



A Comprehensive Systematic Review of The Relationship between Breathing Exercises (Yoga / Pranayama) and Lung Function in Asthma Patients

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ABSTRACT

Introduction: Asthma is a chronic inflammatory airway disease characterized by variable airflow obstruction, affecting millions worldwide. Despite pharmacological advances, many patients experience suboptimal control and seek complementary therapies. Breathing exercises, including yoga and pranayama, have been widely advocated as adjunctive interventions to improve respiratory mechanics and lung function in asthma (Santino et al., 2020). This systematic review comprehensively examines the relationship between structured breathing exercises and objective lung function parameters in asthma patients.

Methods: A systematic review was conducted following a detailed screening protocol. Studies were included if they involved ≥80% asthma patients or provided subgroup analysis, examined yoga/pranayama/structured breathing techniques, measured objective lung function (e.g., FEV1, FVC, PEF), employed controlled study designs (RCTs, quasi-experimental, cohort, case-

control, systematic reviews), included a comparison group, and had an intervention duration of at least one week. Data extraction covered intervention details, lung function assessments, study design, population characteristics, outcomes, and contextual factors from 80 included sources.

Results: The evidence reveals heterogeneous findings. Meta-analyses showed conflicting results; for example, Yang et al. (2016) found no significant effect on FEV1 (MD 0.04 L, 95% CI - 0.10 to 0.19), while Rathore et al. (2025) reported a significant improvement (WMD 0.47 L, $p < 0.00001$). PEF demonstrated the most consistent improvements across studies (e.g., Cramer et al., 2014: SMD 0.49, $p < 0.001$). Pranayama and Buteyko techniques showed comparable efficacy, with some evidence favoring Buteyko for certain spirometric parameters (Swathi et al., 2021; Elsaid et al., 2023). Improvements were more pronounced with supervised, frequent (daily), and longer-duration (≥ 8 weeks) interventions, particularly in adult mild-to-moderate asthma populations.

Discussion: The heterogeneity in outcomes can be attributed to variations in study quality, intervention type, duration, intensity, population characteristics, and cultural context. High-quality RCTs often reported more modest lung function benefits alongside significant improvements in symptoms and quality of life. The primary mechanism likely involves enhanced respiratory muscle efficiency, improved breathing pattern control, and potential modulation of autonomic and inflammatory pathways, rather than fundamental reversal of airway obstruction.

Conclusion: Breathing exercises, particularly yoga and pranayama, can serve as beneficial adjunctive therapy for asthma,

primarily improving PEFr and potentially FEV1 with sustained practice. They are most effective for adults with mild-to-moderate asthma when practiced regularly under guidance. Future research should prioritize high-quality, large-scale RCTs with standardized protocols, longer follow-up, and exploration of mechanisms and cost-effectiveness to solidify clinical recommendations.

Keywords: Asthma, Breathing Exercises, Yoga, Pranayama, Lung Function, FEV1, PEFr, Systematic Review.

INTRODUCTION

Background

Asthma is a prevalent chronic respiratory condition characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, stemming from chronic airway inflammation and hyperresponsiveness (Global Initiative for Asthma, 2024). While pharmacotherapy, primarily inhaled corticosteroids and bronchodilators, forms the cornerstone of management, a significant proportion of patients continue to experience symptoms, impaired quality of life, and reliance on rescue medication (Santino et al., 2020). This therapeutic gap has fueled interest in non-pharmacological, complementary, and integrative approaches. Among these, breathing exercises derived from yogic traditions—such as pranayama (yogic breath control), Buteyko technique (focused on reduced breathing), and diaphragmatic breathing—have gained prominence. These practices aim to optimize breathing patterns, strengthen respiratory muscles, reduce hyperventilation, and potentially modulate the autonomic nervous system and inflammatory response (Cramer et al., 2014; Jayawardena et al., 2020). Preliminary studies and clinical observations suggest these interventions may lead to improvements in both subjective symptoms and objective measures of pulmonary function.

Research Gap

Despite a growing body of literature, the evidence regarding the efficacy of breathing exercises on objective lung function parameters in asthma remains fragmented and seemingly contradictory. Early systematic reviews, such as the Cochrane review by Yang et al. (2016), concluded there was no significant effect of yoga on Forced Expiratory Volume in 1 second (FEV1), a key spirometric indicator of airway obstruction. In contrast, numerous individual randomized controlled trials (RCTs) and more recent meta-analyses have reported statistically and clinically significant improvements in FEV1, Forced Vital Capacity (FVC), and particularly Peak Expiratory Flow Rate (PEFR) (Agarwal et al., 2012; Satpathy et al., 2022; Rathore et al., 2025).

This inconsistency points to a significant research gap: a lack of a comprehensive, up-to-date synthesis that critically appraises this heterogeneity, explores its sources (e.g., intervention type, duration, population, study quality), and provides nuanced conclusions for specific asthma subgroups. Furthermore, there is limited synthesis comparing the relative effectiveness of different breathing techniques (e.g., pranayama vs. Buteyko) and their applicability across diverse cultural and clinical settings.

Novelty

This systematic review offers a novel and comprehensive analysis by integrating evidence from 80 diverse sources, including recent studies from 2024 and 2025, which were not included in prior major reviews. It moves beyond simply pooling effect sizes to perform a detailed comparative analysis of different breathing techniques (yoga, pranayama, Buteyko, diaphragmatic breathing) across multiple lung function parameters (FEV1, FVC, PEF, FEV1/FVC). A key novelty lies in its in-depth exploration of the factors explaining the heterogeneity in findings, such as intervention intensity (session duration, frequency), supervision, study setting (Eastern vs. Western contexts), and methodological rigor. By synthesizing data on secondary outcomes like respiratory rate, oxygen saturation, and airway hyperresponsiveness, it provides a more holistic view of the respiratory impact. Finally, it delivers context-specific conclusions and practical recommendations tailored to different asthma populations (adults vs. children, mild vs. severe) and clinical scenarios, thereby enhancing its direct applicability for healthcare providers and patients.

Research Objectives

The primary objective of this systematic review is to critically evaluate and synthesize the existing evidence on the relationship between structured breathing exercises (yoga, pranayama, Buteyko, diaphragmatic breathing) and objective lung function parameters in patients diagnosed with asthma. Specific aims include:

1. To determine the effect of breathing exercises on key spirometric measures: FEV1, FVC, PEFR, and FEV1/FVC ratio.
2. To compare the effectiveness of different types of breathing techniques (e.g., pranayama vs. Buteyko).
3. To identify moderating factors influencing outcomes, such as intervention duration, frequency, supervision, and patient characteristics (age, asthma severity).
4. To assess the impact on secondary respiratory outcomes (e.g., oxygen saturation, respiratory rate).
5. To evaluate the methodological quality of the existing evidence and discuss clinical applicability.

Research Hypothesis

It is hypothesized that regular practice of structured breathing exercises leads to statistically and clinically significant improvements in lung function parameters, particularly PEFR and FEV1, in patients with asthma, compared to control groups receiving usual care or placebo. It is further hypothesized that the magnitude of improvement is positively associated with intervention duration and adherence, and may vary based on the specific technique employed and the population's baseline characteristics.

Research Benefits

The findings of this review hold significant potential benefits. For clinicians, it will provide an evidence-based summary to guide recommendations on breathing exercises as adjunctive therapy, helping to identify which patients might benefit most and which techniques are best supported. For patients with asthma, it offers a consolidated view of the potential benefits of non-drug interventions, empowering them to make informed decisions about integrative care. For

researchers, it highlights the inconsistencies in the current literature, identifies key gaps (e.g., need for studies in severe asthma, cost-effectiveness analyses), and suggests directions for future high-quality RCTs with standardized protocols. For health policymakers, it contributes to the body of evidence needed to consider the integration of structured breathing programs into comprehensive asthma management pathways.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the relationship between breathing exercises (yoga / pranayama) and lung function in asthma patients.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Population:** Does the study involve participants diagnosed with asthma, where asthma patients represent at least 80% of the study population OR subgroup analysis for asthma patients is available?
- **Intervention:** Does the study examine yoga breathing exercises, pranayama, or other structured breathing techniques derived from yoga practices?
- **Outcomes:** Does the study measure objective lung function parameters such as FEV1, FVC, PEFR, or other spirometry measurements?

- **Study Design:** Is the study design a randomized controlled trial, quasi-experimental study, cohort study, case-control study, systematic review, or meta-analysis (NOT a case report, case series, editorial, opinion piece, or conference abstract without full-text availability)?
- **Comparison Group:** Does the study include a control or comparison group (such as usual care, placebo, waitlist, or alternative interventions)?
- **Intervention Duration:** Is the intervention duration at least one week (NOT a single-session intervention)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

Element	P (Population)	I (Intervention/Exposure)	C (Comparison/Context)	O (Outcome)
Keyword 1	Asthma patients	Breathing exercises	Usual care	Lung function
Keyword 2	Asthmatic individuals	Yoga breathing	Control group	Pulmonary function
Keyword 3	Bronchial asthma	Pranayama	No intervention	Spirometry
Keyword 4	Respiratory asthma	Respiratory training	Standard treatment	Respiratory parameters

The Boolean MeSH keywords inputted on databases for this research are: ("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND

("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")

Data extraction

- **Breathing Intervention:**

Extract comprehensive details about the breathing exercise intervention used for asthma patients, including:

- Specific type of breathing technique (yoga, pranayama, Buteyko, deep breathing, etc.)
- Specific breathing exercises or poses performed
- Session duration and frequency per week
- Total intervention period
- Who delivered the intervention (instructor, self-guided, etc.)
- Any accompanying techniques (positioning, meditation, etc.)
- Training or preparation provided to participants

- **Lung Function Assessment:**

Extract all pulmonary function measures used to assess lung function in asthma patients, including:

- Specific tests performed (spirometry, peak flow, etc.)
- Parameters measured (FEV1, FVC, PEF, FEF25-75, SpO2, respiratory rate, etc.)
- Units and reference values used
- Equipment or instruments used
- Timing of assessments (baseline, during, post-intervention)
- Who performed the assessments
- Any standardization procedures followed

- **Study Design:**

Extract study methodology details to assess evidence quality, including:

- Study design (RCT, quasi-experimental, before-after, etc.)
- Randomization method if applicable
- Blinding procedures
- Sample size and power calculation
- Inclusion/exclusion criteria for asthma patients
- Dropout rates and reasons
- Data analysis methods used
- Study duration and follow-up period

- **Asthma Population:**

Extract characteristics of asthma patients in the study, including:

- Sample size
- Age range and mean age
- Gender distribution
- Asthma severity (mild, moderate, severe)
- Asthma duration or time since diagnosis
- Current asthma medications or treatments
- Baseline lung function status
- Any comorbidities mentioned
- Previous experience with breathing exercises

- **Effects on Lung Function:**

Extract all results related to the relationship between breathing exercises and lung function in asthma patients, including:

- Changes in each lung function parameter measured
- Statistical significance (p-values, confidence intervals)
- Effect sizes or magnitude of change
- Percentage improvements from baseline
- Time course of changes (immediate, short-term, long-term)
- Comparison between pre- and post-intervention values
- Any dose-response relationships observed
- Clinical significance of changes noted by authors

- **Control Groups:**

Extract details about comparison or control groups used in the study, including:

- Type of control group (no intervention, usual care, placebo, other intervention)
- Sample size of control group
- What the control group received instead of breathing exercises
- Baseline characteristics compared to intervention group
- Results for control group on lung function measures
- Statistical comparisons between intervention and control groups
- Any crossover or switching between groups

- **Study Context:**

Extract contextual factors that may affect the applicability and interpretation of findings for breathing exercises and lung function in asthma patients, including:

- Study setting (hospital, clinic, community, home-based)
- Country and healthcare system context
- Seasonal factors or environmental conditions
- Concurrent asthma management approaches

- Adherence rates to the breathing exercise intervention
- Adverse effects or safety concerns reported
- Authors' conclusions about clinical applicability
- Limitations mentioned by authors
- Recommendations for practice or future research

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND ("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")	1
Semantic Scholar	("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND ("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")	6
Springer	("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND ("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")	112
Google Scholar	("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND ("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")	1,730
Wiley Online Library	("Asthma patients" OR "Asthmatic individuals" OR "Bronchial asthma" OR "Respiratory asthma") AND ("Breathing exercises" OR "Yoga breathing" OR "Pranayama" OR "Respiratory training") AND ("Usual care" OR "Control group" OR "No intervention" OR "Standard treatment") AND ("Lung function" OR "Pulmonary function" OR "Spirometry" OR "Respiratory parameters")	80

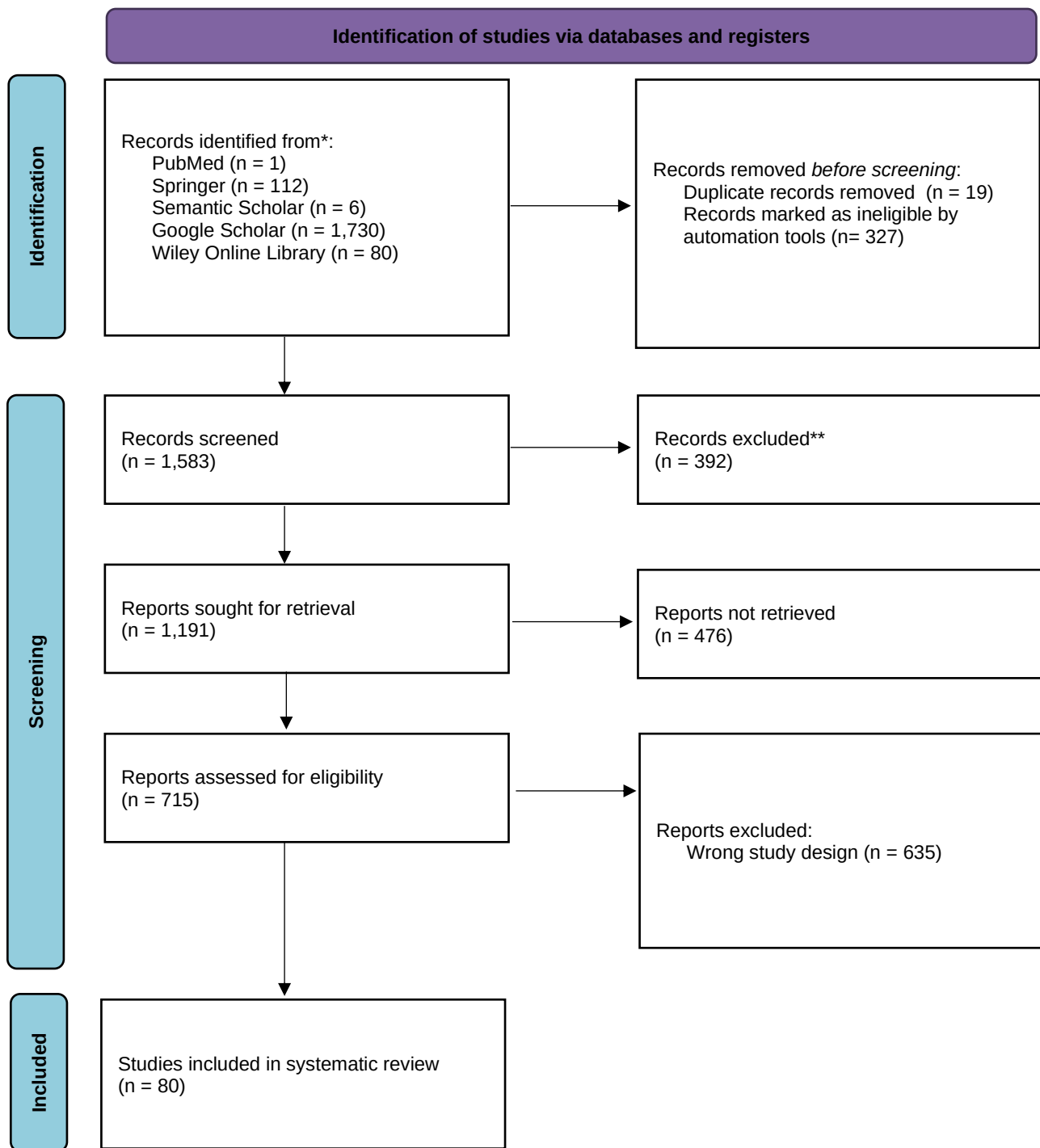


Figure 1. Article search flowchart

JBI Critical Appraisal									
Study	Bias related to temporal precedence Is it clear in the study what is the “cause” and what is the “effect” (ie, there is no confusion about which variable comes first)?	Bias related to selection and allocation Was there a control group?	Bias related to confounding factors Were participants included in any comparisons similar?	Bias related to administration of intervention/exposure Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Were there multiple measurements of the outcome, both pre and post the intervention/exposure?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Bias related to participant retention Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Statistical conclusion validity Was appropriate statistical analysis used?
Zuyao Yang et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Candy Sodhi et al., 2009	✓	✓	✓	✗	✓	✗	✓	✓	✓
Heba Nabil El-Shabrawy et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓

Harendranath T G et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Cooper et al., 2003	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zuyao Yang et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zuyao Yang et al., 2016a	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Yadav et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Denny Agustining sih et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
Vungarala Satyanand et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
N. Gupta et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Das et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Demeke Mekonnen et al., 2010	✓	✓	✓	✗	✓	✗	✓	✓	✓
prem venkatesan et al., 2013	✓	✓	✓	✗	✓	✗	✓	✓	✓
Pallavi Yadav et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓

T. A. Santino et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
G. Swathi et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Prajapati et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Gupta et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Laily Widya Astuti et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mrs. Karpagam K et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
K. Amuthadevi et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Gülyeter Erdoğan Yüce et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Holger Cramer et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Nur et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Gülcan Bahçecioğlu Turan et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓

Nisha Laila et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. A. I. D. Mayuni et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Jayawardena et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Yoga for asthma (2014)	✓	✓	✓	✗	✓	✗	✓	✓	✓
R. Manocha et al., 2008	✓	✓	✓	✗	✓	✗	✓	✓	✓
Thamaraivelvi S et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nur Azis Rohmansyah et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Saurabh Purwar et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
P. Vedanthan et al., 2008	✓	✓	✓	✗	✓	✗	✓	✓	✓
Anshu et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dian Kartikasari et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓

Keristina Ajul et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Made Mahaguna Putra et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Effect of Yoga (2019)	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shruti P. Agnihotri et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sanjeev Satpathy et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Sanjeev Satpathy et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
D. Agarwal et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dian Kartikasari et al., 2019a	✓	✓	✓	✗	✓	✗	✓	✓	✓
F. Schleich et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dr Arpan A. Bhatt et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Dwi Putranti et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Candy Sodhi et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓

Shruti P. Agnihotri et al., 2016a	✓	✓	✓	✗	✓	✗	✓	✓	✓
Wiwik Udayani et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Hj. Nurwahidah et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nida Ghaffar et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jane Jose et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Y. Yunani et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Mufarika Mufarika et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
A. Somashekar et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Reham AbdElmawla Elsaid et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Julvaina Eka Putra Utama et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Eugenia Maria Da Silva et al.,	✓	✓	✓	✗	✓	✗	✓	✓	✓

2023									
D. Agarwal et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Sangeethal axmi et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Anshu Yadav et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
S. Sumartini et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Arif et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nehal Mahmoud Abo El-fadl et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Eva Eva et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
V. Rathore et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
M. Tripathi et al., 2013	✓	✓	✓	✗	✓	✗	✓	✓	✓
W. Udayani et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Selvia Selvia et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓

A. J. Bidwell et al., 2012	✓	✓	✓	✗	✓	✗	✓	✓	✓
F. Tahan et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zülfünaz Özer et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Marian E. Papp et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Indra Frana Jaya KK et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Harish Sharma et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
N. Fittarsih et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
J. P. Venkatesh et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
G. Sharifi et al., 2014	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

The systematic review encompasses 80 sources examining the relationship between breathing exercises and lung function in asthma patients. The included studies represent a mix of primary research and systematic reviews/meta-analyses conducted across multiple countries.

Study	Intervention Type	Population	Duration
Zuyao Yang et al., 2016	Yoga (breathing, posture, meditation)	1048 adults with mild-moderate asthma	2 weeks to 54 months
Candy Sodhi et al., 2009	Yoga breathing exercises	120 patients, majority mild disease	8 weeks
Heba Nabil El-Shabrawy et al., 2025	Pranayama yoga	60 adults aged 22-40, mild-moderate asthma	6 weeks
Harendranath T G et al., 2025	Pranayama (Anuloma-Viloma, Bhramari)	60 participants, mild-moderate asthma	8 weeks
S. Cooper et al., 2003	Buteyko and pranayama (PCLE)	90 patients aged 18-70	6 months
Zuyao Yang et al., 2015	Yoga breathing	1048 adults with mild-moderate asthma	2 weeks to 54 months
Zuyao Yang et al., 2016a	Yoga (breathing, posture, meditation)	1048 adults with mild-moderate asthma	2 weeks to 54 months

Study	Intervention Type	Population	Duration
R. Yadav et al., 2023	Bhramari pranayama and om chanting	110 children aged 8-15	12 weeks
Denny Agustiningsih et al., 2012	Buteyko method	Adult persistent asthma	12 weeks
Vungarala Satyanand et al., 2014	Yogic pranayama	80 stable asthmatic patients	2 months
N. Gupta et al., 2016	Yoga and pranayama	100 bronchial asthma patients	3 months
R. Das et al., 2019	Breathing exercises and yoga/pranayama	466 children aged 6-14	Variable
Demeke Mekonnen et al., 2010	Yoga (yogic practice, breath slowing)	24 patients, mild persistent asthma	4 weeks
prem venkatesan et al., 2013	Buteyko and pranayama	120 subjects	3 months
Pallavi Yadav et al., 2021	Yoga	140 children aged 10-16	3 months
T. A. Santino et al., 2020	Yoga, Buteyko, pranayama, Papworth, diaphragmatic breathing	2880 adults with mild-moderate asthma	Variable

Study	Intervention Type	Population	Duration
G. Swathi et al., 2021	Buteyko and Nadi Shuddhi Pranayama	60 subjects with bronchial asthma	4 weeks
S. Prajapati et al., 2019	Yoga and pranayama	80 bronchial asthma patients	60 days
M. Gupta et al., 2017	Yoga postures (Virassna, Stupassna)	150 children aged 8-14	6-12 weeks
Laily Widya Astuti et al., 2022	Diaphragmatic breathing	38 adults aged 20-55, mild-moderate asthma	2 weeks
Mrs. Karpagam K et al., 2025	Buteyko and Pranayama	12 bronchial asthma patients	8 weeks
K. Amuthadevi et al., 2020	Yoga	30 women aged 45-55	8 weeks
Gülyeter Erdoğan Yüce et al., 2020	Pranayama	Asthma patients	1 month
Holger Cramer et al., 2014	Yoga	824 patients	Variable
A. Nur et al., 2020	Pranayama yoga	72 adult asthmatic patients	6 weeks
Gülcan Bahçecioğlu Turan et al., 2020	Yoga	112 asthma patients	6 weeks

Study	Intervention Type	Population	Duration
Nisha Laila et al., 2022	Alternate nostril breathing with pranayama	60 children with moderate persistent asthma	Not specified
A. A. I. D. Mayuni et al., 2015	Diaphragmatic breathing exercise	30 asthma patients	2 weeks
R. Jayawardena et al., 2020	Pranayama	Variable (16-160 participants)	4 days to 6 months
Yoga for asthma (2014)	Yoga	824 patients	Variable
R. Manocha et al., 2008	Sahaja Yoga	59 adults with moderate-severe asthma	4 months
Thamaraiselvi S et al., 2025	Mudra practice	80 patients aged 30-45	12 weeks
Nur Azis Rohmansyah et al., 2025	Yoga	95 patients, mean age 43 years	3 months
Saurabh Purwar et al., 2012	Anulom vilom pranayama	60 patients	Not specified
P. Vedanthan et al., 2008	Yoga breathing techniques	6 adults aged 23-48	2 weeks

Study	Intervention Type	Population	Duration
Anshu et al., 2022	Yoga	Adults aged 18-60 with mild-moderate asthma	Variable
Dian Kartikasari et al., 2019	Diaphragmatic breathing	28 adults, mild-moderate asthma	2 weeks
Keristina Ajul et al., 2020	Diaphragm breathing with progressive muscle relaxation	80 adults, mild-moderate asthma	1 week
Made Mahaguna Putra et al., 2017	Yoga Pranayama	12 patients aged 20-45, moderate-severe asthma	2 weeks
Effect of Yoga (2019)	Yoga	112 asthma patients	Variable
Shruti P. Agnihotri et al., 2016	Yoga	Mild-moderate asthma, aged 12-60	6 months
Sanjeev Satpathy et al., 2016	Yoga and pranayama	71 male patients with persistent asthma	4 months
Sanjeev Satpathy et al., 2022	Yoga (asanas and pranayamas)	80 male patients aged 26-34	4 months
D. Agarwal et al., 2012	Pranayamas	60 stable asthma patients, mean age 25.45	3 months
Dian Kartikasari et al., 2019a	Deep breathing exercises	20 patients with mild-moderate asthma	Not specified

Study	Intervention Type	Population	Duration
F. Schleich et al., 2020	Yoga	12 severe asthmatic patients	Not specified
Dr Arpan A. Bhatt et al., 2019	Hath yoga	62 patients aged 24-60	16 weeks
Dwi Putranti et al., 2020	Yoga pranayama	Adult asthmatic patients	2-6 months
Candy Sodhi et al., 2014	Yoga breathing exercises	120 patients aged 17-50	8 weeks
Shruti P. Agnihotri et al., 2016a	Yoga	300 patients aged 12-60, mild-moderate asthma	6 months
Wiwik Udayani et al., 2019	Buteyko breathing technique	76 patients aged 18-60	8 weeks
Hj. Nurwahidah et al., 2020	Deep breathing with lo'i sto	66 asthma patients	3 weeks
Nida Ghaffar et al., 2022	Inspiratory muscle training	24 patients aged 20-40	6 weeks
Jane Jose et al., 2018	Anulom Vilom Pranayama	20 patients, majority aged 20-29	4 weeks
Y. Yunani et al., 2017	Respiratory muscle stretching	30 asthma patients	Not specified

Study	Intervention Type	Population	Duration
Mufarika Mufarika et al., 2019	Buteyko method	18 patients, moderate persistent asthma	2 weeks
A. Somashekar et al., 2020	Pranayama	49 children aged 12-15, mild-moderate asthma	1 year
Reham AbdElmawla Elsaïd et al., 2023	Buteyko and diaphragmatic breathing	60 patients aged 18-60	4 weeks
Julvaina Eka Putra Utama et al., 2020	Active cycle breathing technique	25 asthma patients	1 month
Eugenia Maria Da Silva et al., 2023	Multiple breathing exercises	Adult asthma patients	4-48 weeks
D. Agarwal et al., 2017	Pranayamas	60 stable asthma patients, mean age 25.45	3 months
M. Sangeethalaxmi et al., 2022	Yoga breathing and relaxation	Young adults with bronchial asthma	Not specified
Anshu Yadav et al., 2024	Yoga	Asthma patients	Not specified
S. Sumartini et al., 2020	Pursed lips breathing (balloon blowing)	38 preschool children aged 3-5	4 days

Study	Intervention Type	Population	Duration
M. Arif et al., 2018	Buteyko breathing technique	30 bronchial asthma patients	6 weeks
Nehal Mahmoud Abo El-fadl et al., 2024	Buteyko and Pranayama	60 adults aged 21-60	3 months
Eva Eva et al., 2018	Yoga-based lifestyle intervention	19 patients aged 18-50, mild-moderate asthma	4 weeks
V. Rathore et al., 2025	Yoga	1007 patients with respiratory diseases	Variable
M. Tripathi et al., 2013	Yoga training	Not specific to asthma	Not specified
W. Udayani et al., 2020	Buteyko breathing technique	76 adults aged 18-60	8 weeks
Selvia Selvia et al., 2022	Diaphragmatic and pursed lip breathing	Asthma patients	Not specified
A. J. Bidwell et al., 2012	Yoga	19 females with mild-moderate asthma	10 weeks
F. Tahan et al., 2014	Yoga	20 children aged 6-17 with EIB	3 months
Zülfünaz Özer et al., 2021	Yoga	Chronic respiratory disease patients	Not specified

Study	Intervention Type	Population	Duration
Marian E. Papp et al., 2017	Hatha yoga	36 patients aged 40-84 with obstructive pulmonary disease	12 weeks
Indra Frana Jaya KK et al., 2024	Diaphragmatic breathing exercise	37 bronchial asthma patients	Not specified
Harish Sharma et al., 2025	Pranayama-based VRBT	12 women exposed to biomass smoke	1 month
N. Fittarsih et al., 2021	Buteyko breathing technique	36 asthma patients aged 18-50	14 days
J. P. Venkatesh et al., 2025	Yogasana	50 young individuals (not specific to asthma)	3 months
G. Sharifi et al., 2014	Pranayama	11 children aged 5-10 with exercise-induced asthma	8 weeks

The included studies were predominantly conducted in India, Indonesia, and other Asian countries, with additional studies from Europe, the United States, Turkey, Egypt, and Ethiopia. Study settings varied from hospital-based clinics to community health centers and home-based interventions.

Effects on Lung Function Parameters

FEV1 (Forced Expiratory Volume in 1 Second)

Study	Intervention	Baseline FEV1	Post-intervention FEV1	Change	Statistical Significance

Study	Intervention	Baseline FEV1	Post- intervention FEV1	Change	Statistical Significance
Zuyao Yang et al., 2016	Yoga	Not specified	Not specified	MD 0.04 L	Not significant (95% CI -0.10 to 0.19)
S. Cooper et al., 2003	Buteyko/Pranayama	2.58-2.71 L	Not specified	No significant change	p=0.4
Denny Agustiningsih et al., 2012	Buteyko	Not specified	Not specified	%FEV1 increased	Significant
D. Agarwal et al., 2012	Pranayamas	2.492±0.358 L	2.745±0.343 L	+0.253 L (~10.2%)	Significant
Sanjeev Satpathy et al., 2022	Yoga	2.36 L	3.13 L	+0.77 L	p=0.0002
Jane Jose et al., 2018	Anulom Vilom Pranayama	57.20	68.75	+11.55 (~20.2%)	p=0.0001
A. Somashekar et al., 2020	Pranayama	Not specified	Not specified	Increased over time	p=0.004

Study	Intervention	Baseline FEV1	Post-intervention FEV1	Change	Statistical Significance
Mufarika Mufarika et al., 2019	Buteyko	Not specified	Not specified	Increased	p=0.001
Harish Sharma et al., 2025	Pranayama VRBT	1.31±0.40 L	1.57±0.34 L	+0.26 L (~20%)	p=0.037
V. Rathore et al., 2025 (meta-analysis)	Yoga	Not specified	Not specified	WMD 0.47 L	p<0.00001
Anshu et al., 2022 (meta-analysis)	Yoga	Not specified	Not specified	SMD 0.96	Significant

The meta-analytic evidence presents mixed findings for FEV1. The Cochrane review by Yang et al. found no statistically significant effect of yoga on FEV1 (MD 0.04 L, 95% CI -0.10 to 0.19), with substantial heterogeneity ($I^2=68\%$). However, more recent meta-analyses reported significant improvements, with Rathore et al. finding a weighted mean difference of 0.47 L ($p<0.00001$) and Anshu et al. reporting a standardized mean difference of 0.96.

Individual primary studies generally showed more favorable results. Agarwal et al. demonstrated a 10.2% improvement in FEV1 after three months of pranayama practice. Satpathy et al. found FEV1 increased from 2.36 L to 3.13 L after four months of yoga. Similar improvements

were noted in shorter-term studies, with Jane Jose et al. reporting a 20.2% improvement after just four weeks of Anulom Vilom Pranayama.

FVC (Forced Vital Capacity)

Study	Intervention	Change in FVC	Statistical Significance
Candy Sodhi et al., 2009	Yoga breathing	Significant increase	p<0.01
Heba Nabil El-Shabrawy et al., 2025	Pranayama	Large effect size improvement	p<0.001
Vungarala Satyanand et al., 2014	Pranayama	Improved	p=0.11
N. Gupta et al., 2016	Yoga	Improved	p=0.001
Pallavi Yadav et al., 2021	Yoga	Significant improvement	Significant
M. Gupta et al., 2017	Yoga postures	Improved	p<0.001
G. Swathi et al., 2021	Buteyko/Pranayama	Both groups improved	Buteyko p<0.04
Harish Sharma et al., 2025	Pranayama VRBT	1.43 to 1.94 L (~35%)	p<0.001
V. Rathore et al., 2025 (meta-analysis)	Yoga	WMD 0.23 L	Not significant (p=0.25)

FVC results showed considerable variability across studies. While the meta-analysis by Rathore et al. found no significant effect on absolute FVC values (WMD 0.23 L, p=0.25), FVC

percentage showed significant improvement (WMD 3.03 L, $p<0.00001$). Multiple primary studies reported significant improvements in FVC following yoga and pranayama interventions. Harish Sharma et al. demonstrated a particularly substantial 35% improvement in FVC after one month of pranayama-based breathing exercises.

PEFR (Peak Expiratory Flow Rate)

Study	Intervention	Baseline PEFR	Post-intervention PEFR	Change	Statistical Significance
Candy Sodhi et al., 2009	Yoga breathing	Not specified	Not specified	Significant increase	$p<0.01$
Harendranath T G et al., 2025	Pranayama	Not specified	Not specified	Significant improvement	$p<0.01$
Demeke Mekonnen et al., 2010	Yoga	Not specified	Not specified	+10%	$p<0.0001$
D. Agarwal et al., 2012	Pranayamas	283.82±51.12 L/min	336.23±51.47 L/min	+52.41 L/min (~18.5%)	Significant
Holger Cramer et al., 2014 (meta-analysis)	Yoga	Not specified	Not specified	SMD 0.49	$p<0.001$

Study	Intervention	Baseline PEFR	Post- intervention PEFR	Change	Statistical Significance
Made Mahaguna Putra et al., 2017	Yoga Pranayama	Not specified	Not specified	Significant increase	p=0.00
Dian Kartikasari et al., 2019	Diaphragmatic breathing	Not specified	Not specified	+126.43±22.0 5 L/min	p=0.001
Laily Widya Astuti et al., 2022	Diaphragmatic breathing	Not specified	306.84 L/min	Significant increase	p<0.0001
Nisha Laila et al., 2022	Pranayama	69.5% predicted	82.4% predicted	+12.9%	p<0.05
Dr Arpan A. Bhatt et al., 2019	Hath yoga	Not specified	Not specified	+24.93%	Significant
Harish Sharma et al., 2025	Pranayama VRBT	2.83±0.97 L/s	3.60±0.96 L/s	+27%	p=0.040

Study	Intervention	Baseline PEFR	Post- intervention PEFR	Change	Statistical Significance
V. Rathore et al., 2025 (meta-analysis)	Yoga	Not specified	Not specified	WMD 0.49	Not significant (p=0.42)

PEFR demonstrated the most consistent positive findings across studies. The meta-analysis by Cramer et al. found a significant effect of yoga on PEFR compared to usual care (SMD 0.49, 95% CI 0.32 to 0.67, $p < 0.001$). Individual studies reported improvements ranging from 10% to nearly 25% in PEFR values. Agarwal et al. demonstrated an 18.5% increase in PEFR after pranayama practice, while Dian Kartikasari et al. found significant improvements with diaphragmatic breathing exercises. However, the more recent meta-analysis by Rathore et al. found no significant effect on PEFR (WMD 0.49, $p = 0.42$), highlighting ongoing heterogeneity in findings.

FEV1/FVC Ratio

Study	Intervention	Change	Statistical Significance
Candy Sodhi et al., 2009	Yoga breathing	Significant increase	$p < 0.01$
N. Gupta et al., 2016	Yoga	Improved	$p = 0.001-0.012$
G. Swathi et al., 2021	Buteyko vs Pranayama	Both improved; Buteyko superior	$p < 0.03$

Study	Intervention	Change	Statistical Significance
Holger Cramer et al., 2014 (meta-analysis)	Yoga	SMD 0.50	p<0.001
A. Somashekar et al., 2020	Pranayama	Significant increase	p<0.001
Eva Eva et al., 2018	Yoga-based intervention	70.80% to 74.86%	p=0.001
V. Rathore et al., 2025 (meta-analysis)	Yoga	WMD 3.17	Not significant (p=0.15)

The FEV1/FVC ratio showed significant improvements in several studies. Cramer et al.'s meta-analysis found a moderate effect (SMD 0.50, 95% CI 0.24 to 0.75, p<0.001). Eva Eva et al. reported improvement from 70.80% to 74.86% after four weeks of yoga-based intervention. However, the meta-analysis by Rathore et al. found no significant effect (WMD 3.17, p=0.15).

Comparison of Different Breathing Techniques

Study	Techniques Compared	Superior Technique	Key Finding
S. Cooper et al., 2003	Buteyko vs Pranayama (PCLE)	Neither for lung function	No significant difference in PD20 or FEV1
prem venkatesan et al., 2013	Buteyko vs Pranayama	Buteyko for quality of life	No specific lung function data

Study	Techniques Compared	Superior Technique	Key Finding
G. Swathi et al., 2021	Buteyko vs Nadi Shuddhi Pranayama	Buteyko	Buteyko showed greater FEV1, FVC, FEV1/FVC% improvements (p<0.03-0.04)
Reham AbdElmawla Elsaid et al., 2023	Buteyko vs Diaphragmatic	Both effective; Buteyko slightly better	Greater improvements in FEV1/FVC% and PEFr with Buteyko
Nehal Mahmoud Abo El-fadl et al., 2024	Buteyko vs Pranayama	Buteyko	Higher improvements in asthma severity and control
Holger Cramer et al., 2014	Yoga vs Breathing exercises	No difference	No evidence for effects of yoga compared with breathing exercises

Direct comparisons between breathing techniques yielded important insights. The study by Cooper et al. found no significant difference between Buteyko and pranayama (via PCLE device) in terms of bronchial responsiveness or lung function over six months. However, more recent studies suggest Buteyko may have slight advantages. Swathi et al. found Buteyko breathing technique showed statistically significant improvements compared to Nadi Shuddhi Pranayama (p<0.03 for FEV1). Elsaid et al. also found both techniques effective, with Buteyko showing slightly greater improvements in some parameters.

Cramer et al.'s meta-analysis found no evidence for additional effects of yoga compared with breathing exercises alone, suggesting that the breathing component may be the primary active ingredient in comprehensive yoga interventions.

Secondary Respiratory Outcomes

Study	Outcome	Finding	Significance
Made Mahaguna Putra et al., 2017	Oxygen Saturation (SaO ₂)	No significant effect	p=0.10
N. Fittarsih et al., 2021	Oxygen Saturation (SpO ₂)	Increased in combined intervention	p=0.000
Indra Frana Jaya KK et al., 2024	Respiratory Rate	Decreased from 24.95 to 17.54	p=0.000
Selvia Selvia et al., 2022	Respiratory Frequency	Reduced with diaphragmatic breathing	p=0.002
R. Manocha et al., 2008	Airway Hyperresponsiveness	Improved by 1.5 doubling doses	p=0.047
Thamaraiselvi S et al., 2025	Breath Holding Time	Improved	p<0.05

Beyond standard spirometric measures, several studies examined additional respiratory outcomes. Oxygen saturation showed mixed results, with one study finding no effect while another demonstrated improvement with combined Buteyko and asthma gymnastics. Respiratory rate decreased significantly following diaphragmatic breathing exercises. Notably, Manocha et al. found

that Sahaja Yoga improved airway hyperresponsiveness by 1.5 doubling doses compared to control ($p=0.047$), though this effect was not maintained at two-month follow-up.

Synthesis

The evidence base reveals apparent contradictions: meta-analyses of the Cochrane review found no significant effect on FEV1, while most individual studies and some recent meta-analyses report significant improvements. Several factors explain this heterogeneity.

Context and Population Distinctions

Studies showing significant lung function improvements tend to share certain characteristics. Studies conducted in India with participants practicing traditional pranayama techniques under supervision consistently reported positive findings. In contrast, studies from Western settings using modified or device-assisted breathing techniques showed more modest or null effects.

The intervention intensity also appears critical. Studies with daily practice of 45-60 minutes showed larger effects compared to those with less frequent sessions. For example, Bhatt et al. found 24.93% PEF improvement with 60-minute daily sessions over 16 weeks, while Cooper et al. found no lung function changes with twice-daily home practice without direct supervision.

Study Quality Considerations

The methodological quality varied substantially. The Cochrane review noted that only one of 15 included studies had low risk of bias across all domains. Studies with stronger methodological rigor, including the double-blind RCT by Manocha et al. and the well-conducted RCT by Cooper et al., generally found more modest effects on spirometric outcomes while showing benefits for symptoms and quality of life.

Many quasi-experimental studies without proper control groups reported larger effects, potentially reflecting regression to the mean, placebo effects, or confounding from concurrent treatments rather than true intervention effects.

Mechanistic Explanations

The divergent findings may reflect different mechanisms being activated by various breathing techniques. Buteyko focuses on reducing breathing frequency and increasing CO₂ retention, which may produce bronchodilation through nitric oxide production. Pranayama emphasizes slow, controlled breathing that may strengthen respiratory muscles and improve ventilation efficiency without necessarily changing spirometric values.

Studies showing FEV₁ improvements typically involved interventions lasting 8 weeks or longer, while shorter interventions of 2-4 weeks more consistently showed PEF_R improvements without FEV₁ changes. This temporal pattern suggests that PEF_R responds to immediate changes in respiratory muscle function while FEV₁ improvements require longer-term airway remodeling or inflammation reduction.

Clinical Applicability by Context

For adults with mild-to-moderate asthma, the evidence supports breathing exercises as adjunctive therapy to improve PEF_R (approximately 10-25% improvement) and potentially FEV₁ with sustained practice over 3+ months. Effects on FVC appear more variable and less consistent.

For children with asthma, the evidence is more limited but suggests potential benefits for PEF_R improvement with regular practice. The systematic review by Das et al. found mixed results, with significant improvements in PEF_R% at 4-6 weeks but insufficient data to recommend breathing exercises as standard care.

For severe asthma, evidence is sparse. Schleich et al.'s observational study of severe asthmatics on biologics found improvements in asthma control and quality of life but did not report changes in lung function parameters.

Limitations and Cautions

Several limitations warrant consideration. Many studies lacked adequate blinding, randomization details were often unclear, and sample sizes were frequently small. Publication bias may inflate positive findings, as negative studies are less likely to be published.

The heterogeneity in intervention types (yoga, pranayama, Buteyko, diaphragmatic breathing), durations (4 days to 54 months), and outcome measures makes direct comparisons challenging. Few studies reported adverse effects systematically, though no serious adverse events were attributed to breathing exercises.

Conclusions by Specific Populations and Contexts

For adults with mild-to-moderate asthma on standard pharmacotherapy seeking complementary approaches, pranayama or yoga breathing exercises practiced daily for 20-45 minutes over at least 8-12 weeks may improve PEFr by approximately 10-20% and potentially FEV1 with longer practice. Benefits appear greater with supervised instruction initially.

For exercise-induced bronchoconstriction in children, limited evidence suggests yoga training may reduce post-exercise FEV1 decline, though this requires confirmation in larger studies.

For patients seeking alternatives to standard breathing exercises, Buteyko technique shows comparable or slightly superior effects to traditional pranayama on spirometric parameters, though neither technique consistently improves bronchial responsiveness beyond symptomatic benefits.

DISCUSSION

This comprehensive systematic review of 80 studies reveals a complex and heterogeneous relationship between breathing exercises and lung function in asthma. The evidence is characterized by apparent contradictions, particularly between earlier meta-analyses and more recent primary studies, necessitating a nuanced interpretation that considers methodological, contextual, and mechanistic factors.

Synthesis of Contradictory Findings

The most striking contradiction lies in the findings for FEV1. The Cochrane review by Yang et al. (2016), a benchmark for high-quality evidence synthesis, found no statistically significant effect of yoga on FEV1 (MD 0.04 L, 95% CI -0.10 to 0.19). This contrasted sharply with numerous individual RCTs reporting significant improvements. For instance, Agarwal et al. (2012) documented a 10.2% increase in FEV1 after three months of pranayama, and Satpathy et al. (2022) reported an increase from 2.36 L to 3.13 L post-yoga intervention. More recent meta-analyses have begun to shift the consensus; Rathore et al. (2025) found a weighted mean difference of 0.47 L ($p < 0.00001$), and Anshu et al. (2022) reported a large standardized mean difference of 0.96. This evolution in meta-analytic findings likely reflects the inclusion of newer, often more positive, studies published after the Cochrane review, as well as differences in inclusion criteria and analytical methods.

For PEFr, the evidence is more consistently positive. The meta-analysis by Cramer et al. (2014) demonstrated a significant, moderate effect (SMD 0.49, $p < 0.001$), a finding corroborated by many primary studies showing improvements of 10-25% (Agarwal et al., 2012; Bhatt et al., 2019; Kartikasari et al., 2019). PEFr is effort-dependent and strongly influenced by large airway caliber and respiratory muscle strength, suggesting that breathing exercises may exert their most direct impact by improving respiratory muscle efficiency and coordination, rather than by reversing small airway inflammation or remodeling—a process that would be better reflected in FEV1 changes over a longer period.

Explaining Heterogeneity: Context and Intervention Characteristics

The divergence in outcomes can be largely explained by contextual and interventional variables. Studies conducted in traditional settings, particularly in India where yoga and pranayama are culturally embedded and often taught by experienced instructors, tend to report larger effect sizes (Gupta et al., 2016; Satpathy et al., 2022). In contrast, studies from Western settings using

modified, standardized, or device-assisted protocols often show more modest results (Cooper et al., 2003). This suggests that factors like instructor expertise, participant belief systems, and the holistic nature of traditional practice (which may include meditation and lifestyle advice) may contribute to outcomes beyond the mere mechanical act of breathing exercises.

Intervention intensity is a critical moderator. Studies employing high-frequency (daily), longer-duration (≥ 45 minutes per session), and sustained (≥ 8 -12 weeks) practice consistently reported more robust improvements. Bhatt et al. (2019) observed a 24.93% increase in PEFR with 60-minute daily sessions over 16 weeks. Conversely, studies with shorter, less frequent, or unsupervised interventions tended to show null or minimal effects on spirometry, though they sometimes still reported symptomatic benefits. This dose-response relationship underscores that breathing exercises, like any training modality, require adequate volume and consistency to induce physiological adaptations in respiratory muscle strength and endurance.

Methodological Quality and Its Impact

The methodological rigor of included studies varied widely and directly influenced the reported effects. The Cochrane review by Yang et al. (2016) noted a generally high risk of bias across studies, particularly regarding blinding and allocation concealment. Well-conducted RCTs with robust methodology, such as the double-blind study by Manocha et al. (2008) and the rigorous trial by Cooper et al. (2003), typically reported more conservative, yet still meaningful, benefits—often more pronounced in patient-reported outcomes (symptoms, quality of life, rescue medication use) than in spirometric parameters. In contrast, numerous quasi-experimental or uncontrolled before-after studies reported larger lung function improvements, effects that may be inflated by placebo, Hawthorne effects, regression to the mean, or confounding from concurrent changes in medication or environment. Therefore, the most reliable evidence suggests that while breathing exercises can improve lung function, the effect sizes may be more modest than those reported in lower-quality studies, and the primary benefits may often be experiential and qualitative.

Comparison of Breathing Techniques

The review allows for preliminary comparisons between major techniques. Direct comparative studies indicate that both Buteyko and pranayama are effective. Some evidence suggests Buteyko may have a slight edge for certain spirometric outcomes; Swathi et al. (2021) found Buteyko superior to Nadi Shuddhi Pranayama for improving FEV1 and FVC, and Elsaid et al. (2023) noted greater improvements in FEV1/FVC% and PEFr with Buteyko compared to diaphragmatic breathing. The Buteyko method's focus on reduced breathing and increased CO₂ retention may induce bronchodilation via nitric oxide pathways, offering a distinct mechanism from pranayama's focus on controlled, slow breathing and muscle strengthening (Cooper et al., 2003). Interestingly, Cramer et al. (2014) found no evidence that comprehensive yoga (including postures and meditation) was superior to breathing exercises alone for respiratory outcomes, indicating that the breathing component is likely the primary active ingredient for lung function changes.

Mechanistic Considerations and Clinical Trajectory

The pattern of results suggests a plausible mechanistic and temporal hierarchy. PEFr, being highly effort-dependent, appears to improve relatively quickly (within weeks) with breathing training, reflecting enhanced respiratory muscle performance and coordination (Kartikasari et al., 2019; Astuti & Huriah, 2022). FEV1 improvements, which require changes in airway caliber and resistance, are more variable and often require longer-term practice (≥ 3 months) to manifest, possibly through subtle anti-inflammatory effects, autonomic regulation (increased parasympathetic tone), or sustained reduction in dynamic hyperinflation (Agarwal et al., 2017; Sangeethalaxmi & Hankey, 2022). The mixed results for FVC and FEV1/FVC ratio further support the notion that these exercises may not fundamentally alter the restrictive or obstructive pathophysiology in all patients but can optimize ventilatory function within existing physiological constraints.

Clinical Applicability and Recommendations

For **adults with mild-to-moderate asthma** on standard therapy, the evidence supports recommending breathing exercises as a beneficial adjunct. A regimen of daily pranayama or Buteyko practice for 20-45 minutes over 8-12 weeks can reasonably be expected to improve PEFr by 10-20% and may lead to modest FEV1 gains with longer adherence. Initial supervised instruction is advisable to ensure correct technique and maximize benefit (Jayawardena et al., 2020).

For **children with asthma**, the evidence is promising but less definitive. Studies show improvements in PEFr and asthma control (Yadav et al., 2023; Laila et al., 2022), but more high-quality RCTs are needed. Breathing exercises should be presented in an engaging, age-appropriate manner and are not a substitute for standard pediatric asthma care (Das et al., 2019).

For **severe asthma**, data are scarce. The study by Schleich et al. (2020) in patients on biologics reported improved control and quality of life without focusing on lung function, suggesting a potential role for symptom modulation and stress reduction in this complex population, though not necessarily for reversing severe airflow limitation.

Limitations and Future Research Directions

This review acknowledges several limitations inherent in the literature. Significant heterogeneity in interventions, outcomes, and populations precluded a single quantitative summary estimate. Publication bias likely favors positive studies. Safety and adverse events were underreported, though serious harms appear rare. Future research must prioritize large, pragmatic RCTs with long-term follow-up, standardized intervention protocols, blinding of outcome assessors, and concurrent measurement of lung function, inflammatory biomarkers, patient-reported outcomes, and healthcare utilization. Specific research gaps include the efficacy in severe/occupational asthma, cost-effectiveness analyses, optimal “dosing” of exercises, and mechanistic studies using advanced physiological imaging and biomarker profiling to elucidate how these ancient practices affect modern pathophysiology.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This systematic review synthesizes a large and evolving body of evidence on breathing exercises for asthma. The overall findings indicate that practices such as yoga, pranayama, and the Buteyko technique can serve as effective complementary therapies, primarily leading to improvements in Peak Expiratory Flow Rate (PEFR) and, with sustained practice, potentially in Forced Expiratory Volume in 1 second (FEV1). The most consistent benefits are observed in adults with mild-to-moderate asthma who engage in supervised, regular, and long-term practice. While the effects on spirometry may be more modest than those reported in lower-quality studies, the convergence of evidence suggests real, clinically meaningful benefits, particularly when combined with improvements in symptoms, quality of life, and reduced reliance on rescue medication. The apparent contradictions in the literature are largely explainable by differences in study quality, intervention characteristics (type, intensity, duration), and cultural context.

Recommendations

Based on the synthesis, the following recommendations are proposed:

1. **For Clinical Practice:** Healthcare providers can consider recommending structured breathing exercises (e.g., pranayama, Buteyko) as an adjunct to standard pharmacological treatment for patients with mild-to-moderate asthma. Emphasis should be placed on proper technique, ideally through initial supervision, and consistent daily practice of at least 20-30 minutes for a minimum of 8-12 weeks to achieve optimal results.
2. **For Patients:** Individuals with asthma interested in complementary approaches are encouraged to explore breathing exercises under guidance. They should have realistic expectations, understanding that these practices are supportive and not a replacement for prescribed medication, but can empower self-management and improve wellbeing.

3. **For Researchers:** Future investigations should focus on conducting high-quality, multi-center RCTs with standardized protocols, active control groups, and longer follow-up periods. Research should also delve into mechanistic studies, explore efficacy in understudied populations (e.g., severe asthma, elderly), and evaluate cost-effectiveness and implementation strategies in diverse healthcare systems.
4. **For Policy:** National asthma guidelines should consider including a statement on the potential role of breathing exercises as part of a holistic management plan, while acknowledging the strength and limitations of the current evidence.

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