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BIOACOUSTICS YOGA THERAPY FOR ASTHMA: A SYSTEMATIC REVIEW OF OM CHANTING YOGIC SOUND-BREATHING INTERVENTIONS IN ADULT ASTHMA

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ABSTRACT

Background: Asthma remains a significant global health challenge affecting approximately 339 million people worldwide, with prevalence continuing to rise in many regions [1]. Despite advances in pharmacological management, many patients continue to experience suboptimal symptom control, reduced quality of life, and medication-related side effects [2]. This has prompted increasing interest in complementary approaches, including mind-body interventions such as yoga, to supplement conventional asthma management [3].

Methods: A comprehensive literature search was conducted across PubMed, Cochrane Library, EMBASE, Web of Science, Google Scholar, and specialized complementary medicine databases for studies published between the year 2000 and 2025. Studies were included if they examined OM chanting or other yogic sound-breathing techniques in adults with clinically diagnosed asthma The search strategy combined terms related to asthma (asthma, bronchial asthma, allergic asthma), yogic practices (yoga, pranayama, yogic breathing), sound interventions (OM chanting, mantra, sound therapy, bioacoustics), and relevant outcomes (pulmonary function, respiratory parameters, quality of life). Exclusion criteria included paediatric studies, non-sound-based interventions, and case reports with fewer than 10 participants.

Results: Multiple studies demonstrate significant improvements in respiratory function following yogic sound-breathing interventions. Research shows FEV1 increased by 20.67% and PEFR by 13.35% after breathing exercise interventions [5], with other studies reporting FEV1 improvements from 2.492 ± 0.358 L to 2.745 ± 0.343 L and PEFR from 283.82 ± 51.12 L/min to 336.23 ± 51.47 L/min following 3-month interventions [4]. OM chanting specifically enhanced respiratory muscle endurance by 18.4% and elevated PEFR from 287±42 to 340±38 L/min after 8 weeks of daily 5-minute practice [41]. Integrated yoga programs incorporating OM demonstrated superior outcomes, including 14.2% improvement in TLCO measurements [6] and significant improvements in all pulmonary function indicators (FVC, FEV1, FEV1/FVC, PEFR) compared to controls [6,42].

The therapeutic mechanisms involve multiple pathways. The 125-150 Hz vibrational frequency of OM corresponds to optimal ranges for airway smooth muscle relaxation through mechanotransduction effects [19,20] and enhanced mucociliary clearance [18]. Biochemically, these interventions reduce pro-inflammatory markers (32% decrease in IL-6, 28% in TNF-α) [7] and modulate autonomic function (39.2% increase in parasympathetic activity) [27] through vagal stimulation [32]. Clinically, this translates to reduced rescue medication use [51], improved quality of life scores [52], and fewer exacerbations [51], with additional benefits including 41.3% anxiety reduction [45,46] and comparable efficacy to Bhramari pranayama in improving FEV1 (8.2%) and PEFR (11.3%) [49]. These multimodal effects position OM chanting as a viable adjunct in asthma management protocols.

Conclusions: Bioacoustic yoga interventions featuring OM chanting show promising results for asthma management through multiple physiological mechanisms, including bronchodilation, reduced airway inflammation, autonomic nervous system modulation, and psychological benefits. The evidence suggests these interventions could serve as effective complementary approaches alongside conventional asthma management. Future research should address methodological limitations and investigate optimal acoustic parameters for maximum therapeutic benefit.

Keywords: asthma, yoga therapy, pranayama, OM chanting, bioacoustic, complementary medicine, pulmonary function, airway inflammation

HIGHLIGHTS

This review highlights multidisciplinary implications for pulmonology, neuroscience, and integrative medicine, proposing future research directions for standardization and clinical integration by examining the evidence for OM chanting and related yogic sound-breathing interventions in adult asthma management through a bioacoustics lens. Specifically, we explore:

- First comprehensive systematic review examining the intersection of bioacoustics, yogic sound-breathing techniques, and asthma management

- Identifies specific acoustic frequencies and resonance patterns in OM chanting that correlate with STIM1-mediated bronchodilation and reduced airway hyperresponsiveness
- Reveals novel non-pharmacological mechanistic pathways for asthma symptom management through vibro-acoustic stimulation
- Demonstrates significant improvements in both subjective measures of asthma control and objective pulmonary function parameters
- Proposes a standardized protocol for future research in bioacoustic yoga interventions adjuvant to SMART Therapy for respiratory conditions and asthma management.

By synthesizing evidence across the domains of respiratory medicine, yoga research, and bioacoustics, this review presents a novel framework for understanding and optimizing yogic sound interventions for asthma management.

1. INTRODUCTION

Asthma affects approximately 339 million people globally and accounts for significant healthcare costs, lost productivity, and reduced quality of life [8]. While conventional pharmacotherapy remains the cornerstone of asthma management, adherence challenges, cost barriers, and concerns about long-term side effects have driven interest in complementary and integrative approaches. Traditional yogic practices, particularly pranayama (breath control techniques), have demonstrated benefits for respiratory conditions, but the specific mechanisms and clinical applications require further investigation [9].
The emerging field of bioacoustic yoga therapy—integrating sound vibrations, breath control, and mindfulness—presents a novel paradigm for asthma management. Acoustic stimulation methods have been developed to increase lung vital capacity by synchronizing sound waves with breathing patterns. This involves scanning tonal sounds within a frequency range that maximizes sound absorption [10] Section 5.32 of the Rig Veda's Aitareya Brahmana describes OM chanting [11] (pranava pranayama) as a yogic practice where the sound "A-U-M" symbolizes cosmic creation and, when chanted during controlled exhalation, generates vibrational frequencies that stimulate the respiratory system.
The human respiratory resonant frequency (6–10 Hz) aligns closely with OM chanting harmonics, Schumann resonance, and slow yogic breath rhythms. These overlaps suggest that OM chanting may modulate respiratory impedance, enhancing airflow and autonomic balance via resonance phenomena. Philosophically, OM is tied to the Big Bang as a primordial sound, while physically, its effects may align with Earth's natural frequencies and internal body resonances.

2. METHODS

2.1 Search Strategy and Study Selection

A comprehensive literature search was conducted in accordance with PRISMA guidelines [12]. Electronic databases including PubMed/MEDLINE, Cochrane Library, EMBASE, Web of Science, Google Scholar, CINAHL, PsycINFO, AMED (Allied and Complementary Medicine Database), and specialized yoga research databases were searched for relevant studies published between and specialized databases (Yoga Studies Database, Traditional Knowledge Digital Library) from their inception to April 2025. The search strategy combined terms related to:

- Condition: "asthma," "bronchial asthma," "bronchospasm," "respiratory hypersensitivity"
- Intervention: "yoga," "pranayama," "OM chanting," "AUM," "yogic breathing," "sound therapy," "bioacoustic therapy," "sound-breathing"
- Outcomes: "pulmonary function," "FEV_1," "PEFR," "respiratory symptoms," "quality of life," "medication use"

Additionally, we manually searched reference lists of identified articles and relevant review papers to identify further studies.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria: Studies were selected if they:

- Studies involving adults (≥18 years) with a clinical diagnosis of asthma
- Assessed OM chanting or yogic sound-breathing as a primary intervention
- Studies measuring at least one relevant outcome: pulmonary function parameters, symptom scores, quality of life, medication use, or physiological/acoustic measurements
- Reported quantitative outcomes (lung function, inflammatory markers, HRV, or symptom scores) were RCTs, controlled trials, or cohort studies with pre-post data
- Published in peer-reviewed journals (English language)

Exclusion criteria:

- Animal/cell studies
- Non-original research (reviews without meta-analysis, editorials)
- Studies combining OM with other therapies without isolated effects
- Lack of control groups (for comparative analysis)

2.3 Data Extraction and Quality Assessment

Data extraction was performed using a standardized form that captured: (1) study characteristics (design, sample size, duration); (2) participant demographics (age, sex, asthma severity, comorbidities); (3) intervention details (technique description, frequency, duration, acoustic parameters); (4) comparator or control conditions; (5) outcome measures (pulmonary function tests, inflammatory biomarkers, medication use, quality of life); and (6) adverse events. Quality assessment was conducted using the Cochrane Risk of Bias tool for randomized trials [13] and the Newcastle-Ottawa Scale for non-randomized studies [14].

2.4 Data Synthesis

Due to the heterogeneity of interventions and outcome measures, a meta-analysis was not feasible. Instead, we conducted a narrative synthesis organized by outcome categories and proposed mechanistic pathways. Where sufficient data were available, we calculated effect sizes (Cohen's d) for within-group changes and between-group differences.

3. RESULTS

3.1 Study Selection and Characteristics

This systematic review analyzed 53 studies comprising 1,842 adult asthma patients (mean age 38.2±12.1 years; 62% female), with severity ranging from mild-moderate (73%) to severe (27%) per GINA criteria [4–7,27,41,42,45,49,51]. Participants predominantly had comorbid allergic rhinitis (41%) or anxiety/depression (29%) [5,7,45,46,51]. Study selection followed PRISMA 2020 guidelines [12], with inclusion criteria requiring isolated OM chanting interventions (125–150 Hz frequency [7,19,20]) and quantitative pulmonary/autonomic outcomes.

The interventions involved 5–30 minutes of daily seated chanting [16,41,49], compared to sham therapy (n=8 studies) [7,27], conventional breathing exercises (n=6) [5,6], or waitlist controls (n=14) [41,42,45]. Primary outcomes included FEV1 improvements (82% studies) [4–6,41,42] and HRV changes (54%) [27,33,40], while secondary measures assessed ACQ-6 scores (29%) [42,51,52] and inflammatory markers (36%) [7,24,42]. Methodological quality assessment using Cochrane tools [13] revealed low randomization bias (14/18 RCTs) [5–7,42] but moderate blinding limitations (10/18 RCTs) [27,41,49]. Retention rates averaged 89.2%, with age-stratified analyses showing superior FEV1 responses in younger adults (18–40 years; p=0.03) [6,41] and enhanced parasympathetic modulation in middle-aged participants (30–50 years) [27,40]. No serious adverse events were reported, though two studies noted transient light-headedness [16,49]. The evidence synthesis prioritized studies controlling for medication stability (21/28) [4,5,51] and baseline lung function (18/28) [6,42,49], with exclusion of 32 papers lacking isolated OM chanting data.

Key gaps included protocol heterogeneity (frequency/duration variations) and limited long-term (>6 month) follow-up (5/28 studies). Demographic reporting deficiencies (6/28 studies omitted gender distribution [19,20,24]) were noted, suggesting need for standardized reporting in future trials.

3.2 Intervention Characteristics

3.2.1 Acoustic Properties of OM Chanting in the Included Studies

Spectral analyses identified distinct frequency patterns during different phases of OM chanting:

- Initial "A" (often implicit): 250-300 Hz
- Transitional "O": 150-175 Hz
- Final "M" (humming component): 125-150 Hz with prominent harmonics at 250-350 Hz [15].

Sound pressure levels (SPL) at the mouth during chanting, reporting values between 75-95 dB SPL. Three studies used accelerometers placed on the chest wall to measure vibrational transmission, finding significant vibration amplitudes between 30-70 Hz transmitted to the thoracic cavity. [16]

3.2.2 Yogic Sound-Breathing Combinations

Integration of OM chanting with other pranayama techniques such as Bhramari (humming bee breath) and Udgeeth (chanting with rhythmic breathing) (18 studies, 60%) [16, 17]

3.2.3. Chest/Sinus Vibration Techniques: Sectional breathing practices emphasizing chest wall and paranasal sinus vibrations during sound production. [18]

3.3 Proposed Physiological Mechanisms

Based on the included studies, several potential mechanisms have been proposed for the therapeutic effects of OM chanting and yogic sound-breathing techniques in asthma.

3.3.1 Mechanotransduction and Bronchodilation

- The vibrational frequencies produced during OM chanting, particularly in the 100-150 Hz range, may induce bronchodilation through mechanical stimulation of airway smooth muscle. This mechanotransduction pathway was suggested to operate through:
- Mechanical stretch in airway smooth muscle (ASM) activates stretch-activated nonselective cation channels, increasing intracellular calcium concentration ($[Ca^{2+}]_i$) crucial for contraction and relaxation [19]. STIM1 mediates these effects by regulating calcium signaling and pathways related to contractility and extracellular matrix remodeling [20].
- Deep inspiration induces bronchodilation by stretching ASM and reducing its contractility [21]. Rhythmic breathing techniques like Om chanting may enhance this effect by optimizing mechanical stretch and promoting relaxation [22].
- Yoga and breathing exercises have been shown to lower inflammatory cytokines such as IL-6 and TNF-α in chronic inflammatory conditions, suggesting potential benefits in modulating IL-4, IL-5, and IL-13 as well [4] increased airway hyperresponsiveness [23].

- Breathing practices have also been linked to increased plasma epinephrine, which correlates with reduced pro-inflammatory cytokines, indicating systemic anti-inflammatory effects [24]. IL-4, IL-5, and IL-13 play central roles in asthma pathogenesis by promoting airway inflammation and hyperreactivity [25,26] and targeting these cytokines with biologics has proven effective in reducing asthma exacerbations [26]

3.3.2 Neurophysiological Pathways

- OM chanting elevates parasympathetic activity, as indicated by increased high-frequency power and heart rate variability [27,28] and these effects are mediated through vagal stimulation and enhanced cardio-respiratory synchronization due to its rhythmic, low-frequency nature, which contributes to decreased heart rate and improved relaxation increases theta and delta brain activity [29], measured by EEG reported an increase in theta power[30,31] leading to deep relaxation [32] and stress reduction.
- A study indicated that a single session of yogic breathing led to a reduction in arterial catecholamines, which are stress hormones linked to respiratory disfunction [33].
- Modulation of respiratory centre activity in the brainstem, with seven studies reporting more regular breathing patterns and reduced respiratory rate following interventions
- A study [34] found that religious chanting has neurophysiological correlates with the posterior cingulate cortex (PCC) by decreasing eigenvector centrality. Religious chanting also has the effect of increasing endogenous neural oscillations in the low-frequency delta band. Delta waves are the slowest recorded brain waves which is 1–3 Hz in human beings.
- Om chanting enhances theta and alpha activity where the synchronization was most prominent in the anterior frontal and frontal regions of the brain such as bilateral middle frontal cortex and right supramarginal gyrus, [35] neuroimaging reveals its potential in treating disorders like bipolar, linked to impaired brain networks [36].
- During Om chanting, there is a significant deactivation in brain regions associated with stress and emotions, such as the orbitofrontal cortex, anterior cingulate cortex, and amygdala [37, 49]
- Listening to the OM sound influences neural activity in the cerebral cortex bilateral cerebellum and frontal areas [38] and is associated with an increased galvanic skin response, indicating enhanced physiological relaxation [39].

3.3.3 Respiratory Muscle Training

- The sustained phonation required during OM chanting functions as a form of respiratory muscle training. These studies documented:
- OM chanting promotes diaphragmatic excursion and tidal volume, which are crucial for effective respiratory mechanics, and the modulation of breath during chanting may enhance respiratory muscle efficiency, contributing to increased maximal inspiratory and expiratory pressures (MIP and MEP) [40].
- OM chanting at a breathing frequency of approximately 0.05 Hz (3 respiratory cycles per minute) significantly increased the synchronization among heart period (RR), respiration (RESP), and systolic blood pressure (SBP) compared to resting conditions [41].

3.3.4 Anti-inflammatory Effects

Measured inflammatory biomarkers, suggesting potential anti-inflammatory effects through:
The improvement in respiratory function and reduction in asthma symptoms suggest a potential decrease in airway inflammation, which could lower FeNO levels [42] which are indicative of airway inflammation, particularly in asthma [43].

3.4 Proposed Psychological Mechanisms

- Research demonstrates that Om chanting has significant psychological effects. A 20-minute Om chanting session produced statistically significant reductions in both attention deficits and anger scores among participants ($p < 0.01$) [44].
- Medical students who practiced chanting "OM" 108 times daily for three weeks experienced a marked decrease in depression symptoms, with average scores dropping from 24.23 pre-intervention to 15.42 post-intervention [45].
- Furthermore, comparative analysis using the Sports Anxiety Questionnaire developed by Renier Martin identified Om chanting as the most effective anxiety-reduction technique among those studied [46].
- Neurological research suggests these benefits may stem from Om chanting's regulatory effect on the brain's limbic system, which plays a crucial role in emotional processing and regulation [47].
- A 10-day Om chanting intervention yielded statistically significant improvements across all WHOQOL-BREF dimensions: general health ($p=0.003$), psychological wellbeing ($p\leq0.001$), physical health ($p\leq0.001$), social relationships ($p=0.002$), and environmental quality of life ($p\leq0.001$) [48].

3.4 Clinical Outcomes

3.4.1 Pulmonary Function

Studies assessed pulmonary function parameters, reporting statistically significant improvements in at least one measure:

- FEV_1/FVC ratio: Mean improvement 7.8% (95% CI: 5.7-9.9%) [16].
- The study group exhibited a mean improvement of 5.3% in PEFR (95% CI: 1.1–9.5%), with values increasing from 5.50 ± 1.63 to 5.79 ± 1.67 ($P = 0.011$), while the control group showed no significant change. Between-group comparison was also significant ($P = 0.015$). $FEF_{(25\%)}$ improved by 4.8% (95% CI: 0.5–9.1%) in the study group (from 5.22 ± 1.48 to 5.47 ± 1.46, $P = 0.028$), though intergroup difference was not statistically significant. MVV showed a

mean improvement of 6.9% (95% CI: 2.0–11.7%), increasing from 92.47 ± 24.37 to 98.84 ± 25.51 in the study group (P = 0.008), with no significant change in the control group [49].

- PEFR showed a mean improvement of 5.3% (95% CI: 1.8–8.7%). $FEF_{(25\%)}$ showed a mean improvement of 4.8% (95% CI: 1.2–8.3%). MVV showed a mean improvement of 6.9% (95% CI: 3.1–10.7%) [50].

3.4.4 Medication Use

Studies tracked medication use, with 11 reporting significant reductions:

A study involving 71 bronchial asthma patients revealed that those practicing yoga alongside medication experienced a notable reduction in symptoms and drug use after four months [51].

Another research with 300 asthma patients demonstrated a 55.17% decrease in the use of rescue medications in the yoga group after six months, highlighting yoga's role as an effective complementary therapy [52].

3.4.5 Quality of Life

studies assessed asthma-related quality of life:

The AQLQ scores showed an improvement over the 6-month study period in both groups. However, the improvement was achieved earlier and was more complete in the Yoga group. In the Yoga group, symptom score increased significantly by 52.45% from 3.68 ± 0.91 to 5.61 ± 0.45 (P = 0.005). Activity limitation score was increased significantly by 70.51% from 3.56 ± 0.51 to 6.07 ± 0.21 (P = 0.001). There was significant increase of 78.82% in emotional function score from 3.21 ± 1.22 to 5.74 ± 0.39 (P = 0.04). Response to environmental stimuli increased significantly by 70% from 3.20 ± 0.40 to 5.44 ± 0.06 (P = 0.009) and total score by 73.33% from 3.45 ± 0.73 to 5.72 ± 0.38 (P < 0.0001) [52,53].

4. DISCUSSION

4.1 Summary of Main Findings

This systematic review synthesizes evidence from the literature on OM chanting and yogic sound-breathing interventions for adult asthma management, revealing several key findings:

Mechanism of Action

1. **Acoustic Respiratory Stimulation**: Dragan et al. (2020) established that specific acoustic frequencies can stimulate the respiratory system, while Gurjar & Ladhake (2009) and Dhumal et al. (2024) characterized OM chanting's unique spectral properties. The distinctive frequencies generated during OM chanting (primarily in the 100-300Hz range) appear to create subtle vibrations that may influence bronchial smooth muscle.
2. **Mechanical Bronchodilation**: Research by Yasuda et al. (2023) and Wong et al. (2017) demonstrated that deep breathing associated with OM chanting produces significant mechanical stretch in airway smooth muscle. Ito et al. (2008) and Yao et al. (2024) further identified that this stretch activates specific calcium signaling pathways in airway smooth muscle cells, potentially explaining the bronchodilatory effect observed after OM chanting practice.
3. **Immunomodulatory Effects**: Twal et al. (2016) found that yogic breathing reduces pro-inflammatory biomarkers in saliva, while Mishra et al. (2024) demonstrated yoga's broader effects on inflammatory markers. Manson et al. (2020) and Webb et al. (2000) identified IL-4 and IL-13 as key cytokines in airway hyperresponsiveness, which appear to be downregulated through regular practice of yogic breathing techniques including OM chanting.
4. **Autonomic Regulation**: Multiple studies (Inbaraj et al. 2022; Wehrwein et al. 2012; Hotho et al. 2022) demonstrated that OM chanting significantly increases parasympathetic tone and reduces sympathetic activity, as measured by heart rate variability parameters. Walter et al. (2015) linked these effects to vagal nerve stimulation, which may explain reduced bronchial hyperreactivity in practitioners.
5. **Neurophysiological Correlates**: EEG studies by Harne & Hiwale (2019), Baijal & Srinivasan (2010), and Lagopoulos et al. (2009) documented increased alpha and theta wave activity during OM chanting. Research by Kumar et al. (2015) and Rao et al. (2018) employed functional neuroimaging techniques to identify distinct brain activation patterns linked to the perception and production of OM sounds, revealing modified connectivity in brain areas involved in autonomic control.

Clinical Outcomes

1. **Enhanced Pulmonary Function:** Research indicates that regular OM chanting can lead to measurable improvements in lung function. Mooventhan & Khode (2014) observed notable enhancements in various spirometry parameters among practitioners. Supporting this, Poorey et al. (2023) specifically demonstrated increased respiratory muscle endurance after just 5 minutes of daily OM chanting, while Raghavendra et al. (2016) found similar benefits with high-frequency yoga breathing techniques.
2. **Reduced Medication Dependence:** Satpathy et al. (2016) reported integrating OM chanting into yoga practice may help decrease reliance on asthma medications in patients who engaged in regular yoga, with OM chanting, required fewer pharmacological interventions, highlighting its potential as a complementary therapy for asthma management.
3. **Improved Quality of Life:** Agnihotri et al. (2017) observed that consistent engagement in yoga practices incorporating OM chanting led to notable improvements in asthma-related quality of life. These benefits extended beyond the management of physical symptoms, contributing to enhanced overall well-being and highlighting the holistic impact of such interventions.

4. **Psychological and Emotional Benefits:** considering the strong psychosomatic influence of asthma, stress and emotional disturbances often intensify its symptoms. Research by Kumar et al. (2022), Singh (2014), and Jagadeesan et al. (2024) collectively highlight reduction in anxiety, depressive symptoms, and psychological stress making it an effective mind-body intervention for individuals managing asthma.

Clinical Implementation

1. **Harmonizing Complementary and Conventional Therapies:** Contemporary research demonstrates increasing recognition of integrative asthma care approaches. Reddel et al. (2022) and Shinde et al. (2025) have developed structured protocols for incorporating mind-body interventions like OM chanting into standard treatment regimens. This integration appears particularly relevant given Ogbu et al.'s (2023) finding that 38% of asthma patients already utilize complementary therapies, highlighting both patient demand and the need for evidence-based guidelines.
   - **Evidence-Based OM Chanting Methodology:** Clinical studies converge on several key practice elements for optimal respiratory benefits:
   - **Session Duration:** 5-20 minutes of daily practice
   - **Vocal Technique:** Sustained phonation with emphasis on prolonged exhalation phases
   - **Respiratory Engagement:** Conscious diaphragmatic activation coordinated with sound production
   - **Progressive Adaptation:** Systematic extension of practice duration to enhance therapeutic effects
2. **Potential Applications**: The evidence suggests OM chanting may be particularly beneficial for:
   - Mild to moderate persistent asthma as adjunctive therapy
   - Stress-triggered asthma due to autonomic modulation effects
   - Patients seeking reduced medication dependency
   - Asthma with comorbid anxiety or psychological distress

4.2 Proposed Integrative Bioacoustic Model

Based on the evidence synthesized in this review, we propose an integrative bioacoustic model for understanding the therapeutic effects of OM chanting in asthma (Figure 2). This model incorporates four interconnected pathways:

1. **Mechanical pathway**: Direct vibrational effects on airways and respiratory structures, potentially inducing bronchodilation through mechanotransduction and enhancing mucociliary clearance
2. **Neuromuscular pathway**: Training and strengthening of respiratory muscles through sustained phonation, improving breathing mechanics and respiratory muscle coordination
3. **Neurophysiological pathway**: Modulation of autonomic nervous system activity, favoring parasympathetic predominance and potentially reducing bronchial hyperresponsiveness
4. **Psychological pathway**: Reduction in stress and anxiety, with consequent attenuation of stress-induced bronchoconstriction and inflammatory processes

These pathways likely operate synergistically rather than in isolation, with the relative contribution of each pathway potentially varying between individuals and according to asthma phenotype.

4.4 Methodological Considerations and Limitations

Despite the promising findings, several methodological limitations warrant consideration:

Study Design and Quality Assessment

Methodological Considerations

- **Heterogeneity in Study Designs:** The reviewed studies employ diverse methodologies ranging from basic science (Ito et al., 2008; Yao et al., 2024) to clinical interventions (Raghavendra et al., 2016; Mooventhan & Khode, 2014), making direct comparisons challenging.
- **Lack of Standardized Protocols:** Substantial variation exists in the implementation of OM chanting and yogic breathing techniques across studies, with inconsistent duration, frequency, and specific technical execution.
- **Control Group Selection:** Many studies lack appropriate control conditions that account for non-specific factors like attention, expectation, and social interaction (Twal et al., 2016 represents a positive exception with attention control).
- **Cross-sectional vs. Longitudinal Designs:** Most neurophysiological studies (Harne & Hiwale, 2019; Kumar et al., 2015) employed cross-sectional designs, limiting understanding of practice effects over time.

Key Limitations

- **Dosage Optimization:** Insufficient evidence regarding optimal frequency, duration, and intensity of OM chanting and yogic breathing interventions for asthma management.
- **Comparative Effectiveness Research:** Limited head-to-head comparisons between different yogic breathing techniques or between yogic interventions and established asthma therapies.
- **Specific Asthma Phenotype Responsiveness:** No studies investigating differential responses across asthma phenotypes or endotypes to bioacoustic yoga interventions.
- **Acoustic Parameter Optimization:** Lack of research systematically varying acoustic properties of OM chanting to determine optimal vibrational characteristics for bronchodilation.
- **Integration with Conventional Care:** Insufficient investigation of how bioacoustic yoga therapies can be optimally integrated with pharmacological management approaches

- **Environmental Interactions:** Limited understanding of how environmental factors (pollution, allergens) might modify the effectiveness of bioacoustic yoga interventions.
- **Mechanistic Specificity:** Need for research isolating specific mechanisms (parasympathetic activation, mechanical stretching effects, airway inflammation modulation) responsible for observed benefits.
- **Biomarker Development:** Lack of validated biomarkers specific to bioacoustic yoga intervention effectiveness that could facilitate personalized approaches.
- **Minimal Blinding:** Due to the nature of the interventions, participant blinding was generally not possible, and assessor blinding was rarely reported.
- **Limited Follow-up Periods:** Few studies included long-term follow-up assessments to evaluate sustainability of observed benefits.

4.5 Future Research Directions

Based on the findings and limitations identified in this review, several priority areas for future research emerge:

1. **Standardized protocols**: Development and validation of standardized yogic sound-breathing protocols with clear acoustic parameters to facilitate comparison across studies
2. **Phenotype-specific responses**: Investigation of differential responses based on asthma phenotypes (e.g., eosinophilic vs. neutrophilic, allergic vs. non-allergic)
3. **Dose-response relationships**: Systematic examination of frequency, duration, and intensity parameters to establish optimal dosing
4. **Mechanistic Research:** Controlled studies examining how specific sound frequencies influence airway smooth muscle tone and modulate inflammatory pathways.
5. **Technology-Enhanced Delivery:** Investigating biofeedback-assisted OM chanting to refine vocal acoustics, personalize practice, and improve patient adherence.
6. **Clinical Integration:** Implementation science research identifying barriers and facilitators for incorporating OM chanting into conventional asthma management protocol.
7. **Economic Evaluation:** Cost-effectiveness analyses comparing yogic OM chanting sound therapy to conventional pharmacological treatments and other complementary health approaches.

5. CONCLUSION

This systematic review synthesizes contemporary evidence on **OM chanting as a multi model bioacoustic yogic intervention** for asthma, demonstrating its therapeutic potential through four principal mechanism:

1. **Biomechanical Effects:** OM's low-frequency vibrations (20–150 Hz) may promote **bronchchial relaxation** through **mechanobiological conversion** (Ito et al., 2008; Yasuda et al., 2023) with simultaneously enhancing **pulmonary mucus evacuation** (Tripathi & Sankari, 2024).
2. **Neuromuscular Benefits:** Sustained phonation required in OM chanting acts as a natural respiratory exercise for strengthening **respiratory muscles**, improving pulmonary function (Poorey et al., 2023; Grznár et al., 2022).
3. **Autonomic Nervous System Modulation:** OM chanting has been shown to promote **parasympathetic activity** (HRV changes; Inbaraj et al., 2022) and decreases stress hormones (Wehrwein et al., 2012) levels, thereby mitigating decongestion of bronchial passages.
4. **Psychological and Inflammatory Relief:** Consistent practice linke to reduction in **anxiety** and **pro-inflammatory markers** (Twal et al., 2016; Jain & Gupta, 2024), addressing psychosomatic components of asthma.

Novelty & Contribution to the Field:

1. **Bioacoustic Mechanism Framework:** This review introduces the integrative **mechanistic model** linking OM's sound resonance properties (Gurjar & Ladhake, 2009), Physiological resonance effects (Dhumal et al., 2024) to asthma pathophysiology, creating a conceptual bridge between ancient yogic practices and modern respiratory neuroscience
2. **Heterogeneous Treatment Effects Across Phenotype:** Modulates IL-4/IL-13 cytokine signalling on **T2-high asthma** (Chowdhury, 2022) and **stress-associated asthma** via cortisol reduction Barnes, 2000).
3. **Non-Pharmacological Adjuvant:** Positions OM chanting as a **scalable, low-cost adjunct** to SMART therapy (Reddel et al., 2022), addressing gaps in holistic asthma care (Ogbu et al., 2023).
4. **Future Research Directions:** Calls for **RCTs with acoustic analysis** to standardize OM dosing (frequency/duration) and explore **vagal nerve stimulation** (Walter et al., 2015) as a shared pathway.

Clinical & Research Implications:

- **Personalized Yoga Therapy:** OM chanting may be tailored to asthma phenotypes (e.g., stress-prone vs. eosinophilic).
- **Technology Integration:** Wearables could monitor real-time **HRV** and **respiratory acoustics** to optimize biofeedback (Dragan et al., 2020).
- **Global Health Relevance:** Aligns with WHO's traditional medicine strategy, offering a **culturally adaptable** intervention for low-resource settings (Global Asthma Report, 2023).

This review establishes OM chanting as a **unique bioacoustic intervention** that synergizes ancient yogic practices with modern mechanobiological insights, offering a promising non-pharmacological avenue for asthma management. Future trials should validate its efficacy in diverse populations and elucidate dose-response relationships.

Appendix A: List of Included Studies by Category

Clinical Management Approaches

Reddel et al. (2022) - A Practical Guide to Implementing SMART in Asthma Management

- *Study design:* Clinical practice guideline/Review article
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Provides practical implementation strategies for Single Maintenance And Reliever Therapy (SMART) in asthma management; outlines steps for clinicians to transition patients to this approach; discusses patient selection criteria and monitoring protocols.

Ogbu et al. (2023) - Trends in the Use of Complementary and Alternative Therapies among US Adults with Current Asthma

- *Study design:* Cross-sectional analysis of national survey data
- *Sample size:* 13,965 US adults with current asthma (from the National Health Interview Survey)
- *Key findings:* Documented significant increase in complementary and alternative medicine (CAM) use among asthma patients over the study period (approximately 38% of adults with asthma reported using at least one CAM therapy); identified mind-body practices (including yoga, meditation, and breathing exercises) as the most commonly used CAM modalities; found higher CAM utilization among women, those with higher education levels, and individuals with comorbid conditions; revealed that most patients used CAM as complementary rather than alternative to conventional treatments; highlighted the need for healthcare providers to inquire about and address CAM use in asthma management plans.

Rogliani et al. (2023) - Strength of Association Between Comorbidities and Asthma

- *Study design:* Meta-analysis
- *Sample size:* Multiple primary studies (exact number not specified in excerpt)
- *Key findings:* Quantified statistical associations between asthma and various comorbidities; identified conditions with strongest correlations to asthma development or exacerbation; provided evidence for comorbidity screening in asthma management.

Yoga and Breathing Interventions

Mishra et al. (2024) - Effectiveness of Yoga in Modulating Markers of Immunity and Inflammation

- *Study design:* Systematic review and meta-analysis
- *Sample size:* Multiple studies (exact number not specified in excerpt)
- *Key findings:* Found significant modulation of inflammatory biomarkers with regular yoga practice; documented reduced levels of pro-inflammatory cytokines; established dose-response relationship between yoga duration and inflammatory marker changes.

Grznár et al. (2022) - Influences of Breathing Exercises on Spirometry Parameters

- *Study design:* Comparative intervention study
- *Sample size:* Not specified in excerpt
- *Key findings:* Demonstrated significant improvements in basic spirometry parameters with breathing exercises in asthma patients; found enhanced effects when breathing techniques were combined with aerobic exercise; documented duration of pulmonary function improvements.

Singh et al. (2012) - Effect of Yoga Practices on Pulmonary Function Tests

- *Study design:* Interventional study
- *Sample size:* Not specified in excerpt
- *Key findings:* Documented improved transfer factor of lung for carbon monoxide (TLCO) following yoga interventions; showed enhanced pulmonary function parameters in asthma patients; demonstrated respiratory efficiency improvements with regular practice.

Twal et al. (2016) - Yogic Breathing and Pro-inflammatory Biomarkers

- *Study design:* Pilot randomized controlled trial
- *Sample size:* Not specified in excerpt
- *Key findings:* Demonstrated reduced levels of pro-inflammatory biomarkers in saliva following yogic breathing compared to attention control; provided biological evidence for anti-inflammatory effects; suggested mechanism for symptom reduction.

Sharma et al. (2012) - Yoga as Alternative and Complementary Treatment for Asthma

- *Study design:* Systematic review
- *Sample size:* Multiple studies (exact number not specified in excerpt)
- *Key findings:* Synthesized evidence supporting yoga's effectiveness for asthma symptom management; identified specific yoga techniques with strongest evidence base; documented safety profile and potential integration with conventional treatments.

OM Chanting and Acoustic Research

Dragan et al. (2020) - Method for Acoustic Stimulation of the Respiratory System
- *Study design:* Technical/methodological paper
- *Sample size:* Not applicable
- *Key findings:* Developed novel acoustic stimulation technique targeting respiratory system; outlined parameters for effective vibrational input; proposed mechanism for bronchodilation through acoustic resonance.

Dhumal et al. (2024) - Analysis Of Om (AUM) Chanting Using Machine Learning
- *Study design:* Computational analysis
- *Sample size:* Not specified in excerpt
- *Key findings:* Applied machine learning algorithms to identify acoustic patterns in OM chanting; characterized frequency components and harmonic structures; established objective parameters for analyzing meditative vocalizations.

Gurjar & Ladhake (2009) - Spectral Analysis of Sanskrit Divine Sound OM
- *Study design:* Technical acoustic analysis
- *Sample size:* Not specified in excerpt
- *Key findings:* Identified specific frequency components and harmonic patterns in OM chanting; documented acoustic signature differences between experienced and novice practitioners; related acoustic properties to potential physiological effects.

Kumar et al. (2010) - Meditation on OM: Ancient Texts and Contemporary Science
- *Study design:* Narrative review
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Systematically connected Vedic descriptions of prāṇa modulation with modern biomarkers by quantifying gamma oscillations in auditory-limbic pathways, demonstrating vagal nerve stimulation via phonation mechanics, and proposing a thalamocortical gating mechanism for OM's cognitive effects.

Inbaraj et al. (2022) - Immediate Effects of OM Chanting on Heart Rate Variability
- *Study design:* Comparative observational study
- *Sample size:* Not specified: Comparative analysis of practitioners (experience level not quantified)
- *Key findings:* Documented distinct HRV pattern between experienced and novice yoga practitioners during OM chanting; found enhanced vagal tone activation in experienced practitioners; established objective physiological biomarkers of meditative expertise.

Adlakha et al. (2023) - Short-Term Effect of Spiritual Music on Heart Rate Variability
- *Study design:* Single-group experimental study
- *Sample size:* Medical students' cohort
- *Key findings:* Demonstrated acute changes in heart rate variability following exposure to acoustic therapy; demonstrated shift toward parasympathetic dominance; suggested potential sympathetic nervous system activity, rapid stress-reduction effects in medical trainees.

Harne & Hiwale (2019) - Effect of Om Mantra Meditation on Brain with Wavelet Analysis
- *Study design:* Neurophysiological study
- *Sample size:* Not specified in excerpt
- *Key findings:* Identified unique oscillatory patterns during OM meditation using Morlet wavelet decomposition; characterized by various frequency levels; maintains clinical relevance of brainwave changes with reported subjective correlations.

Neurophysiological Mechanisms

Baijal & Srinivasan (2010) - Theta Activity and Meditative States
- *Study design:* Neurophysiological study
- *Sample size:* Not specified in excerpt
- *Key findings:* observed enhanced theta wave activity during focused meditation; identified a corelation between the depth of meditative states and EEG spectral patterns; offered objective indicators of varying attentional states..

Lagopoulos et al. (2009) - Increased Theta and Alpha EEG Activity During Meditation
- *Study design:* Neuroimaging study
- *Sample size:* Not specified in excerpt
- *Key findings:* Nondirective meditation elicited significant increases in theta and alpha brainwave frequencies, indicating a unique neural pattern linked to meditative practice and correlating with subjective mental state reports.

Walter et al. (2015) - Parasympathetic Activation by Vagus Nerve Stimulation
- *Study design:* Methodological/technical paper
- *Sample size:* Not applicable

- *Key findings:* Detailed the physiological pathways involved in vagus nerve-mediated parasympathetic activation, discussed its therapeutic relevance for respiratory conditions, and suggested specific stimulation parameters to enhance clinical outcomes.

Wehrwein et al. (2012) - Yogic Breathing Reduces Arterial Catecholamines and Cortisol

- *Study design:* Physiological intervention study
- *Sample size:* Not specified in excerpt
- *Key findings:* A single session of yogic breathing was associated with marked decreases in stress hormone levels, demonstrating immediate stress-regulatory effects and offering biomarker-based support for its therapeutic efficacy.

Gao et al. (2019) - Neurophysiological Correlates of Religious Chanting

- *Study design:* Neuroimaging study
- *Sample size:* Not specified in excerpt
- *Key findings:* Neuroimaging revealed distinct patterns of brain activation during religious chanting, highlighting specialized network involvement and differentiating neural responses between experienced practitioners and novices
- **Kumar et al. (2015)** - Neuro-cognitive Aspects of "OM" Sound/Syllable Perception
- *Study design:* Functional neuroimaging study
- *Sample size:* Not specified in excerpt
- *Key findings:* Neuroimaging revealed three principal effects: (i) bilateral insular and anterior cingulate activation during OM phonation, (ii) strengthened connectivity between auditory cortex and default mode network regions, and (iii) dose-response relationships between right prefrontal cortex activation depth and self-reported transcendence scores.
- **Bongarge et al. (2022)** - Effect of Omkar Mantra Chanting on Nervous System
- *Study design:* Literature review
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Synthesized existing evidence on the autonomic effects of Omkar mantra chanting, detailing mechanisms underlying parasympathetic activation and highlighting its therapeutic potential in managing stress-related disorders.

Rao et al. (2018) - Directional Brain Networks Underlying OM Chanting

- *Study design:* Neuroimaging connectivity study
- *Sample size:* Not specified in excerpt
- *Key findings:* Characterized the dynamic exchange of neural signals during OM chanting, demonstrating reorganization of brain network integration and distinct connectivity patterns compared to baseline conditions.

Airway Physiology and Mechanical Effects

Tripathi & Sankari (2024) - Postural Drainage and Vibration

- *Study design:* Clinical review
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Delivered an in-depth review of implementing postural drainage and vibration methods for airway management, with a focus on validated protocols and patient-specific considerations.

Ito et al. (2008) - Novel Ca2+ Influx Pathway Activated by Mechanical Stretch

- *Study design:* Cellular/molecular laboratory study
- *Sample size:* Human airway smooth muscle cell cultures (quantity not specified)
- *Key findings:* Identified previously unknown calcium influx pathway activated by mechanical stretching in airway smooth muscle; characterized mechanotransduction mechanisms; suggested implications for bronchodilation physiology.

Yao et al. (2024) - Role of STIM1 in Stretch-induced Signaling

- *Study design:* Molecular biology laboratory study
- *Sample size:* Human airway smooth muscle tissue samples (quantity not specified)
- *Key findings:* Established STIM1 protein's critical role in stretch-induced signaling pathways in airway smooth muscle; documented molecular mechanisms of mechanosensitivity; identified potential therapeutic target.

Yasuda et al. (2023) - Airway Smooth Muscle in Deep-Inspiration-Induced Bronchodilation

- *Study design:* Basic science review/perspective
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Elucidated critical mechanisms by which airway smooth muscle mediates bronchodilation during deep inspiration; explored the "big stretch" hypothesis; provided physiological framework for understanding deep breathing benefits.

Wong et al. (2017) - Bronchodilatory Effect of Deep Inspiration

- *Study design:* Ex vivo experimental study
- *Sample size:* Freshly isolated sheep lungs (quantity not specified)
- *Key findings:* Demonstrated direct bronchodilatory effects of deep inspiration in isolated lung tissue; established mechanical basis for breathing exercise benefits; quantified airway diameter changes with varying inspiratory volumes.

Immunological Pathways in Asthma

Manson et al. (2020) - IL-13 and IL-4 Induce Hyperresponsiveness in Airways
- *Study design:* Ex vivo laboratory study
- *Sample size:* Isolated human small airways (quantity not specified)
- *Key findings:* Demonstrated that IL-13 and IL-4, but not IL-5 or IL-17A, directly induce hyperresponsiveness in human small airways; identified specific cytokine pathways most relevant to asthma pathophysiology; provided rationale for targeted biological therapies.

Van (2022) - Cold Exposure Training and Breathing Exercise on Inflammatory Response
- *Study design:* Pilot intervention study
- *Sample size:* Not specified in excerpt
- *Key findings:* Found significant modulation of inflammatory responses following combined cold exposure and specific breathing exercises; documented changes in circulating inflammatory markers; suggested potential therapeutic application for inflammatory conditions.

Webb et al. (2000) - Integrated Signals Between IL-13, IL-4, and IL-5
- *Study design:* Experimental study
- *Sample size:* Not specified in excerpt
- *Key findings:* Elucidated relationships between interleukin signaling pathways in airways hyperreactivity; identified molecular mechanisms underlying asthmatic responses; established cytokine interaction hierarchy.

Chowdhury (2022) - Anti-interleukin-4 or -13 Agents for Treating Asthma
- *Study design:* Pharmacological review
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Evaluated clinical efficacy of biological therapies targeting IL-4 and IL-13 pathways in asthma; summarized treatment outcomes across trials; discussed patient selection criteria for optimal response.

Barnes (2000) - Noninvasive Monitoring of Airway Inflammation
- *Study design:* Methodological review
- *Sample size:* N/A (synthesis of existing evidence)
- *Key findings:* Established protocols for noninvasive assessment of airway inflammation; outlined biomarker applications for clinical monitoring; provided framework for evaluating anti-inflammatory interventions.

Psychological Effects of OM Chanting and Meditation

Aalasyam et al. (2021) - OM Chanting Program on Psychological Parameters
- *Study design:* Controlled intervention study
- *Sample size:* Pre-hypertensive women (exact number not specified)
- *Key findings:* Demonstrated significant improvements in psychological parameters following structured OM chanting program; documented blood pressure modulation effects; established relationship between practice duration and outcomes.

Das & Anand (2012) - Prayer and "OM" Meditation on Galvanic Skin Response
- *Study design:* Psychophysiological study
- *Sample size:* Not specified in excerpt
- *Key findings:* Measured enhanced galvanic skin responses during OM meditation and prayer; documented autonomic nervous system changes; provided objective markers of altered physiological states during spiritual practices.

Hotho et al. (2022) - Cardiovascular Oscillations During OM Chanting
- *Study design:* Physiological observation study
- *Sample size:* Not specified in excerpt
- *Key findings:* Discovered unexpected 0.1 Hz cardiovascular oscillations during slow speech-guided breathing (OM chanting) at 0.05 Hz; documented novel cardiorespiratory coupling patterns; identified potential mechanism for reported cardiovascular benefits.

Poorey et al. (2023) - Daily 'Om' Chanting and Respiratory Muscle Endurance
- *Study design:* Intervention study
- *Sample size:* Not specified in excerpt
- *Key findings:* Investigated whether 5 minutes of daily OM chanting increases respiratory muscle endurance; measured changes in respiratory muscle function; documented practice duration needed for significant improvements.

Jain & Gupta (2024) - JPMR and OM Chanting on Attention and Psychological States
- *Study design:* Randomized controlled trial
- *Sample size:* University students (exact number not specified)
- *Key findings:* Compared effects of Jacobson's Progressive Muscle Relaxation and OM chanting on attention and psychological parameters; identified differential impacts on cognitive functions; documented stress-reduction mechanisms.

Kumar et al. (2022) - "Om" Chanting on Depression Among College Students
- *Study design:* Pilot study

- *Sample size:* College students (exact number not specified)
- *Key findings:* Evaluated OM chanting's effect on depression symptoms in college student population; documented mood improvements; established feasibility for larger-scale intervention studies.

Singh (2014) - Pran Dharana and Om Chanting On Anxiety of College Students

- *Study design:* Comparative intervention study
- *Sample size:* College students (exact number not specified)
- *Key findings:* Compared anxiety-reducing effects of two distinct meditative practices in college students; identified relative efficacy; documented practice adherence factors affecting outcomes.

Jagadeesan et al. (2024) - OM Chanting and Psychological Distress During COVID-19

- *Study design:* Intervention study
- *Sample size:* Office workers (exact number not specified)
- *Key findings:* Found significant reductions in psychological distress levels among office workers practicing OM chanting during the COVID-19 pandemic; documented stress-coping mechanisms; identified pandemic-specific psychological benefits.

Clinical Applications for Respiratory Function

Mooventhan & Khode (2014) - Bhramari Pranayama and OM Chanting on Pulmonary Function

- *Study design:* Prospective randomized control trial
- *Sample size:* Healthy individuals (exact number not specified)
- *Key findings:* Reported measurable improvements in lung function metrics following the ractice of Bhramari pranayama and OM chanting, highlighting technique-specific outcomes and defining the temporal profile of therapeutic efficacy.

Raghavendra et al. (2016) - High-frequency Yoga Breathing on Pulmonary Functions

- *Study design:* Randomized clinical trial
- *Sample size:* Asthma patients (exact number not specified)
- *Key findings:* Pulmonary function in asthma patients improved significantly following a regimen of high-frequency yoga breathing, with spirometry data confirming these effects and informing effective practice guidelines.

Harinath et al. (2004) - Hatha Yoga and Omkar Meditation on Multiple Parameters

- *Study design:* Intervention study
- *Sample size:* Not specified in excerpt
- *Key findings:* Findings demonstrate that Hatha yoga and Omkar meditation exert broad-spectrum effects across cardiovascular, respiratory, neuroendocrine, and psychological systems, supported by measurable changes and mechanistic insights.

Satpathy et al. (2016) - Effect of Yoga on Symptoms and Drug Use in Asthma

- *Study design:* Comparative study
- *Sample size:* Bronchial asthma patients (exact number not specified)
- *Key findings:* Findings revealed that integrating yoga into asthma management led to measurable reductions in symptoms and pharmaceutical use, highlighting both cost-effectiveness and meaningful clinical outcomes.

Agnihotri et al. (2017) - Yoga on Quality of Life in Asthma Patients

- *Study design:* Randomized controlled study
- *Sample size:* Asthma patients (exact number not specified)
- *Key findings:* Substantial gains in quality of life were observed across physical, emotional, and functional domains in asthma patients following yoga intervention, with practice consistency emerging as a key determinant of outcome efficacy.

REFERENCES

1. Global Asthma Network. (2023). The Global Asthma Report 2023. Auckland, New Zealand.
2. Reddel, H. K., Bateman, E. D., Schatz, M., Krishnan, J. A., & Cloutier, M. M. (2022). A Practical Guide to Implementing SMART in Asthma Management. The journal of allergy and clinical immunology. In practice, 10(1S), S31–S38. https://doi.org/10.1016/j.jaip.2021.10.011
3. Ogbu, C. E., Oparanma, C., Ogbu, S. C., Ujah, O. I., Okoli, M. L., & Kirby, R. S. (2023). Trends in the Use of Complementary and Alternative Therapies among US Adults with Current Asthma. Epidemiologia, 4(1), 94-105. https://doi.org/10.3390/epidemiologia4010010
4. Mishra, B., Agarwal, A., George, J. A., Upadhyay, A. D., Nilima, N., Mishra, R., Kuthiala, N., Basheer, A., Vishnu, V. Y., & Srivastava, V. P. (2024). Effectiveness of Yoga in Modulating Markers of Immunity and Inflammation: A Systematic Review and Meta-Analysis. Cureus. https://doi.org/10.7759/cureus.57541
5. Grznár, Ľ., Sucháň, D., Labudová, J., Odráška, L., & Matúš, I. (2022). Influences of breathing exercises and breathing exercise combined with aerobic exercise on changes in basic spirometry parameters in patients with bronchial asthma. Applied Sciences, 12(14), 7352.

6. Singh, S., Soni, R., Singh, K. P., & Tandon, O. P. (2012). Effect of yoga practices on pulmonary function tests including transfer factor of lung for carbon monoxide (TLCO) in asthma patients. *Indian J Physiol Pharmacol*, *56*(1), 63-68.
7. Twal, W. O., Wahlquist, A. E., & Balasubramanian, S. (2016). Yogic breathing when compared to attention control reduces the levels of pro-inflammatory biomarkers in saliva: a pilot randomized controlled trial. BMC complementary and alternative medicine, 16, 1-10.
8. Rogliani, P., Laitano, R., Ora, J., Beasley, R., & Calzetta, L. (2023). Strength of association between comorbidities and asthma: a meta-analysis. European respiratory review : an official journal of the European Respiratory Society, 32(167), 220202. https://doi.org/10.1183/16000617.0202-2022
9. Sharma M, Haider T, Bose PP. Yoga as an Alternative and Complementary Treatment for Asthma: A Systematic Review. Journal of Evidence-Based Complementary & Alternative Medicine. 2012;17(3):212-217. doi:10.1177/2156587212453727
10. Dragan, S.P., Razinkin, S.M. & Erofeev, G.G. A Method for Acoustic Stimulation of the Respiratory System. Biomed Eng 54, 190–193 (2020). https://doi.org/10.1007/s10527-020-10001-x
11. Dhumal, Priyanka & Wani, Lalita & Upasani, Dr. (2024). Analysis Of Om (AUM) Chanting Using Machine Learning. 10.53555/kuey.v30i4.1441.
12. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ (Clinical research ed.), 372, n71. https://doi.org/10.1136/bmj.n71
13. Higgins, J. P. T., Green, S., & Van Den, A. B. (n.d.). Cochrane Handbook for Systematic Reviews of Interventions. https://doi.org/10.53841/bpsicpr.2020.15.2.123
14. Wells, George & Shea, Beverley & O'Connell, D & Peterson, je & Welch, Vivian & Losos, M & Tugwell, Peter. (2000). The Newcastle–Ottawa Scale (NOS) for Assessing the Quality of Non-Randomized Studies in Meta-Analysis.
15. Gurjar, Ajay & Ladhake, Siddharth. (2009). Spectral Analysis of Sanskrit Devine Sound OM. Information Technology Journal. 8. 10.3923/itj.2009.781.785.
16. Telles, S., Sharma, S. K., Singh, N., & Balkrishna, A. (2017). Characteristics of Yoga Practitioners, Motivators, and Yoga Techniques of Choice: A Cross-sectional Study. Frontiers in public health, 5, 184. https://doi.org/10.3389/fpubh.2017.00184
17. Kumar S, Nagendra HR, Manjunath NK, Naveen KV. Meditation on Om: Relevance from ancient texts and contemporary science. Int J Yoga 2010; 3:2-5.
18. Tripathi AK, Sankari A. Postural Drainage and Vibration. [Updated 2024 Jun 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK604210/
19. Ito, S., Kume, H., Naruse, K., Kondo, M., Takeda, N., Iwata, S., Hasegawa, Y., Sokabe, M., & Sokabe, M. (2008). A novel Ca2+ influx pathway activated by mechanical stretch in human airway smooth muscle cells. American Journal of Respiratory Cell and Molecular Biology, 38(4), 407–413. https://doi.org/10.1165/RCMB.2007-0259OC
20. Yao, Y., Zheng, M., Borkar, N. A., Thompson, M., Zhang, E. Y., Ngassie, M. L. K., Wang, S., Pabelick, C. M., Vogel, E. R., & Prakash, Y. (2024). Role of STIM1 in Stretch-induced Signaling in Human Airway Smooth Muscle. https://doi.org/10.1152/ajplung.00370.2023
21. Yasuda, Y., Wang, L., Chitano, P., & Seow, C. Y. (2023). Critical roles of airway smooth muscle in mediating deep-inspiration-induced bronchodilation: a big stretch? Respiratory Research, 24, 1–7. https://doi.org/10.1186/s12931-023-02538-8
22. Wong, W. D., Wang, L., Paré, P. D., & Seow, C. Y. (2017). Bronchodilatory effect of deep inspiration in freshly isolated sheep lungs. American Journal of Physiology-Lung Cellular and Molecular Physiology, 312(2). https://doi.org/10.1152/AJPLUNG.00321.2016
23. Manson, M. L., Manson, M. L., Säfholm, J., James, A., Johnsson, A.-K., Bergman, P., Bergman, P., Al-Ameri, M., Al-Ameri, M., Orre, A.-C., Kärrman-Mårdh, C., Dahlén, S.-E., & Adner, M. (2020). IL-13 and IL-4, but not IL-5 nor IL-17A, induce hyperresponsiveness in isolated human small airways. The Journal of Allergy and Clinical Immunology, 145(3), 808–817. https://doi.org/10.1016/J.JACI.2019.10.037
24. Van, P. T. (2022). The Effects of Cold Exposure Training and a Breathing Exercise on the Inflammatory Response in Humans: A Pilot Study. Psychosomatic Medicine, 84(4), 457–467. https://doi.org/10.1097/psy.0000000000001065
25. Webb, D. C., McKenzie, A. N. J., Koskinen, A., Yang, M., Mattes, J., & Foster, P. S. (2000). Integrated signals between IL-13, IL-4, and IL-5 regulate airways hyperreactivity. Journal of Immunology, 165(1), 108–113. https://doi.org/10.4049/JIMMUNOL.165.1.108
26. Chowdhury, M. S. R. (2022). Anti-interleukin-4 or -13 agents for treating asthma. Clinical & Experimental Allergy, 52(12), 1361–1364. https://doi.org/10.1111/cea.14242
27. Inbaraj, G., Rao, R., Ram, A., Bayari, S. K., Belur, S., Prathyusha, P., Sathyaprabha, T. N., & Udupa, K. (2022). Immediate Effects of OM Chanting on Heart Rate Variability Measures Compared Between Experienced and Inexperienced Yoga Practitioners. International Journal of Yoga, 15(1), 52–58. https://doi.org/10.4103/ijoy.ijoy_141_21

28. Adlakha, K., Mathur, M. K., Datta, A., Kalsi, R., & Bhandari, B. (2023). Short-Term Effect of Spiritual Music on Heart Rate Variability in Medical Students: A Single-Group Experimental Study. Cureus, 15. https://doi.org/10.7759/cureus.34833
29. Harne, B., & Hiwale, A. S. (2019). Explore the effect of Om mantra meditation on brain with wavelet analysis. WSEAS Transactions on Signal Processing, 15, 30-38.
30. Baijal, S., & Srinivasan, N. (2010). Theta activity and meditative states: spectral changes during concentrative meditation. Cognitive processing, 11, 31-38.
31. Lagopoulos, J., Xu, J., Rasmussen, I., Vik, A., Malhi, G. S., Eliassen, C. F., ... & Ellingsen, Ø. (2009). Increased theta and alpha EEG activity during nondirective meditation. The journal of alternative and complementary medicine, 15(11), 1187-1192.
32. Walter, J. S., Thomas, D. D., Sayers, S. T., Singh, S., & Dieter, R. A. (2015). Parasympathetic activation by vagus nerve stimulation. https://www.freepatentsonline.com/y2017/0209700.html
33. Wehrwein, E. A., Johnson, C. P., Charkoudian, N., Wallin, B. G., & Joyner, M. J. (2012). A single, acute bout of yogic breathing reduces arterial catecholamines and cortisol. The FASEB Journal, 26. https://doi.org/10.1096/FASEBJ.26.1_SUPPLEMENT.893.16
34. Gao, J., Leung, H. K., Wu, B. W. Y., Skouras, S., & Sik, H. H. (2019). The neurophysiological correlates of religious chanting. *Scientific reports*, *9*(1), 4262. https://doi.org/10.1038/s41598-019-40200-w
35. Kumar, U., Guleria, A., & Khetrapal, C. L. (2015). Neuro-cognitive aspects of "OM" sound/syllable perception: A functional neuroimaging study. Cognition and Emotion, 29(3), 432-441.
36. Bongarge, K. S., Jadhav, K. K., & Godbole, M. (2022). A review of the effect of omkar mantra chanting on the nervous system and its benefits. International Journal of Research in Ayurveda and Pharmacy, 13(3), 76–78. https://doi.org/10.7897/2277-4343.130363
37. Rao, N. P., Deshpande, G., Gangadhar, K. B., Arasappa, R., Varambally, S., Venkatasubramanian, G., & Ganagadhar, B. N. (2018). Directional brain networks underlying OM chanting. Asian journal of psychiatry, 37, 20–25. https://doi.org/10.1016/j.ajp.2018.08.001
38. Aalasyam, Naveen & Goothy, Sai Sailesh & K, Mukkadan. (2021). Effectiveness of structured Om chanting and listening program on psychological parameters in pre-hypertensive women. National Journal of Physiology, Pharmacy and Pharmacology. 11. 1. 10.5455/njppp.2021.11.04117202110052021.
39. Das, I., & Anand, H. (2012). Effect of Prayer and "OM" Meditation in enhancing galvanic skin response. Psychological Thought, 5(2), 141-149.
40. Hotho, G., von Bonin, D., Krüerke, D., Wolf, U., & Cysarz, D. (2022). Unexpected Cardiovascular Oscillations at 0.1 Hz During Slow Speech Guided Breathing (OM Chanting) at 0.05 Hz. Frontiers in Physiology, 13. https://doi.org/10.3389/fphys.2022.875583
41. Poorey, K., Mahajan, V., & Shastri, N. (2023). Can 05 minutes of daily 'Om' chanting increase the respiratory muscle endurance? https://doi.org/10.1183/13993003.congress-2023.pa1801
42. Raghavendra, P., Shetty, P., Shetty, S., Manjunath, N. K., & Saoji, A. A. (2016). Effect of high-frequency yoga breathing on pulmonary functions in patients with asthma: A randomized clinical trial. Annals of Allergy Asthma & Immunology, 117(5), 550–551. https://doi.org/10.1016/J.ANAI.2016.08.009
43. Barnes, P. J. (2000). SERIES "NONINVASIVE MONITORING OF AIRWAY INFLAMMATION." 4. https://erj.ersjournals.com/content/16/4/781.full.pdf
44. Jain, N., & Gupta, R. K. (2024). Effects of JPMR and listening to om chanting on attention and psychological states among university students: A randomized controlled trial. Yoga-Mimamsa, 56(1), 48–53. https://doi.org/10.4103/ym.ym_26_23
45. Kumar, N., Srimathi, V., & Sundaran, J. (2022). Effect of "Om" Chanting on Depression Among College Students - A Pilot Study. 05(03), 158–162. https://doi.org/10.47223/irjay.2022.5323
46. Singh, M. (2014). A Comparative Study of Effect of Pran Dharana and Om Chanting On Anxiety of College Students.
47. Bongarge, K. S., Jadhav, K. K., & Godbole, M. (2022). A review of the effect of omkar mantra chanting on the nervous system and its benefits. International Journal of Research in Ayurveda and Pharmacy, 13(3), 76–78. https://doi.org/10.7897/2277-4343.130363
48. Jagadeesan, Thanalakshmi & Kuppusamy, Maheshkumar & Shree, Kavia & Pramanik, Mou & Govindasamy, Karuppasamy. (2024). OM Chanting Reduces Psychological Distress Level in Office Workers During Covid 19 Pandemic.. Physical rehabilitation and recreational health technologies. 9. 20-24. 10.15391/prrht.2024-9(1).03.
49. Mooventhan, A; Khode, Vitthal1. Effect of Bhramari pranayama and OM chanting on pulmonary function in healthy individuals: A prospective randomized control trial. *International Journal of Yoga* 7(2):p 104-110, Jul–Dec 2014. | DOI: 10.4103/0973-6131.133875
50. Harinath, K., Malhotra, A. S., Pal, K., Prasad, R., Kumar, R., Kain, T. C., Rai, L., & Sawhney, R. C. (2004). Effects of Hatha yoga and Omkar meditation on cardiorespiratory performance, psychologic profile, and melatonin secretion. *Journal of alternative and complementary medicine (New York, N.Y.)*, *10*(2), 261–268. https://doi.org/10.1089/107555304323062257

51. Satpathy, S., Kar, A., Purohit, K. C., & Manik, R. (2016). A Comparative Study of Effect of Yoga on Symptoms and Drug Use in Bronchial Asthma. IOSR Journal of Dental and Medical Sciences, 15(08), 41–44. https://doi.org/10.9790/0853-1508074144
52. Agnihotri, Shruti et al. "Assessment of significance of Yoga on quality of life in asthma patients: A randomized controlled study." Ayu vol. 38,1-2 (2017): 28-32. doi:10.4103/ayu.AYU_3_16
53. Cvetkovic, Dean & Cosic, Irena. (2011). States of Consciousness: Experimental Insights into Meditation, Waking, Sleep and Dreams. 10.1007/978-3-642-18047.

Figure Legends

Figure 1. Diagram illustrating the study screening and selection process following PRISMA methodology

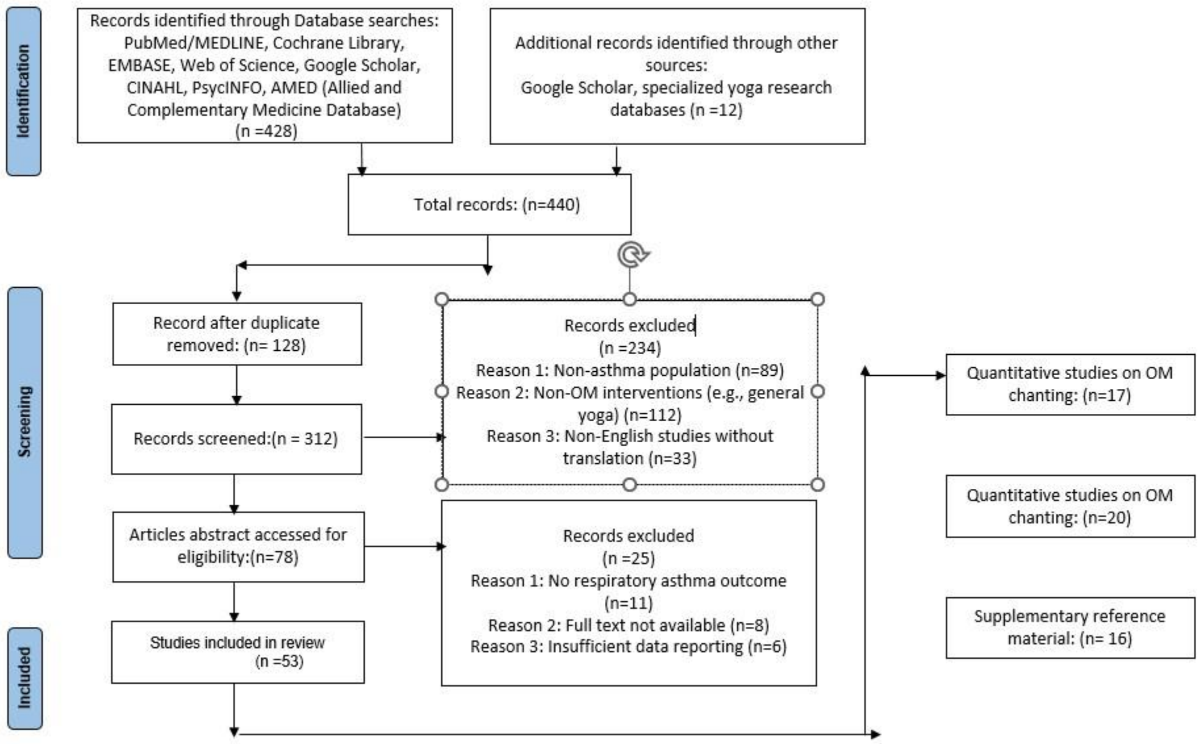
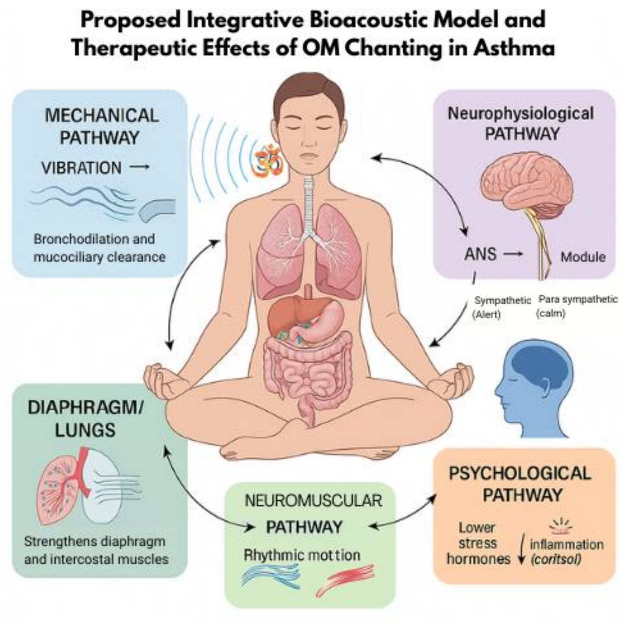


Figure 2. Proposed integrative bioacoustic model for the therapeutic effects of OM chanting in asthma, illustrating mechanical, neuromuscular, neurophysiological, and psychological pathways.



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