. This pathway is associated with improved endothelial function and reduced cardiovascular disease risk.

Yoga also promotes parasympathetic activation, leading to relaxation and stress reduction.[21] It modulates hormonal stress responses and influences the autonomic nervous system, contributing to balanced physiological responses.[22] In addition, yoga's impact extends to the brain, increasing body awareness, enhancing motor performance, and reducing pain.[23] The precise mechanisms underlying these effects are still under investigation but may involve brain activity and structure alterations.[24,25]

Other proposed pathways include physical movement, relief of physical and mental stress, enhanced body awareness, and potential influences on stem cell trafficking and tissue regeneration. These pathways collectively contribute to yoga's positive effects on conditions such as chronic low back pain and type II diabetes and enhance overall well-being.

Impact of Yoga on Epigenetics and Gene Expression

Emerging research indicates a potential role of Yoga in epigenetic regulation and gene expression modification. Several randomized trials have explored the influence of yoga interventions on gene expression profiles, thought to be mediated by epigenetic pathways. In this section, we will discuss the key findings of those trials. A summary of these studies is also listed in Table 1.

The randomized controlled study by Bower *et al*. investigated the impact of a 12-week Iyengar yoga intervention on inflammation-related gene expression in breast cancer (BC) survivors experiencing persistent fatigue.[26] The findings revealed that the yoga group exhibited decreased activity of the pro-inflammatory transcription factor NF-κB, increased anti-inflammatory glucocorticoid receptor activity, and reduced cyclic amp responsive element binding protein (CREB) family transcription factor activity compared to the control group. In addition, while the control group showed an increase, the yoga group maintained stable levels of the soluble tumor necrosis factor (TNF) receptor type II, a marker of pro-inflammatory cytokine activity. These observations suggest that a restorative Iyengar yoga program could potentially benefit inflammatory activity in fatigued BC survivors.

In their randomized trial, Black *et al*. investigated the effects of an 8-week yogic meditation intervention on the activity of inflammatory and antiviral transcription control pathways in family dementia caregivers.[27] The participants were randomized to either Kirtan Kriya meditation (KKM) or Relaxing Music listening. Genome-wide transcriptional profiles were collected from peripheral blood leukocytes at baseline and follow-up. The results showed that KKM treatment led to differential expression of 68 genes, including upregulated immunoglobulin-related transcripts and downregulated pro-inflammatory cytokines. Plasmacytoid dendritic cells and B-lymphocytes were identified as the primary cellular context for these transcriptional alterations. Bioinformatic analysis suggested reduced NF-κB signaling and increased activity of IRF1 in structuring these effects. Overall, the findings suggest that a brief daily yogic meditation intervention can reverse the pattern of increased pro-inflammatory cytokines and decreased innate antiviral response genes observed in individuals facing significant life stressors.

The randomized study by Hashizume *et al*. explored the effects of a Mindfulness-Based Stress Reduction (MBSR) program on the elderly individuals in Chitose City, Japan.[28] The results revealed that participants in the MBSR group, who underwent the program thrice weekly for 4 weeks, showed significant improvements in cognitive function, as measured by the Japanese version of the Montreal Cognitive Assessment-J. They also exhibited increased expression of microRNA-29c (miR-29c) in neuron-derived exosomes (NDEs) in their blood. Moreover, a significant decrease

Table 1: Characteristics of the selected studies

Study	Description	Population and size	Type of intervention	Outcome measures	Conclusion
Bower *et al*., 2014[26]	RCT	Breast cancer survivors, *n*=21	Iyengar yoga versus health education	Inflammation-related gene expression and circulating pro-inflammatory cytokine activity	Iyengar Yoga intervention reduced inflammation-related gene expression in breast cancer survivors
Black *et al*., 2013[27]	RCT	Dementia Caregivers, *n*=39	KKM versus RM	Activity of inflammatory and antiviral transcription factors	In response to KKM treatment, 68 genes were found to be differentially expressed (19 up-regulated, 49 down-regulated) after adjusting for potentially confounded differences in sex, illness burden, and BMI
Hashizume *et al*., 2021[28]	RCT	People aged 65 or above, *n*=45	Meditation versus no intervention	Expression of miR-29c in NDEs in blood	Meditation can prevent neuronal loss and cognitive impairment in elderly people by increasing the neuronal expression of miR-29c
Epel *et al*., 2016[29]	RCT	Meditators and nonmeditators in a retreat, *n*=102	Meditation versus vacation	Transcriptome-wide expression patterns and aging-related biomarkers	Increased expression of a number of telomere maintenance pathway genes and an increase in measured telomerase enzymatic activity in regular meditators
Chen *et al*., 2016[30]	RCT	Healthy female Chinese participants, *n*=30	Yoga versus control group	Metabolic profile and inflammatory cytokines	Hatha yoga practice in healthy Chinese female participants could improve hallmarks related to MetS
Harkess *et al*., 2016[31]	RCT	Psychologically stressed women, *n*=28	Yoga versus control	IL-6, TNF and CRP protein levels, and the DNA methylation of these genes and the global indicator, *LINE-1*	Reduced DNA methylation in the yoga group
Twal *et al*., 2016[32]	RCT	Healthy volunteers, *n*=20	Yoga versus reading	Salivary secretion of pro inflammatory markers	Levels of IL-1β, IL-8, and MCP-1 were significantly reduced in yoga group when compared to control group
Rajbhoj *et al*., 2023[33]	RCT	Male volunteers from an industrial area, *n*=48	Yoga versus observation	sIL-2R and lung functions	Improved lung functions and reduced sIL-2R
Dada *et al*., 2021[34]	RCT	POAG, *n*=60	Meditation and medical therapy versus medical therapy	IOP and TM gene expression	Significant decrease in IOP and changes in TM gene expression in the meditation group
Nair *et al*., 2022[35]	RCT	Type 2 diabetes mellitus patients, *n*=61	Yoga versus exercise	OS-induced DNA damage and the efficiency of DNA repair	Mediation analysis indicated that improvements in oxidative DNA damage and DNA repair in the Yoga Group
Khedmati Zare *et al*., 2021[36]	RCT	Breast cancer survivors, *n*=30	Yoga with VD supplementation versus VD	Expression of survival-related genes in leukocytes and psycho-physical status in breast cancer survivors	Yoga combined with low and high doses of VD improved physical fitness and psychological measures while only in combination with a high dose of VD positively modified the leukocytes cell survival-related gene expression
Sharma *et al*., 2022[37]	RCT	Obese adults, *n*=72	Yoga versus standard of care	Expression of genes related to oxidative stress, inflammation, and aging	Significant relative fold change in the expression of the TERT gene, linked to ageing, in the yoga group compared to standard care

RCT: Randomized controlled trial, BMI: Body mass index, DNA: Deoxyribonucleic acid, LINE: Long Interspersed Nuclear Elements, TERT: Telomerase reverse transcriptase, VD: Vitamin D, OS: Oxidative stress, IOP: Intraocular pressure, TM: Trabecular meshwork, sIL-2R: Soluble interleukin-2 receptor, CRP: C-reactive protein, TNF: Tumor necrosis factor, IL: Interleukin, miR: MicroRNA, NDEs: Neuron-derived exosomes, MetS: Metabolic syndrome, MCP-1: Monocyte chemotactic protein-1, POAG: Open-angle glaucoma patients, KKM: Kirtan Kriya meditation, RM: Relaxing music was observed in the expression of DNA methyltransferase three alpha, DNA methyltransferase three beta, and signal transducer and activator of transcription 3 in NDEs of the MBSR group. These findings imply that MBSR could potentially prevent neuronal loss and cognitive decline in the elderly by enhancing neuronal miR-29c expression.

The study by Epel *et al*. examined the effects of a meditation retreat and a vacation-like environment on cellular health in healthy women nonmeditators.[29] The results showed significant gene expression changes in all groups, indicative of improved stress response, immune function, and amyloid beta metabolism-a “vacation effect” phenomenon. Those experienced in meditation demonstrated additional postintervention changes in gene networks associated with lower protein synthesis and viral genome activity. While all groups reported enhanced well-being after the intervention, novice meditators maintained lower distress levels over time than the vacation group. Regular meditators showed a trend toward increased telomerase activity, suggesting that meditation retreats provide additional cellular health benefits beyond the vacation effect.

The randomized study by Chen *et al*. investigated the effects of an 8-week Hatha yoga training on blood glucose, insulin, lipid profiles, endothelial microparticles (EMPs), and inflammatory status in healthy Chinese females.[30] The results demonstrated that Yoga significantly reduced plasma cholesterol, low-density lipoprotein-cholesterol, insulin levels, and several EMPs. Furthermore, there was a reduction in pro-inflammatory cytokines secretion in both unstimulated conditions and when stimulated with Pam3Cys-SK4 in the cultured whole blood from the yoga group. The authors hypothesized that this could be due to a decrease in toll-like receptor 2 protein expression in peripheral blood mononuclear cells in the Yoga group. They concluded that yoga practice may benefit metabolic and inflammatory markers.

The pilot randomized study by Harkess *et al*. investigated the molecular impact of an 8-week yoga intervention on immune markers in a nonclinical population of women reporting psychological distress.[31] The study measured protein levels of interleukin (IL)-6, TNF, and C-reactive protein (CRP), as well as DNA methylation of these genes and a global indicator, long interspersed nuclear elements (LINE)-1. Moderate correlations were found between these markers and psychological variables, particularly with CRP protein levels and methylation of IL-6, methylation of IL-6, CRP, and LINE-1, as well as the TNF region, was examined. The yoga group showed a trend of elevated IL-6 levels and reduced methylation of the TNF region compared to the wait-list control group. However, no significant differences were observed for other genes. The authors proposed the need for more extensive research to understand the epigenetic mechanisms and the correlation between mind–body therapies and the immune system.

In their study, Twal *et al*. investigated the impact of yogic breathing exercises on salivary cytokines using a multiplex enzyme-linked immunosorbent assay.[32] Twenty healthy volunteers were divided into two groups: one group performed yogic breathing exercises, and the other read a text of their choice. Saliva samples collected postexercise showed significant reductions in IL-1 β, IL-8, and monocyte chemotactic protein-1 levels in the yoga group compared to the control group. The findings point to the potential anti-inflammatory effects of Yoga practices.

In their randomized pilot study, Rajbhoj *et al*. examined the impact of a 16-week yoga practice on lung function and inflammation levels in 48 male volunteers living in a polluted industrial area.[33] The results revealed that those who participated in yoga training witnessed significant improvements in lung function, including forced vital capacity, forced expiratory volume, and peak expiratory flow rate, compared to the control group. In addition, participants in the yoga group experienced a notable reduction in soluble IL-2 receptor (sIL-2 R) levels, indicating decreased inflammation. The study concludes that Yoga could enhance lung function and reduce inflammation in individuals residing in pollution-exposed industrial regions.

Dada *et al*. investigated the impact of mindfulness meditation (MM) combined with standard medical therapy on patients with primary open-angle glaucoma.[34] This randomized controlled trial found that 3 weeks of daily 45-min MM sessions, combined with medical therapy, significantly reduced intraocular pressure compared to medical therapy alone. In addition, MM led to significant upregulation of nitric oxide synthetase and neuroprotective genes and downregulation of pro-inflammatory genes ($P = 0.001$), suggesting a direct effect on ocular tissues.

In a randomized clinical trial by Nair *et al*. involving 61 patients with type 2 diabetes (T2D), a 10-week yoga intervention significantly reduced DNA damage indicators and oxidative DNA damage markers and improved fasting blood sugar levels compared to routine exercises.[35] The study also identified increased oxoguanine glycosylase 1 (OGG1) protein expression, indicating enhanced DNA repair ($P = 0.034$). The beneficial effects of Yoga on DNA damage in T2D patients were found to be mediated primarily by the reduction of oxidative DNA damage and the enhancement of DNA repair.

In their study, Khedmati Zare *et al*. examined the combined effect of Yoga and Vitamin D supplementation on gene expression and psycho-physical status in BC survivors who had completed chemotherapy and radiotherapy 5 years before recruitment.[36] Thirty patients were randomly assigned into three groups: high dose (4000 IU) of Vitamin D supplementation; yoga training with a high dose of Vitamin D; and yoga training with a low dose (2000 IU) of Vitamin D. Participants performed the Hatha yoga style twice a week. Patients in the Vitamin D and the Yoga combined groups showed significant improvements in body fat percentage, shoulder flexibility, walk tests, and anxiety compared to those taking only high-dose Vitamin D. In addition, Yoga combined with high-dose Vitamin D significantly increased the expression of the p53 gene ($P = 0.002$). In contrast, both yoga and Vitamin D groups showed upregulated Bcl2 genes. Although NF-κB and Bax expression decreased in all groups, this was not statistically significant. The authors concluded that combining yoga training with a high dose of VD supplementation has further benefits on some crucial molecular markers of immune cell survival and BC survivors' physical and psychological status.

Finally, a randomized control trial by Sharma *et al*. examined the impact of a 12-week yoga-based lifestyle intervention (YBLI) on gene expression related to OS, inflammation, and aging in obese adults.[37] The study results did not reveal significant changes in Telomerase Reverse Transcriptase (TERT), IL-6, and NF-kappa B fold change between the groups at week 12. However, noteworthy observations included a more significant relative fold change of TERT in the YBLI group at 2 weeks and a lower relative fold change of TNF α at week 12 in the YBLI group, albeit inconsistently. Both groups exhibited increased TERT expression at week 2, more pronounced in the YBLI group, and the SC group demonstrated lower TNF α gene expression at weeks 2 and 4 but an increase at week 12. While these findings contradicted the study's original hypothesis, they provide valuable insights for the scientific community to refine future research designs. The authors suggested potential benefits of YBLI and SC on aging-related TERT gene fold change in obesity, though these benefits were not discernible until week 12. However, these results must be interpreted cautiously and in correlation with other studies. Further comprehensive studies are necessary to fully understand the beneficial effects of YBLI on OS, inflammation, and aging-related gene expression in obesity.

These studies provide evidence of the potential of Yoga in modulating gene expression and epigenetic mechanisms across various health conditions. However, larger and more rigorous studies are needed to validate these findings and unravel the precise mechanisms underlying the beneficial effects of Yoga.

Discussion

The current literature on yoga's influence on gene expression and epigenetic modifications is promising, highlighting its potential in various physiological functions and stress responses. Studies indicate that Yoga has the potential to regulate our body at a cellular level. It appears to downregulate pro-inflammatory cytokines and decrease the expression of the sIL-2 R gene and transcription factors, suggesting an anti-inflammatory effect. In addition, Yoga appears to increase innate antiviral response which may boost our natural defense genes and also enhances the neuronal expression of miR-29c, potentially promoting brain health. It also stimulates telomerase activity, suggesting its potential role in cellular longevity. Furthermore, Yoga appears to upregulate nitric oxide synthetase and neuroprotective genes, resulting in improved ocular health. It also seems to increase OGG1 protein expression and the p53 gene, suggesting its role in enhancing DNA repair and maintaining cellular integrity.

However, several limitations in the existing research must be addressed to enhance the reliability and understanding of these effects. The diversity of yoga interventions used in research complicates comparisons and generalizations. Most studies have focused on short-term effects, leaving a gap in our knowledge about the long-term sustainability of yoga-induced epigenetic changes.

Future studies should implement standardized protocols, rigorous study designs, and appropriate control groups to strengthen the scientific basis of Yoga's effects on gene expression and epigenetic modifications. Interdisciplinary collaborations among researchers from various fields can provide a comprehensive understanding of the underlying mechanisms. In addition, exploring the potential of Yoga as a cost-effective and accessible complementary therapy in health-care systems can lead to valuable insights.

Health-care professionals play a pivotal role in integrating Yoga as a complementary therapy by staying informed about research findings and providing patient guidance. Specialized training programs for yoga therapists can ensure the safe and effective delivery of interventions in clinical settings. Future research directions could focus on tailoring yoga practices to specific population groups and developing personalized yoga prescriptions to optimize therapeutic benefits.

Advancements in technology, such as telehealth platforms, virtual reality, and wearable devices, promise to facilitate the adoption and personalization of yoga therapy. Investigating the relationship between Yoga and epigenetics offers a unique opportunity to uncover Yoga's physiological and psychological benefits. Tailored yoga interventions for individuals with chronic stress or metabolic disorders could provide targeted and effective therapies.

Addressing current research gaps, such as protocol standardization, rigorous study design, and inclusion of stratified control groups, is essential to strengthen the scientific basis of Yoga's effects on gene expression and epigenetic modifications. An interdisciplinary approach and integrating yoga into mainstream health-care systems will be crucial in harnessing its therapeutic potential and promoting health and resilience through epigenetic regulation.

Conclusion

Yogas influence on gene expression, and epigenetic modifications illustrate its potential in promoting overall health. It helps understand the interplay between genetics and environment in disease development, providing new diagnostic markers and treatments. Future studies should focus on Yoga's long-term epigenetic impacts, personalizing interventions, and comparing techniques. Integrating Yoga could improve therapeutic benefits and patient outcomes, emphasizing the need for evidence-based guidelines for its clinical use. This fosters interdisciplinary collaboration, encourages a more comprehensive health-care approach, and positions epigenetics as a crucial area for future health research.

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Conflicts of interest

There are no conflicts of interest.

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