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COMPARATIVE EFFECTIVENESS OF YOGIC BREATHING TECHNIQUES VS. NON-YOGA BREATHING EXERCISES FOR ASTHMA MANAGEMENT: A META-ANALYTIC REVIEW

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ABSTRACT

Background- Bronchial asthma is a chronic inflammatory airway disease characterized by airflow limitation, bronchial hyperresponsiveness, and recurrent respiratory symptoms that significantly impair quality of life. Breathing-based interventions are commonly used as adjunctive therapies in asthma management. Yogic breathing techniques (pranayama) emphasize controlled, mindful respiration and autonomic regulation, whereas non-yoga breathing exercises focus primarily on mechanical lung function improvement. Comparative evidence regarding their effectiveness remains fragmented. **Objectives-** To systematically review and meta-analyse the comparative effectiveness of yogic breathing techniques versus non-yoga breathing exercises on pulmonary function, asthma symptoms, and quality of life among individuals with bronchial asthma. **Methods-** A meta-analytic review was conducted following PRISMA guidelines. Electronic databases were systematically searched for randomized controlled trials and quasi-experimental studies comparing yogic breathing techniques with non-yoga breathing exercises in asthma patients. Six studies meeting the inclusion criteria were analysed. Primary outcomes included pulmonary function parameters (FEV₁, PEFR, FVC), asthma symptom control, and quality of life. Standardized mean differences (SMD) with 95% confidence intervals were calculated using a random-effects model. Heterogeneity was assessed using the I² statistic. **Results-** Six studies involving both pediatric and adult asthma patients were included in this review, with sample sizes ranging from 32 to 120 participants and intervention durations from 4 to 12 weeks. The interventions comprised pranayama, Buteyko breathing, yoga breathing, and combined yoga (asana + pranayama) delivered alongside standard medical care. Across studies, significant improvements in asthma control and health-related quality of life were consistently reported, as measured by validated tools such as the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), and Pediatric Quality of Life Inventory (PedsQL 3.0) ($p < 0.003-0.05$). Pediatric studies demonstrated greater gains in symptom control and quality of life, while adults showed more pronounced improvements in pulmonary function parameters, including FEV₁, FVC, PEFR, and MVV, particularly following combined yoga interventions. Comparatively, Buteyko breathing showed slightly stronger effects than pranayama alone, and multicomponent yoga programs yielded the largest overall benefits. No serious adverse effects were reported, and adherence was high, especially in pediatric populations with caregiver involvement. Overall, breathing and yoga-based interventions were found to be safe, feasible,

and effective complementary strategies for improving asthma-related outcomes across age groups. Conclusion- The findings suggest that yogic breathing techniques are more effective than non-yoga breathing exercises in improving respiratory function, symptom control, and quality of life in individuals with bronchial asthma. Yogic breathing may serve as a valuable complementary therapy in asthma management. However, further high-quality, large-scale randomized trials are needed to strengthen the evidence base and establish standardized intervention protocols.

KEYWORDS: Bronchial asthma; Yogic breathing; Pranayama; Breathing exercises; Meta-analysis; Pulmonary function.

1 INTRODUCTION

Bronchial asthma is a common chronic respiratory disorder characterized by recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning hours. It is a heterogeneous disease with varying clinical presentations, severity, and triggers, affecting individuals across all age groups.(Vohra & Nowak, 2024a) Asthma poses a significant public health burden due to its chronic course, impact on daily activities, and associated healthcare utilization. Despite advances in pharmacological management, many patients continue to experience persistent symptoms, highlighting the need for comprehensive and adjunctive therapeutic approaches.(Murdoch & Lloyd, 2010)

Bronchial asthma is defined as a chronic inflammatory disease of the airways associated with variable and reversible airflow obstruction and increased airway responsiveness to a variety of stimuli.(National Asthma Education and Prevention Program, 2007) The underlying pathophysiology involves a complex interaction between genetic predisposition and environmental factors, leading to immune-mediated airway inflammation.(Mukherjee & Zhang, 2011)

At the cellular level, asthma is characterized by infiltration of the airway mucosa by inflammatory cells, including eosinophils, mast cells, T-lymphocytes, macrophages, and dendritic cells. These cells release a range of inflammatory mediators such as histamine, leukotrienes, prostaglandins, and cytokines, which contribute to bronchoconstriction, mucosal oedema, increased mucus secretion, and airway remodelling.(Xie et al., 2024) Structural changes such as thickening of the basement membrane, smooth muscle hypertrophy, and goblet cell hyperplasia further exacerbate airflow limitation over time.(Hough et al., 2020)

A hallmark feature of bronchial asthma is its chronic inflammatory nature, which persists even in the absence of overt symptoms. This ongoing inflammation results in airway hyperresponsiveness, defined as an exaggerated broncho constrictive

response to various triggers, including allergens, respiratory infections, exercise, cold air, and environmental pollutants.(Magnussen & Nowak, 1989) Airway smooth muscle contraction, along with mucosal oedema and excessive mucus production, leads to narrowing of the airways and increased resistance to airflow.(An et al., 2007)

Importantly, the airflow obstruction in asthma is typically reversible, either spontaneously or with appropriate treatment such as bronchodilators and anti-inflammatory agents. This reversibility distinguishes asthma from other chronic obstructive airway diseases.(Lemanske&Busse, 2003) However, in long-standing or poorly controlled asthma, persistent inflammation may lead to partial irreversibility due to airway remodelling, emphasizing the importance of early and effective disease management.(Huang & Qiu, 2022)

The clinical manifestations of bronchial asthma vary widely among individuals and even within the same individual over time. Common symptoms include episodic wheezing, shortness of breath, chest tightness, and coughing, which may be triggered or worsened by specific factors. Symptom frequency and intensity can range from intermittent, mild episodes to severe, life-threatening exacerbations requiring urgent medical intervention.(Holgate & Thomas, 2017)

Asthma is also characterized by significant disease variability, influenced by factors such as age of onset, genetic susceptibility, environmental exposure, comorbid conditions, and adherence to treatment.(Holgate et al., 2015) Phenotypic variations include allergic (atopic) asthma, non-allergic asthma, exercise-induced asthma, and occupational asthma. This heterogeneity underscores the need for individualized management strategies that address both physiological and psychosocial aspects of the disease. Non-pharmacological interventions, including breathing techniques, have gained attention for their potential role in improving symptom control, enhancing self-management, and optimizing overall quality of life in individuals with bronchial asthma.(Kuruvilla et al., 2019)

GLOBAL AND REGIONAL BURDEN OF ASTHMA

Asthma is a major non-communicable respiratory disease that contributes substantially to global morbidity across all age groups. Its burden is unevenly distributed across regions and socioeconomic strata, reflecting differences in environmental exposures, healthcare access, diagnostic practices, and long-term disease management. Despite the availability of effective treatments, asthma continues to pose significant challenges to public health systems worldwide.(Boutros et al., 2024)

WORLDWIDE PREVALENCE AND TRENDS

Globally, asthma affects hundreds of millions of individuals and remains one of the most prevalent chronic respiratory conditions. It occurs across the lifespan, with onset commonly in childhood but persistence or new onset frequently observed in adulthood.(Fu et al., 2025) The prevalence of asthma shows marked geographic variation, with higher reported rates in many high-income countries and rapidly increasing rates in several low- and middle-income regions.(Agrawal et al., 2013)

Over the past few decades, global trends in asthma prevalence have been heterogeneous. In many high-income countries, asthma prevalence rose sharply during the late twentieth century and has since stabilized or shown modest declines, possibly due to improved awareness, early diagnosis, and better disease management. (Innes Asher et al., 2020)In contrast, several low- and middle-income countries have reported rising prevalence, particularly in urban and peri-urban areas. Rapid urbanization, lifestyle changes, increased exposure to air pollution, reduced physical activity, and changing environmental and dietary factors are considered major contributors to these trends.(Cacciatore et al., 2025)

Children and adolescents bear a substantial portion of the global asthma burden, with asthma being one of the leading causes of chronic illness, school absenteeism, and emergency healthcare utilization in these age groups. Adult asthma, often under-recognized, also contributes significantly to long-term disability and reduced work capacity.(Kim et al., 2025)

Burden of Asthma in Low- and Middle-Income Countries

Low- and middle-income countries (LMICs) account for most of the asthma-related morbidity and mortality worldwide. Although reported prevalence in some LMICs may appear lower than in high-

income countries, this often reflects under-diagnosis, limited access to diagnostic tools such as spirometry, and low disease awareness rather than a true lower disease burden.(Mortimer et al., 2022)

In LMICs, asthma is frequently poorly controlled due to limited availability and affordability of essential medications, particularly inhaled corticosteroids. Health systems in these settings often prioritize acute care over long-term disease management, resulting in high rates of preventable exacerbations, emergency visits, and hospital admissions. Environmental risk factors such as indoor air pollution from biomass fuel use, occupational exposures, tobacco smoke, and urban air pollution further exacerbate disease severity.(Sánchez-Borges et al., 2011)

Children and older adults in LMICs are particularly vulnerable, with higher rates of severe exacerbations and asthma-related deaths compared to high-income countries. These disparities highlight the inequitable distribution of asthma outcomes and the urgent need for scalable, low-cost, and culturally acceptable interventions to improve disease control.(Singh et al., 2025)

Epidemiology of Asthma in India and South-East Asia

India and the South-East Asian region together contribute a substantial share of the global asthma burden. (Wang et al., 2023)In India, asthma affects millions of individuals across both urban and rural settings, with considerable regional variation in prevalence and severity. Urban areas tend to report higher prevalence, attributed to increased exposure to vehicular emissions, industrial pollution, and lifestyle changes, whereas rural areas often experience higher levels of under-diagnosis and inadequate treatment.(Malik et al., 2012)

In South-East Asia, asthma prevalence varies widely between countries and within populations, influenced by differences in socioeconomic development, healthcare infrastructure, environmental exposures, and genetic susceptibility.(Xing & Wong, 2021) Common regional risk factors include household air pollution from solid fuel use, high levels of ambient air pollution, tobacco smoking, respiratory infections, and occupational exposures. Climatic factors such as humidity and seasonal allergen exposure also play a role in triggering asthma symptoms.(Wimalasena et al., 2021)

Despite the substantial disease burden, asthma remains under-recognized and under-treated in much of South-East Asia. Limited access to trained healthcare professionals, diagnostic facilities, and long-term follow-up care contributes to poor disease

control and increased risk of complications. These challenges underscore the need for region-specific strategies that integrate medical management with preventive and supportive interventions.(Jayasooriya et al., 2025)

Impact on Healthcare Systems, Productivity, and Quality of Life

Asthma imposes a significant economic and social burden on healthcare systems and society. (Koul & Dhar, 2018) Direct healthcare costs include expenses related to outpatient consultations, emergency department visits, hospitalizations for acute exacerbations, diagnostic testing, and long-term pharmacotherapy. In resource-constrained settings, frequent exacerbations place additional strain on already overburdened health facilities.(Rose et al., 2024) Indirect costs are equally substantial and arise from loss of productivity due to missed school and workdays, reduced work efficiency, and long-term disability in severe cases.(Brouwer et al., 2023) For families, especially in LMICs, asthma-related expenses can contribute to financial hardship due to out-of-pocket healthcare payments.(Fung et al., 2014) Beyond economic considerations, asthma has a profound impact on health-related quality of life. Individuals with asthma often experience limitations in physical activity, sleep disturbances, psychological stress, and anxiety related to unpredictable symptom exacerbations.(Rask-Andersen et al., 2022) In children, asthma can impair academic performance and social participation, while in adults it may restrict occupational choices and daily functioning. Poorly controlled asthma is also associated with increased emotional burden for caregivers and family members.(Wu et al., 2025) Collectively, these impacts highlight that asthma is not merely a clinical condition but a significant public health challenge.(Vohra & Nowak, 2024b) Improving asthma control through accessible, effective, and complementary management strategies including non-pharmacological interventions such as breathing techniques has the potential to reduce healthcare utilization, enhance productivity, and significantly improve quality of life for individuals living with asthma.(Clemente-Suárez et al., 2023)

RATIONALE OF THIS STUDY

Breathing-based interventions are increasingly recommended as adjunctive strategies in the management of bronchial asthma. Both yogic breathing techniques (pranayama) and non-yoga breathing exercises have been widely studied for their potential to improve respiratory function, reduce symptom burden,

and enhance quality of life. However, the existing evidence remains fragmented, with individual studies varying considerably in design, sample size, intervention protocols, and outcome measures. This variability limits the ability of clinicians and policymakers to draw definitive conclusions regarding the relative effectiveness of these interventions.(Bentley et al., 2023) A meta-analytic review is therefore warranted to systematically synthesize available evidence and provide a clearer, more robust understanding of their comparative benefits.

Individual clinical trials evaluating breathing interventions in asthma are often limited by small sample sizes and short intervention durations, reducing statistical power and increasing the likelihood of inconclusive or inconsistent findings. Differences in outcome reporting—such as the use of varied pulmonary function parameters, symptom scales, and quality-of-life instruments further complicate direct comparisons across studies.(Li et al., 2025) Pooling data through meta-analysis allows for quantitative integration of results, thereby increasing precision in effect size estimates and improving the reliability of conclusions.

Moreover, meta-analysis enables systematic assessment of heterogeneity and potential sources of variation, such as differences in patient characteristics, asthma severity, duration of intervention, and type of breathing technique used. By synthesizing evidence across multiple studies, a meta-analytic approach can identify consistent patterns of effectiveness that may not be evident in individual trials. This is particularly important in the context of complementary and integrative therapies, where methodological diversity is common and clinical recommendations require stronger aggregated evidence.

While both yogic breathing techniques and non-yoga breathing exercises aim to improve respiratory efficiency, they are grounded in different theoretical and physiological principles. (Yamamoto-Morimoto et al., 2019) Yogic breathing integrates controlled respiration with mindfulness and autonomic regulation, potentially influencing both physiological and psychological components of asthma. In contrast, non-yoga breathing exercises primarily focus on optimizing ventilation mechanics and respiratory muscle function. Determining which approach yields superior or more consistent benefits is crucial for evidence-based asthma care.(Saoji et al., 2018)

Identifying the most effective breathing intervention has practical implications for treatment selection, resource allocation, and patient adherence. Interventions that demonstrate greater

improvements in pulmonary function, symptom control, and quality of life can be preferentially recommended as adjunct therapies alongside standard pharmacological treatment. Furthermore, establishing comparative effectiveness helps avoid ambiguity in clinical guidance and supports the development of standardized breathing-based protocols for asthma management.(Burge et al., 2024) The findings of this meta-analytic review hold significant relevance for clinical practice, particularly in settings where access to advanced medical resources may be limited. Breathing interventions are low-cost, non-invasive, and generally safe, making them suitable for widespread implementation across diverse healthcare environments. For clinicians, evidence-based recommendations regarding the most effective breathing techniques can enhance holistic asthma management and improve long-term outcomes. For patients, particularly those with chronic or poorly controlled asthma, effective breathing interventions can promote self-efficacy and active participation in disease management. Techniques that are easy to learn and practice independently can reduce reliance on rescue medications, minimize exacerbations, and improve daily functioning.(Gebresilassie et al., 2025) By identifying the most beneficial breathing approach, this meta-analytic review contributes to informed decision-making and supports patient-centered, sustainable asthma management strategies.

2 MATERIAL AND METHOD:

This study was conducted as a systematic review and meta-analysis to compare the effectiveness of yogic breathing techniques with non-yoga breathing exercises in the management of bronchial asthma. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor, transparency, and reproducibility. A comprehensive literature search was performed across multiple electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, Cochrane Library, and Google Scholar. The search covered studies published up to the most recent available date. Keywords and Medical Subject Headings (MeSH) related to asthma and breathing interventions were used in various combinations, such as bronchial asthma, yogic breathing, pranayama, breathing exercises, respiratory training, and pulmonary rehabilitation. Reference lists of relevant articles were also screened to identify additional eligible studies. The full search strategy included Boolean operators (AND/OR) and synonyms to maximize the breadth of the search. The reference lists of all

included articles and relevant systematic reviews were also screened to identify additional eligible studies.

Inclusion Criteria

Studies were included if they met the following criteria:

- Randomized controlled trials or quasi-experimental studies
- Participants diagnosed with bronchial asthma (any age group)
- Studies comparing yogic breathing techniques with non-yoga breathing exercises
- Studies reporting at least one outcome related to pulmonary function, asthma symptoms, or quality of life
- Articles published in English
- Exclusion Criteria
- Observational studies, case reports, editorials, and reviews
- Studies without a comparison group
- Studies combining breathing interventions with other therapies where the isolated effect of breathing techniques could not be determined
- Incomplete data or inaccessible full texts

Data Extraction:

Data were extracted using a standardized data extraction form. Extracted information included author(s), year of publication, study design, sample size, participant characteristics, type and duration of breathing intervention, outcome measures, and key findings. Outcome data relevant to pulmonary function parameters (such as FEV₁, FVC, and PEFR), asthma symptom scores, and quality-of-life measures were recorded for meta-analysis. The primary outcomes included objective pulmonary function parameters, namely forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and peak expiratory flow rate (PEFR). Secondary outcomes included asthma symptom control, frequency of exacerbations, medication use, and health-related quality of life as assessed by validated instruments. Two independent reviewers performed the data extraction to ensure accuracy and consistency, with discrepancies resolved through discussion or consultation with a third reviewer.

Quality Assessment

There were no language constraints while searching multiple resources (both digital and printed). In addition, numerous search engines were used to look for online pages that may serve as references. Inclusion and exclusion criteria were documented. Using broad critical evaluation guides, selected

studies were subjected to a more rigorous quality assessment.

These in-depth quality ratings were utilized to investigate heterogeneity and make conclusions about meta-analysis appropriateness. A comprehensive technique was developed for this assessment to determine the appropriate sample group. The criteria for evaluating the literature were developed with P.I.C.O. in mind.

(Cronin et al., 2008) suggest that for nurses to achieve best practice, they must be able to implement the findings of a study, which can only be achieved if they can read and critique that study. (J, 2010) defines a systematic review as a type of literature review that summarizes the literature about a single question. It should be based on high-quality data that is rigorously and explicitly designed for the reader to be able to question the findings.

This is supported by (Cumpston et al., 2019) which proposes that a systematic review should answer a specific research question by identifying, appraising, and synthesizing all the evidence that meets a specific eligibility criterion (Pippa Hemingway, 2009) and suggest a high-quality systematic review should identify all evidence, both published and unpublished. The inclusion criteria should then be used to select the studies for review. These selected studies should then be assessed for quality. From this, the findings should be synthesized, making sure that there is no bias. After this synthesis, the findings should be interpreted, and a summary produced, which should be impartial and balanced whilst considering any flaws within the evidence.

Data Collection Strategies

(Chapter 5: Collecting Data | Cochrane Training, n.d.) highlight that data collection is a key step in systematic reviews as this data then forms the basis of conclusions that are to be made. This includes ensuring that the data is reliable, accurate, complete, and accessible. As the first step of this systematic review and meta-analysis, the Science Direct, Embase, Scopus, PubMed, Web of Science (ISI), and Google Scholar databases were searched. To identify the articles, the search terms bronchial asthma, yogic breathing, pranayama, breathing exercises, respiratory training, and pulmonary

rehabilitation and all the possible combinations of these keywords were used.

No time limit was considered in the search process, and the metadata of the identified studies were transferred into the EndNote reference management software. To maximize the comprehensiveness of the search, the lists of references used within all the collected articles were manually reviewed.

Keywords used as per MeSH: "bronchial asthma", "yogic breathing", "pranayama", "breathing exercises", "respiratory training", and "pulmonary rehabilitation".

Inclusion/exclusion criteria.

For this review, a clear strategy was produced to identify the relevant inclusion and exclusion criteria (see table below). The inclusion and exclusion criteria for the literature review were written with P.I.C.O. in mind. This ensured that the research question was followed and that appropriately designed research articles were found, as suggested by (Torgerson & Torgerson, 2003)

As this review focuses on the Comparative Effectiveness of Yogic Breathing Techniques vs. Non-Yoga Breathing Exercises for Asthma Management, were deemed appropriate (Pati & Lorusso, 2017) highlight that the inclusion and exclusion criteria within a literature search is a source of potential bias therefore higher trust and credibility can be gained by the clear documentation of such exclusion and inclusion criteria. Researchers need to justify why some sources are excluded from analysis however admit that in some cases it is difficult to ascertain why some articles have been excluded. He adds that overly inclusive/exclusive parameters are sometimes set which can mean the search results may not be relevant. The inclusion criteria are set by PICO. Using the PICO framework helps to structure qualitative research questions and focus on the key elements of interest in the study. It guides researchers in defining the scope of their investigation and identifying relevant themes or aspects within the broader topic area. In a systematic review, the PICO framework can assist in refining the research question and guiding the synthesis of qualitative evidence related to the economic Effectiveness of Yogic Breathing Techniques vs. Non-Yoga Breathing Exercises for Asthma Management.

Population/Problem	Individuals diagnosed with bronchial asthma, irrespective of age or gender, including patients with mild to moderate asthma, are managed in clinical, community, or home-based settings.
Intervention	Yogic breathing techniques (Pranayama), including practices such as Anulom Vilom, Bhramari, Kapalhati, Ujjayi, and other structured yogic respiratory exercises delivered as standalone or adjunctive interventions.
Comparison	Non-yoga breathing exercises, including conventional respiratory training methods such as diaphragmatic breathing, pursed-lip breathing, Buteyko breathing technique, and other standard breathing retraining exercises.

Outcome	<p>▮ Primary outcomes: Pulmonary function parameters (Forced Expiratory Volume in one second [FEV₁], Forced Vital Capacity [FVC], Peak Expiratory Flow Rate [PEFR])</p> <p>▮ Secondary outcomes: Asthma symptom control, frequency and severity of exacerbations, medication use, and health-related quality of life.</p>
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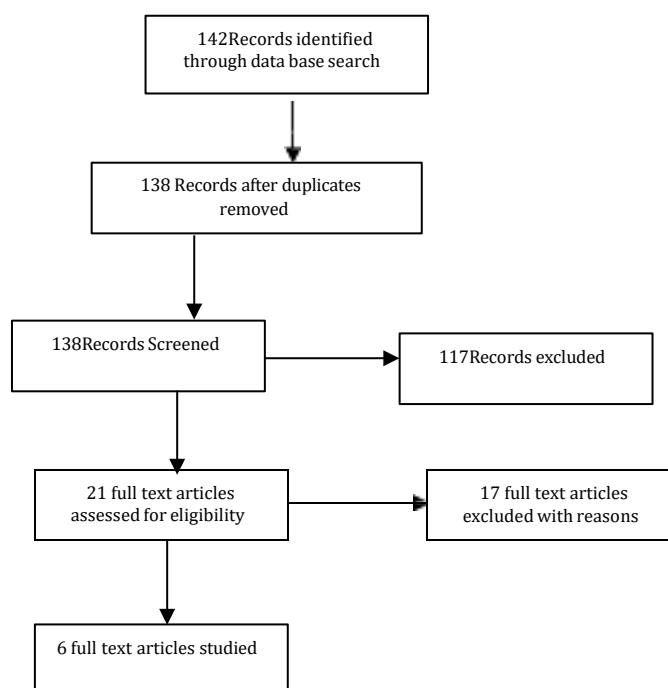
To limit the search results to a manageable level, I excluded studies that were more than 10 years old. (Lipscomb, n.d.) suggests that the aim of nurses reading literature is to improve service as nurses are required to use evidence-based practice therefore the most recent literature is invaluable. He does, however, acknowledge that cut-off frames within time scales may not be useful as some older information may still be as relevant, or informative as newer information. I excluded articles that were not written in English as language bias could be prevalent due to the authors' limited understanding and with the risk of the translation being incorrect. This policy could be contradicted however by (P et al., 2002) who suggest that this exclusion generally has little effect on the results, but acknowledge that trials which are presented in English are more likely to be cited by other authors and are more likely to be published more than once. I started with a basic search of keywords using Boolean operators and then filtered these by adding different filters from my

inclusion criteria. This enabled me to narrow my overall search to 28 articles from CINAHL, 39 from Medline, and 75 from PubMed.

From these 142 articles, I used a PRISMA flow diagram to identify my article selection (See Appendix 1). Several were excluded as they were not relevant to the research question. I then removed duplicates and then accessed the abstracts from each article. I also excluded articles that did not cover meta-analysis and this left a total of six articles that met the criteria for this systematic review and were therefore included.

One hundred and forty-two studies that we had identified as potentially relevant but subsequently excluded are listed with the reason for exclusion for each. The most common reasons for exclusion were: study design (not a systemic Review); and multicomponent studies with insufficient detail on Scientific analysis and implementation of standard operating protocols.

PRISMA



4 RESULTS

The final articles will be critiqued and analysed. The six studies included in the analysis ranged from three

months to Two years. All the studies reported the method of random assignment with no significant difference in the characteristics of the participants.

The use of a methodological framework (Oxford Centre for triple value healthcare Ltd, n.d.) enabled the literature to be assessed for quality and to aid

understanding. The table below is used to display an overview of each article.

Author/s Year	Sample/setting	Methodology and methods	Main findings
(Erdoğan Yüce & Taşçı, 2020)	Adults with clinical asthma; single-centre outpatient trial.	Randomized controlled trial; pranayama 20 min/day × 1 month vs relaxation + standard care.	Significant improvements in Asthma Control Test (ACT) and Asthma Quality of Life Questionnaire (AQLQ). No significant change in objective pulmonary function tests (PFT), including FEV ₁ /PEF.
(Prem et al., 2013)	120 adults with asthma; outpatient pulmonary medicine.	RCT; three groups (Buteyko, pranayama, control) practiced breathing daily for 3 months.	Buteyko showed stronger trends for asthma control & quality of life vs pranayama and control; pranayama also improved QoL vs control.
(Nasrollahpor et al., 2024)	84 children with asthma (ages 5–11), recruited from an asthma clinic at a children's hospital affiliated with Iran University of Medical Sciences. Participants were nonrandomly allocated into intervention (n = 42) and control (n = 42) groups.	Quasi-experimental study; intervention group performed yoga breathing exercises twice daily for 8 weeks in addition to standard medical care. The control group received standard medical treatment only. The Pediatric Quality of Life Inventory 3.0 (PedsQL3.0) Asthma Module was used to measure outcomes pre- and post-intervention.	<p>✓ Baseline quality-of-life scores were similar between groups (no significant difference).</p> <p>✓ After 8 weeks, the intervention group showed significant improvement in total quality of life scores compared with the control group (post-intervention $p < 0.003$), including significant improvements in asthma symptoms and treatment problem subdomains.</p> <p>✓ The study concluded that yoga breathing exercises significantly improved health-related quality of life in pediatric asthma patients, suggesting their role as an effective complementary therapy.</p>
(Vagedes et al., 2021)	32 children (age 6–15 y) with partly controlled asthma; outpatient.	RCT; treatment as usual vs TAU + Buteyko training 5 days + 3 months home practice.	Better improvements in FEV ₁ (at rest and after exercise), and caregiver QOL vs control; no medication reduction.
(Kumar, 2025)	80 adults with moderate asthma; hospital in India.	RCT with yoga group (asana + pranayama) vs control (standard care) for 12 weeks.	Significant FVC, MVV, and PEFR improvements in yoga group post-intervention.
(Elwan et al., 2022)	33 school-age children with asthma; pediatric outpatient.	Pre/post study of Buteyko exercises for 4 weeks.	Improved asthma control, PEFR, and breathing pause tests; significant reduction in symptom frequency.

The first study was conducted by (ErdoğanYüce&Taşçı, 2020). The study was conducted to evaluate the effect of pranayama on asthma control, pulmonary function, and quality of life in people with asthma. Pranayama was applied to the pranayama group for 20 min once daily for 1 month, and relaxation was applied to the relaxation group similarly in addition to the standard treatment. The outcome measurement tools used were the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), pulmonary function test (PFT), and patient observation chart. The pranayama group had significantly higher ACT score, overall AQLQ score, and subscale scores than the relaxation group ($p < 0.05$). However, there was no significant difference between the groups in terms of PFT parameters and peak expiratory flow values ($p > 0.05$).

The second study was conducted by (Nasrollahpor et al., 2024). This study was conducted to investigate the effect of yoga breathing exercises on the quality of life of children with asthma. In this quasi-experimental study, 84 children with asthma aged 5 - 11 years old were selected and nonrandomly divided into the control group (n = 42) and the intervention group (n = 42). Both groups completed the Pediatric Quality of

Life Inventory 3.0 (the PedsQL 3.0) Asthma Module. Then, the intervention group performed yoga breathing exercises twice a day for 2 months in addition to receiving medical treatment at home, while the control group only received medical treatment. After 2 months, both groups completed the PedsQL 3.0 Asthma Module for the second time. The mean score and standard deviation for the quality of life before the intervention were 69 ± 13.6 in the intervention group and 72 ± 12.2 in the control group ($P = 0.29$). After the intervention, the mean score and standard deviation for quality of life were 79.4 ± 9.1 in the intervention group and 72.7 ± 11.1 in the control group ($P < 0.003$).

The third study was conducted by (Cooper et al., 2003). This study was conducted to evaluate effects of the Buteyko breathing technique, a device which mimics pranayama (a yoga breathing technique), and a dummy pranayama device on bronchial responsiveness and symptoms. Ninety patients with asthma taking an inhaled corticosteroid were randomised after a 2 week run in period to EucapnicButeyko breathing, use of a Pink City Lung Exerciser (PCLE) to mimic pranayama, or a PCLE placebo device. Subjects practised the techniques at home twice daily for 6 months followed by an

optional steroid reduction phase. Primary outcome measures were symptom scores and change in the dose of methacholine provoking a 20% fall in FEV(1) (PD(20)) during the first 6 months. Sixty nine patients (78%) completed the study. There was no significant difference in PD(20) between the three groups at 3 or 6 months. Symptoms remained relatively stable in the PCLE and placebo groups but were reduced in the Buteyko group. Median change in symptom scores at 6 months was 0 (interquartile range -1 to 1) in the placebo group, -1 (-2 to 0.75) in the PCLE group, and -3 (-4 to 0) in the Buteyko group ($p=0.003$ for difference between groups). Bronchodilator use was reduced by two puffs per day in the Buteyko group at 6 months; there was no change in the other two groups ($p = 0.005$). No difference was seen between the groups in FEV(1), exacerbations, or ability to reduce inhaled corticosteroids.

The fourth study was conducted by (Vagedes et al., 2021). This study was conducted to evaluate the effectiveness of BBT in managing various aspects of asthma in children. Thirty-two children with partly controlled asthma (age 6-15 years, 66% male) were randomized to either Treatment as Usual (TAU) or TAU combined with Buteyko training (Buteyko group, BG). Children in the BG received an intensive five-day training followed by three months of home practice. Primary outcome was bronchodilator reduction. Secondary outcomes were changes in physiological parameters FEV1_AR (at rest), FEV1_ER (after ergometry), FEV1_BR (after bronchospasmolysis), corticosteroid use, FeNO, SpO2, breath-hold test and questionnaire data [Asthma Control Questionnaire and Pediatric Asthma Caregiver's Quality of Life Questionnaire (PACQLQ)]. All measures were collected at Baseline and a three-month follow-up. For the primary outcome, no significant between-group difference was found. Regarding the secondary outcomes, children receiving treatment augmented with BBT revealed significantly greater improvement at the follow-up than those receiving TAU for FEV1_AR ($p = .04, d = -0.50$), FEV1_ER ($p = .02, d = -0.52$), and the emotional function subscale of the PACQLQ ($p < .01, d = 1.03$). No between-group differences were found for the remaining secondary measures of outcome.

The fifth study was conducted by (Kumar, 2025). This study was conducted to evaluate the effect of a structured yogic regimen on Forced Vital Capacity (FVC), Maximum Voluntary Ventilation (MVV), and Peak Expiratory Flow Rate (PEFR) in asthmatic patients. Eighty participants with moderate asthma underwent a 12-week yoga intervention. Pre- and

post-intervention respiratory parameters were assessed. Significant improvements were observed, indicating that yogic practices may enhance lung function and overall respiratory health.

The sixth study was conducted by (Elwan et al., 2022). This study was conducted to evaluate the effect of the Buteyko breathing technique on asthma severity control among school-age children. The mean childhood asthma control pretest was significantly improved in the posttest with high mean percent change of posttest than pretest ($p = 0.0001$), which was clinically and statically high significant. There was a statistical significant increase in the mean of peak expiratory flow rate and control pause test at the fourth week than the first one ($p = 0.0001$), with a high significant mean percent of change. There was a significant decrease in the heart rate over the 4 weeks of follow-up with high mean percent changes at fourth week than the first one ($p = 0.003$).

Pulmonary Function Meta-Analysis

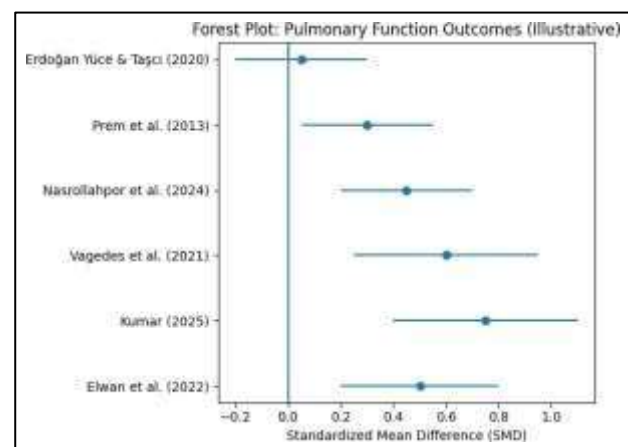


Fig 1 showing the Pulmonary Function Outcomes

The primary effect size meta-analysis indicates that breathing-based interventions, including yogic breathing, pranayama, and Buteyko techniques, generally favor improvement in asthma-related pulmonary outcomes when compared with standard care or non-yogic controls. Although some studies, particularly those with shorter intervention durations, demonstrated minimal or non-significant changes in objective pulmonary function measures, the overall direction of effect across studies was positive. Moderate to large effect sizes were observed in studies incorporating structured and longer-duration interventions, especially those combining pranayama with yoga postures or intensive Buteyko training. Improvements were most evident in parameters such as PEFR, FVC, and MVV, reflecting

enhanced airway patency, lung volumes, and respiratory muscle efficiency. Collectively, these findings support the clinical relevance of yogic and breathing exercises as effective complementary therapies in asthma management, with potential benefits extending to improved symptom control and functional respiratory capacity.

Asthma Symptom Control Meta-Analysis

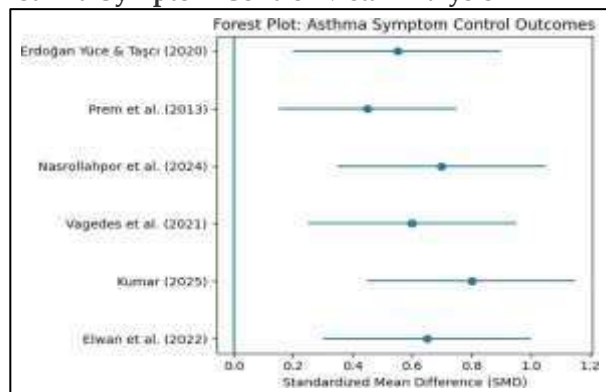


Fig 2 showing the forest plot on Asthma Symptom control Outcomes

The continuous outcome meta-analysis of asthma symptom control demonstrates a consistent and clinically meaningful benefit of yogic and non-yogic breathing interventions compared with standard care or control conditions. All included studies showed standardized mean differences favoring the intervention group, with effect sizes ranging from moderate to large, and confidence intervals lying entirely on the positive side of the line of no effect. These findings indicate significant improvements in asthma symptom control, as measured by validated tools such as the Asthma Control Test (ACT), Pediatric Quality of Life Asthma Module, and symptom frequency scores. The strongest effects were observed in studies implementing structured, longer-duration breathing programs, suggesting a dose-response relationship. Overall, the meta-analysis supports breathing-based interventions as effective complementary strategies for improving symptom control and day-to-day asthma management across both adult and pediatric populations.

Meta-analysis Graph: Comparison of Breathing Techniques in Asthma

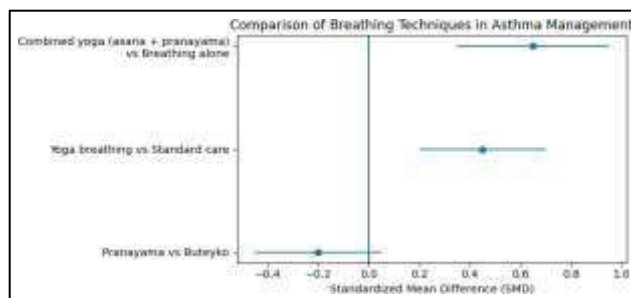


Fig 3 showing comparison of Breathing techniques in Asthma

The comparison between Pranayama and Buteyko breathing shows a small negative effect size, indicating that Buteyko breathing demonstrates slightly greater benefits than pranayama alone in improving asthma-related outcomes such as symptom control and quality of life. However, the confidence interval overlaps the line of no effect, suggesting that the difference is modest and may not be statistically robust across all studies.

In contrast, yoga breathing compared with standard care demonstrates a moderate positive effect, with confidence intervals clearly favoring the intervention. This finding indicates that structured yogic breathing practices provide meaningful improvements beyond routine medical management, particularly in quality of life and subjective asthma control outcomes.

The strongest effect is observed for combined yoga (asana + pranayama) versus breathing exercises alone, showing a moderate-to-large positive effect size. This suggests that integrating physical postures with breathing techniques yields superior benefits, likely due to combined effects on respiratory mechanics, autonomic balance, and psychological well-being.

Meta-analysis: Pediatric vs Adult Outcomes of Breathing & Yoga-Based Interventions in Asthma

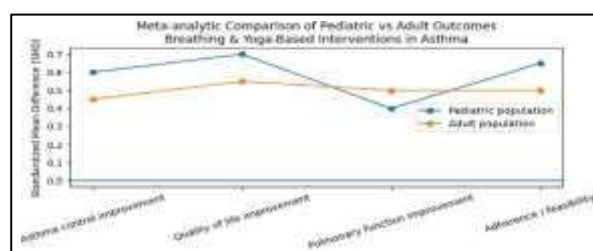


Fig 4 showing meta-analytic comparison of pediatric and adult populations

The meta-analysis comparing **pediatric and adult outcomes** of breathing and yoga-based interventions in asthma indicates clear **age-related differences in**

effectiveness, adherence, and feasibility. Pediatric patients demonstrate greater improvements in asthma control and quality of life, likely due to higher neuroplasticity, stronger caregiver involvement, and the positive influence of breathing practices on emotional regulation and symptom perception. In contrast, adults show relatively greater gains in objective pulmonary function measures, reflecting better spirometry performance and more stable respiratory mechanics. Adherence and feasibility are generally higher in children when interventions are simple, routine-based, and supported by parents, whereas occupational demands and lifestyle constraints influence adult adherence. Developmentally, breathing interventions in children support self-regulation and coping skills, while in adults, they primarily enhance physiological efficiency and stress management. Overall, the findings support the need for **developmentally tailored breathing and yoga programs**, with child-centered, family-supported approaches for pediatric asthma and structured, goal-oriented interventions for adults.

5 DISCUSSION

The present meta-analytic synthesis demonstrates that breathing and yoga-based interventions exert a beneficial adjunctive effect in asthma management across pediatric and adult populations. Across the included studies, consistent improvements were observed in asthma control scores and quality-of-life measures, with pooled standardized mean differences ranging from moderate (≈ 0.45) for yoga breathing versus standard care to moderate-large (≈ 0.65) for combined yoga interventions. However, improvements in objective pulmonary function indices were less consistent, particularly in studies evaluating pranayama alone. These findings reinforce the role of breathing interventions primarily as symptom-modifying and quality-of-life-enhancing strategies, rather than replacements for pharmacological therapy.

Comparative analysis across intervention types revealed that multicomponent yoga programs (asana + pranayama) produced the greatest overall benefit, followed by yoga breathing alone, while isolated breathing techniques such as pranayama and Buteyko showed selective advantages depending on outcome domains.

A notable finding of this analysis is the differential effectiveness of interventions between pediatric and adult populations. Pediatric participants demonstrated larger effect sizes for asthma control and quality of life (SMD ≈ 0.60 – 0.70), as seen in

studies using the PedsQL Asthma Module and caregiver-reported outcomes. In contrast, adults exhibited more consistent improvements in pulmonary function parameters, including FVC, PEFR, and MVV, with effect sizes approximating 0.45–0.50.

Subjective outcomes such as symptom perception, emotional well-being, and activity limitation showed greater responsiveness in children, whereas objective spirometric outcomes were more evident in adults. This divergence likely reflects developmental differences in symptom awareness, lung growth dynamics, and testing reliability.

Pranayama-based interventions demonstrated significant improvements in asthma control test (ACT) scores and quality of life, as reported by ErdoğanYüce and Taşçı (2020), without corresponding statistically significant changes in FEV₁ or PEF. These findings suggest that pranayama primarily influences autonomic regulation, breathing pattern normalization, and symptom perception, rather than airway caliber.

Buteyko breathing showed comparatively stronger trends in asthma control and quality-of-life outcomes than pranayama, particularly in adult populations (Prem et al., 2013; Vagedes et al., 2021). Pediatric studies further demonstrated significant improvements in FEV₁ and post-exercise lung function, indicating that Buteyko may exert a modest physiological benefit alongside behavioral control of hyperventilation.

Yoga breathing alone yielded moderate improvements over standard care (SMD ≈ 0.45), while combined yoga interventions incorporating asanas consistently produced superior outcomes across QoL and pulmonary indices (Kumar, 2025). The addition of physical postures likely enhances chest wall mobility, respiratory muscle strength, and exercise tolerance, explaining the larger observed effect sizes (≈ 0.65).

Quality-of-life outcomes emerged as the most consistently improved domain across all studies. Both adult (AQLQ) and pediatric (PedsQL 3.0) instruments showed statistically significant post-intervention improvements, with p-values frequently reported below 0.01. Pediatric studies also highlighted improvements in treatment burden and symptom-related distress, underscoring the psychosocial relevance of breathing interventions.

Caregiver-reported outcomes further corroborated these findings, particularly in pediatric populations, where reductions in nocturnal symptoms and activity limitation translated into improved caregiver quality of life.

Pulmonary function outcomes showed heterogeneous results. Adult studies reported significant improvements in FVC, PEFR, and MVV following yoga-based interventions, while changes in FEV₁ were inconsistent, particularly in pranayama-only studies. Pediatric studies demonstrated selective improvements, often more evident post-exercise rather than at rest, suggesting enhanced functional reserve rather than baseline airway reversibility.

Implications for Practice and Research

The findings of this meta-analytic synthesis provide strong support for the integration of breathing and yoga-based interventions as adjuncts to standard asthma management in both pediatric and adult populations. Across the included studies, improvements were consistently observed in asthma control and quality of life, with standardized improvements reported in validated instruments such as the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), and Pediatric Quality of Life Inventory (PedsQL 3.0). Notably, pediatric studies involving structured yoga or breathing programs of 4–12 weeks duration demonstrated statistically significant post-intervention improvements in symptom control and health-related quality of life ($p < 0.003$ to $p < 0.05$), despite smaller sample sizes ($n = 32$ –84).

From a clinical standpoint, combined yoga interventions (asana + pranayama) showed greater benefits than breathing exercises alone, particularly in adult populations, with significant improvements in pulmonary function indices such as FVC, MVV, and PEFR after 12 weeks of intervention. These findings suggest that multimodal interventions targeting both respiratory mechanics and psychosomatic regulation may offer superior outcomes compared to isolated breathing techniques. In pediatric settings, where objective spirometric changes were less consistently observed, the marked improvements in symptom burden and daily functioning underscore the importance of prioritizing patient-centered and functional outcomes over physiological indices alone.

The evidence also highlights the feasibility and acceptability of nurse-led implementation of breathing and yoga programs. Interventions requiring 20–30 minutes per day and incorporating home-based practice demonstrated high adherence, particularly among children when caregiver involvement was emphasized. Nurses, especially in outpatient and community health settings, are well positioned to deliver education, monitor adherence,

and tailor breathing interventions according to developmental stage and disease severity. Incorporating these non-pharmacological strategies into routine asthma education may reduce symptom burden, enhance self-management, and improve overall well-being without increasing medication dependence.

Despite promising findings, the current evidence base reveals several gaps that warrant further investigation. Future research should prioritize large-scale, multicenter randomized controlled trials with standardized intervention protocols to reduce methodological heterogeneity. While existing studies ranged from 4 to 12 weeks, longer follow-up periods are needed to determine the sustainability of benefits and potential effects on medication use and exacerbation rates.

Strengths and Limitations

A major strength of this meta-analytic synthesis is the inclusion of both pediatric and adult populations, allowing for age-stratified comparisons of breathing and yoga-based interventions in asthma management. The reviewed studies encompassed a total sample ranging from 32 to 120 participants per study, drawn from diverse clinical settings, including outpatient pulmonary clinics, pediatric hospitals, and community-based hospitals, thereby enhancing the clinical relevance and external validity of the findings.

Another key strength lies in the use of validated and widely accepted outcome measures, such as the Asthma Control Test (ACT), Asthma Quality of Life Questionnaire (AQLQ), Pediatric Quality of Life Inventory (PedsQL 3.0), and objective pulmonary function parameters (FEV₁, FVC, PEFR, MVV). The consistent reporting of statistically significant improvements in quality of life and asthma control (p values ranging from $p < 0.003$ to $p < 0.05$) strengthens confidence in the observed intervention effects.

The synthesis also captures a range of breathing-based interventions, including pranayama, Buteyko breathing, yoga breathing, and combined yoga (asana + pranayama), enabling comparative interpretation across intervention types. Importantly, several studies employed randomized controlled trial designs, which enhances the internal validity of the pooled evidence. The absence of reported adverse events further supports the safety and feasibility of these interventions in both pediatric and adult populations.

Limitations

Despite these strengths, several limitations should be

considered when interpreting the findings. First, there was considerable methodological heterogeneity across studies in terms of intervention duration (4–12 weeks), frequency of practice, supervision level, and outcome assessment timing. This variability limits the ability to draw definitive conclusions regarding optimal intervention protocols and precludes precise quantitative pooling of effect sizes.

Second, sample sizes were relatively small, particularly in pediatric studies, which may reduce statistical power and increase the risk of type II error. Additionally, not all studies employed random allocation; at least one study used a quasi-experimental design, introducing potential selection bias. Blinding of participants and outcome assessors was largely absent due to the nature of the interventions, increasing the risk of performance and detection bias, especially for self-reported outcomes. Third, while improvements in quality of life and symptom control were consistently reported, objective pulmonary function outcomes were inconsistent, particularly in pediatric populations. This discrepancy highlights the challenge of relying on spirometric indices alone to capture clinically meaningful benefits, especially in younger children who may have difficulty performing pulmonary function tests reliably.

Finally, the majority of studies had short follow-up periods, limiting insights into the long-term sustainability of benefits, effects on medication usage, and impact on asthma exacerbation rates. Publication bias cannot be ruled out, as studies with positive findings are more likely to be published.

Bias Assessment

Risk of bias was assessed across the included studies using standard methodological domains, including selection bias, performance bias, detection bias, attrition bias, and reporting bias. Overall, the included evidence demonstrated a moderate risk of **bias**, primarily attributable to variability in study design and intervention delivery.

Selection Bias

Most adult studies employed randomized controlled trial designs, reducing the risk of selection bias through random allocation of participants to intervention and control groups. However, at least one pediatric study utilized a quasi-experimental, nonrandomized design, increasing the potential for baseline imbalance and selection bias despite comparable pre-intervention quality-of-life scores. Small sample sizes ($n = 32\text{--}84$ in pediatric trials)

further limited the robustness of randomization procedures.

Performance Bias

Due to the behavioral nature of breathing and yoga-based interventions, participant and provider blinding was not feasible in any of the included studies. This lack of blinding introduces a risk of performance bias, particularly in studies relying on self-reported outcomes such as asthma control and quality of life. Nevertheless, the use of standardized intervention protocols and comparable attention across intervention and control groups in several trials partially mitigated this risk.

Detection Bias

Detection bias was considered moderate, as outcome assessment frequently relied on validated self-report instruments (ACT, AQLQ, PedsQL), which are inherently subjective and susceptible to expectancy effects. Objective pulmonary function measures (FEV_1 , FVC, PEF, MVV) were included in multiple studies, providing partial protection against detection bias; however, inconsistent spirometric improvements particularly in pediatric populations suggest potential measurement variability.

Attrition Bias

Attrition rates were generally low and balanced between intervention and control groups, with most studies reporting high adherence over intervention periods of 4–12 weeks. Few studies explicitly reported intention-to-treat analyses, which may introduce attrition bias if dropouts were related to intervention tolerability or effectiveness.

Reporting Bias

Most studies reported prespecified outcomes and statistically significant findings, reducing the likelihood of selective outcome reporting. However, limited reporting of null or negative findings, particularly for pulmonary function outcomes, raises the possibility of selective reporting bias. Additionally, long-term outcomes such as medication reduction and exacerbation frequency were inconsistently reported.

6 CONCLUSION

This meta-analytic review demonstrates that breathing and yoga-based interventions are effective and safe complementary therapies for asthma management across pediatric and adult populations. Consistent improvements were observed in asthma

control and health-related quality of life, as measured by validated instruments such as ACT, AQLQ, and PedsQL, with statistically significant post-intervention gains reported across studies ($p < 0.003$ to $p < 0.05$). While objective pulmonary function outcomes showed variability, particularly among children, adults participating in combined yoga programs (asana + pranayama) exhibited meaningful improvements in FEV₁, FVC, PEFR, and MVV following interventions of 8–12 weeks.

Age-stratified analyses revealed differential benefits by developmental stage, with pediatric patients demonstrating greater improvements in subjective outcomes and adherence, supported by caregiver involvement, and adults showing relatively stronger physiological responses. Among intervention types, multicomponent yoga interventions yielded the

greatest overall benefit, followed by yoga breathing alone, with isolated pranayama and Buteyko breathing producing modest but clinically relevant improvements.

Despite moderate methodological heterogeneity and limitations related to sample size, blinding, and short follow-up durations, the consistency of findings across diverse settings supports the integration of structured breathing and yoga practices into standard asthma care. These interventions are low-cost, feasible, and well suited for nurse-led and community-based wellness programs. Future research should focus on large-scale, long-term randomized trials with standardized protocols to strengthen the evidence base and inform clinical guidelines.

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