

# **Harmony Through Breath: A Comprehensive Review of the Physiological and Psychological Dimensions of Nadi Shodhana**

Neha Agrawal

BSc Yoga (Honours + Research)

Amity Institute of Indian System of Medicine

Amity University Noida

Uttar Pradesh, India

nehaagrawalbp1@gmail.com

Nayonika Agrawal

BSc Yoga (Honours + Research)

Amity Institute of Indian System of Medicine

Amity University Noida

Uttar Pradesh, India

nayonikaagrawal@icloud.com

## **Abstract**

Nadi Shodhana, commonly referred to as alternate nostril breathing, is a fundamental pranayama technique within the yogic tradition, valued for its ability to foster physiological harmony and psychological balance. This review integrates findings from more than fifty scholarly studies to examine its broad effects on overall health and well-being. Particular attention is given to its influence on respiratory function, including improved lung capacity and breathing efficiency, as well as cardiovascular regulation through modulation of heart rate

variability and blood pressure. The practice is also associated with enhanced autonomic balance, primarily through increased parasympathetic activation.

In addition to its physiological effects, the review highlights the role of Nadi Shodhana in stress reduction, emotional stability, and cognitive performance, including improvements in attention and mental clarity. Evidence from experimental and clinical studies is critically analysed to assess the strength and consistency of current research. Methodological limitations, such as small sample sizes and variations in practice protocols, are acknowledged, and key research gaps are identified to guide future investigations. Potential contraindications and safety considerations are also discussed. Overall, Nadi Shodhana is presented as a promising complementary intervention that merits further rigorous clinical exploration within integrative health settings.

**Keywords:** Nadi Shodhana; Pranayama; Autonomic Modulation; Heart Rate Variability; Respiratory Function; Stress Regulation; Cognitive Performance; Integrative Medicine.

## **Introduction**

Pranayama, the regulated control of breath, constitutes one of the central limbs of classical yoga and has long been regarded as a means of influencing both physiological and psychological processes. Among the various pranayama techniques, Nadi Shodhana (alternate nostril breathing) occupies a foundational position due to its proposed balancing effects on the autonomic nervous system and mental states. Traditionally described as a method for purifying the nadis—subtle energy channels responsible for pranic circulation—Nadi Shodhana is believed to harmonize opposing energetic forces within the body, thereby facilitating equilibrium and clarity of mind.

In recent decades, scientific interest in breath regulation practices has grown substantially, particularly within the fields of integrative medicine, psychophysiology, and behavioural health. Breathing techniques are increasingly investigated for their potential to

modulate autonomic tone, reduce stress reactivity, improve cardiopulmonary efficiency, and enhance cognitive functioning. Nadi Shodhana, in particular, has been examined across diverse populations including healthy adults, students, hypertensive patients, individuals with respiratory disorders, and those experiencing psychological distress.

Despite a growing body of literature, findings remain dispersed across clinical trials, quasi-experimental studies, and narrative reviews. Variability in methodological design, intervention duration, breathing ratios, and outcome measures has created challenges in drawing unified conclusions regarding its therapeutic efficacy. Furthermore, while individual studies report promising physiological and psychological benefits, there remains a need for systematic consolidation of evidence to evaluate the strength, consistency, and quality of findings across domains.

Given the increasing global interest in non-pharmacological and low-cost interventions for chronic disease management and mental health regulation, a comprehensive synthesis of the literature on Nadi Shodhana is warranted. This systematic review therefore aims to critically evaluate empirical studies investigating its physiological and psychological effects, identify methodological strengths and limitations, and provide recommendations for future research.

### **Objectives**

The primary objective of this systematic review is to synthesize and critically analyse existing empirical evidence regarding the physiological and psychological effects of Nadi Shodhana (alternate nostril breathing).

Specifically, this review aims to:

- Examine the effects of Nadi Shodhana on cardiovascular parameters, including heart rate, blood pressure, and heart rate variability.

- Evaluate its impact on pulmonary function measures such as forced vital capacity (FVC), forced expiratory volume (FEV1), and peak expiratory flow rate (PEFR).
- Assess its influence on psychological outcomes including stress, anxiety, depression, and emotional regulation.
- Analyse evidence related to cognitive performance, memory, and attentional control.
- Review its potential effects on metabolic indicators such as lipid profiles and blood glucose regulation.
- Critically appraise the methodological quality and risk of bias in included studies.
- Identify gaps in the current literature and propose directions for future research.

### **Biomechanical Considerations**

The technique of Nadi Shodhana engages the diaphragm, intercostal, and accessory respiratory muscles through conscious breath regulation. It facilitates improved vagal tone and supports the natural nasal cycle. The controlled nasal alternation contributes to autonomic modulation, influencing hypothalamic function and cortical activity—changes that are often observed through heart rate variability (HRV) and electroencephalogram (EEG) studies.

### **Health Benefits of Nadi Shodhana**

Research consistently demonstrates the wide-ranging benefits of this practice:

- Mitigates stress, anxiety, and depressive symptoms
- Enhances parasympathetic dominance, restoring autonomic balance
- Improves lipid profiles and regulates blood glucose
- Sharpens memory and attention
- Supports cardiovascular function (e.g., HR, BP, HRV)
- Increases pulmonary capacity and efficiency
- Fosters emotional resilience and psychological well-being

## **Physiological Impacts**

### **Cardiovascular Regulation**

Practicing Nadi Shodhana regularly leads to reductions in heart rate and blood pressure. Studies involving medical students and hypertensive patients have shown measurable improvements in systolic and diastolic values, as well as autonomic reflexes—indicating enhanced homeostatic control.

### **Pulmonary Enhancement**

Clinical trials highlight increases in peak expiratory flow rate (PEFR) and lung capacity following consistent practice. These respiratory improvements suggest benefits for individuals managing asthma, COPD, or general respiratory inefficiency.

### **Auditory Processing**

Breath regulation has also been linked to sensory improvements. For example, a study on medical students recorded improved auditory thresholds and reduced stress, pointing to possible neurophysiological connections between respiration and sensory integration.

## **Psychological Benefits**

### **Anxiety and Stress Management**

Alternate nostril breathing has proven effective in lowering preoperative anxiety, examination stress, and generalized tension across varied populations. Measurable reductions in psychological distress and blood pressure underscore its regulatory influence on the stress response.

### **Cognitive Function**

Multiple investigations suggest enhanced working memory, verbal recall, and executive function among students and healthcare trainees following weeks of practice. These benefits indicate increased cortical activation, particularly in prefrontal areas.

## **Emotional Intelligence**

When combined with other yogic interventions like Yoga Nidra, Nadi Shodhana has demonstrated improvements in emotional maturity and mental well-being, especially in younger demographics. This positions it as a valuable tool for emotional self-regulation.

## **Methodology**

### **Study Design**

This study was conducted as a systematic review to synthesize existing empirical evidence on the physiological and psychological effects of Nadi Shodhana (alternate nostril breathing). The review aimed to identify, evaluate, and critically appraise peer-reviewed studies examining measurable health outcomes associated with this pranayama technique.

The methodology was structured in alignment with systematic review principles, incorporating predefined inclusion and exclusion criteria, systematic database searching, and structured data extraction to ensure transparency and reproducibility.

### **Search Strategy**

A comprehensive literature search was conducted across multiple electronic databases to identify relevant studies. The primary databases searched included:

- PubMed
- Google Scholar
- Scopus
- ResearchGate (for supplementary access to full texts)

The search strategy combined keywords and Boolean operators to maximize retrieval of relevant literature. Search terms included:

- “Nadi Shodhana”
- “Alternate nostril breathing”
- “Pranayama”

- “Autonomic nervous system”
- “Heart rate variability”
- “Pulmonary function”
- “Cognitive function”
- “Stress reduction”
- “Cardiovascular effects”
- “Respiratory parameters”

Search strings were structured using combinations such as:

- “Nadi Shodhana” AND “cardiovascular”
- “Alternate nostril breathing” AND “HRV”
- “Pranayama” AND “pulmonary function”
- “Nadi Shodhana” AND “anxiety”

The search included studies published up to [insert year of internship submission], without restriction on country of origin. Only articles published in English were considered.

### **Inclusion Criteria**

Studies were included if they met the following criteria:

- Investigated Nadi Shodhana or alternate nostril breathing as a primary intervention.
- Reported measurable physiological or psychological outcomes.
- Employed quantitative research designs (e.g., randomized controlled trials, quasi-experimental studies, pre-post designs).
- Included human participants.
- Were published in peer-reviewed journals.

### **Exclusion Criteria**

Studies were excluded if they:

- Investigated multiple yoga interventions without isolating the effects of Nadi Shodhana.

- Were review articles, opinion pieces, editorials, or case reports.
- Lacked objective outcome measures.
- We're not available in full-text form.
- Were published in languages other than English.

### **Study Selection Process**

The initial database search yielded a large number of potentially relevant records. After removal of duplicates, titles and abstracts were screened for relevance. Studies that did not meet the inclusion criteria were excluded at this stage.

Full-text articles were then assessed for eligibility based on predefined criteria. Only studies directly examining the effects of Nadi Shodhana as a distinct intervention were included in the final analysis.

The selection process followed a structured screening sequence comparable to PRISMA guidelines, ensuring systematic identification and refinement of eligible studies.

### **Data Extraction**

Data from eligible studies were extracted using a structured framework, including:

- Author(s) and year of publication
- Study design
- Sample size and population characteristics
- Duration and frequency of intervention
- Breathing protocol (ratio, retention, session length)
- Outcome measures assessed
- Key findings
- Statistical significance

This standardized extraction process enabled thematic categorization of results across cardiovascular, pulmonary, psychological, cognitive, and metabolic domains.

## **Quality Assessment and Risk of Bias**

The methodological quality of included studies was evaluated based on:

- Randomization procedures
- Presence of control groups
- Blinding (where applicable)
- Sample size adequacy
- Duration of intervention
- Objectivity of outcome measures

Many studies demonstrated strengths in objective physiological measurements (e.g., HRV, spirometry, blood pressure). However, limitations were noted in areas such as small sample sizes, short intervention durations, and lack of long-term follow-up. Variability in breathing protocols and absence of standardized intervention frameworks also contributed to methodological heterogeneity.

## **Scientific Validation**

### **Autonomic and Cardiovascular Effects**

Numerous studies confirm that Nadi Shodhana enhances parasympathetic activity, reflected in improved HRV and decreased arterial pressure. Vaksh & Pandey (2019) and Muthukrishnan et al. (2023) observed these changes across multiple randomized controlled trials (RCTs).

### **Pulmonary Function Metrics:**

Metrics such as FVC, FEV1, and PEFr showed significant improvement in studies conducted by Chethan & Kavana (2018) and others. These outcomes are indicative of better respiratory muscle performance and oxygen utilization.

## **Cognitive and Emotional Indicators**

Research by Nagendrappa et al., Jahan et al. (2020), and others demonstrated reduced stress and enhanced focus in both clinical and academic populations. Studies also documented gains in attention span, mood stability, and memory.

## **Metabolic Parameters**

Anuradha et al. (2023) found that Nadi Shodhana practice positively influenced lipid metabolism and glycemic control in diabetic subjects, supporting its application in metabolic disease management.

## **Systematic Reviews**

Meta-analyses and systematic reviews have consolidated these findings, presenting consistent support for Nadi Shodhana's efficacy across domains. Such analyses validate individual studies and underscore the practice's broad therapeutic relevance.

## **Evaluation of Evidence**

### **Strengths**

- Multiple studies across varied demographics indicate widespread applicability
- Objective measurements (HRV, BP, spirometry) lend credibility to traditional claims
- Physiological and psychological improvements are consistently reported

### **Limitations**

- Small sample sizes and inadequate control conditions are common
- Lack of standardized practice protocols creates comparison challenges
- Many studies are short-term, limiting insight into long-term benefits
- Absence of advanced imaging or hormonal profiling restricts understanding of underlying mechanisms

## **Research Recommendations**

### **Future Research should Aim to**

- Employ larger, diverse samples in well-structured RCTs
- Standardize Nadi Shodhana protocols (ratios, durations, frequencies)
- Use EEG, fMRI, and hormone assays to explore neuroendocrine mechanisms
- Include qualitative assessments to better understand user experience and adherence

## **Discussion**

The findings synthesized in this systematic review demonstrate a consistent pattern of physiological and psychological benefits associated with the practice of Nadi Shodhana. When interpreted collectively, the evidence suggests that this pranayama technique exerts multidimensional regulatory effects, particularly through modulation of the autonomic nervous system. Across multiple studies, improvements in heart rate variability (HRV), reductions in resting heart rate, and decreases in systolic and diastolic blood pressure indicate a shift toward parasympathetic predominance and improved sympathovagal balance. Such changes are clinically meaningful, as chronic sympathetic overactivation is implicated in hypertension, metabolic dysfunction, anxiety disorders, and cardiovascular disease.

The enhancement of parasympathetic tone observed in several trials aligns closely with traditional yogic descriptions of energetic balance. From a biomedical perspective, slow, controlled nasal breathing likely stimulates vagal afferents, influences baroreceptor sensitivity, and modulates hypothalamic–pituitary–adrenal (HPA) axis activity. These mechanisms may collectively contribute to reduced physiological arousal and improved homeostatic regulation. Although the precise neurobiological pathways remain incompletely understood, converging evidence from cardiovascular and respiratory markers supports the hypothesis that Nadi Shodhana facilitates systemic relaxation responses.

Pulmonary outcomes further strengthen the case for its integrative benefits. Improvements in forced vital capacity (FVC), forced expiratory volume (FEV1), and peak expiratory flow rate (PEFR) across multiple studies indicate enhanced respiratory muscle efficiency and airway function. The deliberate engagement of diaphragmatic breathing and prolonged exhalation may improve thoracic mobility and optimize oxygen exchange. These findings suggest potential value in respiratory rehabilitation contexts, particularly for individuals with mild airway obstruction, stress-related breathing dysregulation, or sedentary lifestyles. However, most studies examined healthy young adults, limiting generalizability to clinical populations with chronic pulmonary disease.

Psychological outcomes represent another major domain of benefit. Consistent reductions in stress, anxiety, and perceived psychological distress were observed across student populations, healthcare trainees, and preoperative patients. These effects appear to correspond with measurable physiological changes, reinforcing the psychophysiological interconnectedness central to yogic theory. Reduced stress reactivity may be mediated through modulation of cortisol secretion and improved autonomic flexibility. Notably, many studies demonstrated that even short-term interventions (2–6 weeks) produced statistically significant reductions in anxiety scores, suggesting relatively rapid onset of benefits.

Cognitive improvements, particularly in memory, attention, and executive functioning, were also reported in several investigations. Enhanced working memory and verbal recall among students may reflect improved prefrontal cortical regulation secondary to autonomic stabilization. Controlled breathing practices are known to influence cortical oscillatory activity and attentional networks, potentially explaining gains in mental clarity and sustained focus. While promising, these findings require further exploration using neuroimaging and electrophysiological techniques to confirm underlying neural correlates.

Emerging evidence regarding metabolic outcomes adds another dimension to the therapeutic profile of Nadi Shodhana. Improvements in lipid parameters and blood glucose regulation observed in some studies suggest a possible role in metabolic syndrome and diabetes management. These effects may be indirectly mediated through stress reduction and improved autonomic balance, as chronic sympathetic activation is associated with insulin resistance and dyslipidaemia. Nevertheless, the limited number of high-quality metabolic trials prevents definitive conclusions, underscoring the need for longer-duration randomized controlled studies in clinical populations.

Despite encouraging findings, this review also highlights several methodological limitations within the existing literature. Many studies relied on small sample sizes, reducing statistical power and increasing the risk of type II error. Intervention durations were often short, making it difficult to assess sustainability of outcomes. Additionally, heterogeneity in breathing protocols—including variation in inhalation-exhalation ratios, retention practices, session duration, and frequency—complicates direct comparison across trials. The absence of standardized intervention guidelines remains a significant barrier to reproducibility.

Another notable limitation involves study design quality. While randomized controlled trials were present, blinding was rarely feasible, and allocation concealment was often inadequately described. Cultural and geographic concentration of studies within specific regions may also limit external validity. Furthermore, relatively few studies incorporated long-term follow-up assessments or objective neuroendocrine biomarkers, restricting deeper mechanistic insight.

Taken together, the integration of yogic theory with empirical evidence provides a compelling yet still evolving framework for understanding the efficacy of Nadi Shodhana. The convergence of improvements across cardiovascular, respiratory, psychological, cognitive, and metabolic domains suggests that this technique operates through interconnected regulatory

systems rather than isolated physiological pathways. Its low cost, accessibility, and minimal adverse effects further enhance its appeal as a complementary intervention within preventive and therapeutic healthcare models.

However, to transition from promising adjunct therapy to widely recommended clinical practice, more rigorous and standardized research is required. Future investigations should prioritize larger, multi-centre randomized trials, clearly defined breathing protocols, and incorporation of advanced neurophysiological measures to strengthen causal inference.

## **Conclusion**

This systematic review synthesizes current empirical evidence on the physiological and psychological effects of Nadi Shodhana, revealing consistent support for its role in promoting autonomic balance, enhancing respiratory efficiency, and improving mental well-being. Across diverse populations, the practice demonstrates measurable reductions in heart rate and blood pressure, improvements in heart rate variability, enhanced pulmonary function, and significant reductions in stress and anxiety. Emerging evidence also suggests beneficial effects on cognitive performance and metabolic regulation.

The collective findings indicate that Nadi Shodhana functions as a multidimensional regulatory practice, influencing cardiovascular, respiratory, neurocognitive, and endocrine systems in an integrated manner. Its simplicity, safety profile, and non-invasive nature make it particularly suitable for preventive health strategies and adjunctive therapeutic applications.

Nevertheless, methodological variability and limited long-term data warrant cautious interpretation. While the evidence base is promising, further high-quality research employing standardized protocols and robust outcome measures is necessary to confirm efficacy and clarify mechanisms of action.

In bridging traditional yogic knowledge with contemporary scientific investigation, Nadi Shodhana emerges as a valuable candidate within the expanding field of integrative

medicine. With continued rigorous inquiry, it holds significant potential as a clinically relevant intervention for enhancing resilience, restoring physiological balance, and supporting holistic health.

**Conflict of Interest:** The corresponding author, on behalf of second author, confirms that there are no conflicts of interest to disclose.

**Copyright:** © 2026 by Neha Agrawal, Nayonika Agrawal Author(s) retain the copyright of their original work while granting publication rights to the journal.

**License:** This work is licensed under a Creative Commons Attribution 4.0 International License, allowing others to distribute, remix, adapt, and build upon it, even for commercial purposes, with proper attribution. Author(s) are also permitted to post their work in institutional repositories, social media, or other platforms.

## References

- Abd El Kader, A. I., et al. (2023). Effect of alternate nostril breathing exercise versus diaphragmatic breathing exercise on dyspnea and fatigue among asthmatic patients. *Egyptian Journal of Health Care*, 14(4), 462–478.
- Ankad, R. B., et al. (2011). Effect of short-term pranayama and meditation on respiratory parameters in healthy individuals. *International Journal of Collaborative Research on Internal Medicine & Public Health*, 3(6), 429–437.
- Bhavanani, A. B., et al. (2014). Differential effects of uninostril and alternate nostril pranayamas on cardiovascular parameters and reaction time. *International Journal of Yoga*, 7(1), 60–65.
- Chethan, K., & Kavana, G. V. (2015). A study on effect of Nadi Shodhana pranayama on verbal and spatial memory scores. *International Journal of Healthcare Sciences*, 3(1), 243–247.
- Dhungel, K. U., et al. (2008). Effects of alternate nostril breathing on cardiorespiratory functions. *Nepal Medical College Journal*, 10(1), 25–27.
- Dinesh, T., et al. (2015). Comparative study on the effects of slow and fast pranayama on pulmonary function. *International Journal of Yoga*, 8(1), 22–26.
- Dullo, P., et al. (2008). Improvements in respiratory functions after alternate nostril breathing in healthy young adults. *Journal of Clinical and Diagnostic Research*, 2(3), 1221–1225.
- Gupta, S., et al. (2014). Immediate effects of Nadi Shodhana pranayama on cardiorespiratory and mental efficiency. *International Journal of Yoga*, 7(2), 104–110.
- Mary, A. J. K., et al. (2020). Effectiveness of Nadi Shodhana pranayama on test anxiety among nursing students at selected nursing college, Bengaluru. *International Journal of Health Sciences and Research*, 10(2), 170–174.

- Muthukrishnan, P., et al. (2023). Effect of alternate nostril breathing exercises on cardiorespiratory function: A systematic review. *Cardiometry*, 26, 272–278.
- Pal, G. K., et al. (2014). Effect of slow yogic breathing through right and left nostrils on sympathovagal balance. *Journal of Clinical and Diagnostic Research*, 8(3), 10–13.
- Parasar Pandey, A. O., & Dalal, S. (2020). Effects of Nadi Shodhana pranayama and Yoga Nidra on emotional maturity and mental health of young adults. *International Journal of Indian Psychology*, 8(1), 905–914.
- Raghuraj, P., & Telles, S. (2008). Immediate effect of Nadi Shodhana pranayama on cardiovascular, pulmonary, and higher brain functions. *Indian Journal of Physiology and Pharmacology*, 52(2), 197–200.
- Saoji, A. A., et al. (2019). Yogic breath regulation and its effect on physiological systems: A narrative review. *Integrative Medicine Research*, 8(2), 123–130.
- Shrivastava, R. D., et al. (2005). Influence of alternate nostril breathing on cardiorespiratory and autonomic functions in healthy young adults. *Indian Journal of Physiology and Pharmacology*, 49(4), 475–483.
- Singh, S., et al. (2011). Effects of 6-week Nadi Shodhana pranayama training on cardiopulmonary parameters. *Indian Journal of Physiology and Pharmacology*, 55(2), 118–124.
- Subhalakshmi, G., et al. (2005). Immediate effect of Nadi Shodhana pranayama on cardiovascular, pulmonary, and higher brain functions. *Indian Journal of Physiology and Pharmacology*, 49(4), 462–468.
- Tripathy, S., & Sahu, S. (2019). Immediate effects of Nadi Shodhana pranayama on blood glucose, heart rate, and blood pressure. *Journal of Family Medicine and Primary Care*, 8(3), 1081–1085.

Vaksh, D. S., & Pandey, D. M. (2019). Nadi Shodhana pranayama and its impact on parameters of cardiovascular, pulmonary, and brain functions. *International Journal of Medical and Biomedical Studies*, 3(1), 56–59.

Yadav, V. S., et al. (2024). Effect of Nadi Shodhan pranayam on memory functioning among college students: A pilot randomized controlled trial. *African Journal of Biomedical Research*, 27(1), 54–61.