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**LITERATURE REVIEW**

# Evaluating the Efficacy of Breathing Exercises Among Healthy Adult Smokers

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## ABSTRACT

Introduction: Smoking contributes significantly to preventable diseases such as chronic obstructive pulmonary disease. Breathing exercises have emerged as potential complementary therapies aimed at improving lung function among smokers. This study aims to evaluate the efficacy of breathing exercises in improving lung function among adult smokers.

Methods: A comprehensive search of peer-reviewed literature from PubMed, Semantic Scholar, and Google Scholar from the past ten years. Eligible studies included randomized controlled trials (RCTs), quasi-experimental studies, and pilot studies on the impact of breathing exercises on lung function in adult smokers. Narrative data synthesis was conducted.

Results: Nine studies met the inclusion criteria. Diaphragmatic breathing, balloon blowing, and feedback breathing exercises significantly improved pulmonary parameters, including the FEV1/FVC ratio, tidal volume, inspiratory reserve volume, inspiratory capacity, vital capacity, and respiratory muscle activity. One study shows that FVC ($3.77 \pm 0.30$) and FEV1 ($3.13 \pm 0.54$) significantly improved after exercise ($p < 0.05$).

Conclusions: Breathing techniques can be a beneficial complementary treatment for improving lung function, particularly in terms of vagus nerve control and the balance between sympathetic and parasympathetic systems, as well as the kinesiology and physiology of the lung's dynamics. The findings are limited by study design, sample size, and intervention protocols. Future research should focus on high-quality randomized controlled trials (RCTs) with long-term follow-ups to evaluate the long-term effects.

Keyword: Breathing exercise, lung function, adult smokers, respiratory muscle training, pulmonary rehabilitation

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## INTRODUCTION

Smoking is a leading cause of preventable morbidity and mortality worldwide, contributing to diseases such as chronic obstructive pulmonary disease (COPD), lung cancer, and cardiovascular conditions.[1] Despite widespread awareness of the health risks associated with smoking, many individuals struggle to quit due to the addictive nature of nicotine and the psychological dependency associated with smoking behavior.[2] Traditional smoking cessation methods, such as nicotine replacement therapy (NRT) and behavioural interventions, have shown variable success rates, and there remains a need for complementary approaches that can support smokers in their cessation efforts.[3]

Breathing exercises have gained attention as a non-pharmacological intervention that may benefit smokers in several ways. By promoting relaxation, reducing stress, and improving lung function, breathing exercises offer both physiological and psychological support to individuals attempting to quit smoking. Deep breathing and diaphragmatic breathing, for instance, have been associated with improved lung mechanics, reduced respiratory discomfort, and decreased cravings for cigarettes, especially in stressful situations where smokers often relapse.[4]

Moreover, smokers tend to have impaired lung function due to chronic exposure to harmful substances in tobacco smoke.[5] Breathing exercises could serve as a rehabilitative tool, potentially improving respiratory muscle strength, enhancing oxygen exchange, and mitigating symptoms such as shortness of breath.[6] Additionally, given the strong link between stress and smoking, the calming effects of controlled breathing may help smokers better manage withdrawal symptoms and reduce their reliance on cigarettes as a coping mechanism.[7]

While the theoretical benefits of breathing exercises are promising, the scientific evidence on their efficacy for smokers remains scattered and underexplored. This review aims to systematically assess the available evidence on the effectiveness of breathing exercises for smokers in terms of smoking cessation, improvement in lung function, and stress reduction. By synthesizing data from various studies, this review seeks to determine whether breathing exercises can be considered a viable adjunctive therapy for smoking cessation and lung rehabilitation in smokers.

The objective of this systematic review is to examine the effects of breathing exercises on lung function in smokers.

Through a rigorous analysis of the current literature, this review aims to contribute to a deeper understanding of the potential role that breathing exercises may play in supporting the health and cessation efforts of smokers. The findings of this review may inform future clinical guidelines and interventions aimed at improving smoking cessation outcomes and overall respiratory health.

## METHODS

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Eligible studies included adult smokers (≥18 years), encompassing habitual and social smokers while excluding adolescents, non-smokers, former smokers, and users of electronic cigarettes. Interventions of interest were structured breathing exercises with clearly reported frequency, duration, and type. Studies involving multimodal interventions or insufficiently detailed breathing practices were excluded. Comparator groups included standard care, smoking cessation counselling, nicotine replacement therapy, or no intervention.

The primary outcomes were improvements in lung function, as measured by spirometry or equivalent tests, and secondary outcomes included quality-of-life measures. Eligible study designs were randomized controlled trials, quasi-experimental studies, and pilot studies. A comprehensive search of PubMed, Semantic Scholar, and Google Scholar was conducted from inception to September 2, 2024, using tailored search strings that combined relevant keywords and subject terms. Only English-language, peer-reviewed articles were included; conference abstracts and articles in press were excluded. Reference lists of included studies were manually screened. Title, abstract, and full-text screenings were independently conducted by three authors, with discrepancies resolved by consensus. A PRISMA flow diagram illustrates the study selection process.

## RESULTS

Studies were identified from electronic database, screened, and included for review.

Following the elimination of redundant entries, a total of 257 articles were retained for examination of titles and abstracts. Submissions that failed to adhere to the determined inclusion and exclusion standards were excluded from the ongoing assessment. A total of 18 articles underwent a thorough assessment for eligibility, of which 9 conformed to all established inclusion criteria. (Figure 1).

The authors conducted a thorough review of the papers, excluding those irrelevant to our research focus, with Table 1 summarizing the relevant studies.

**Figure 1 PRISMA flow chart**[8]

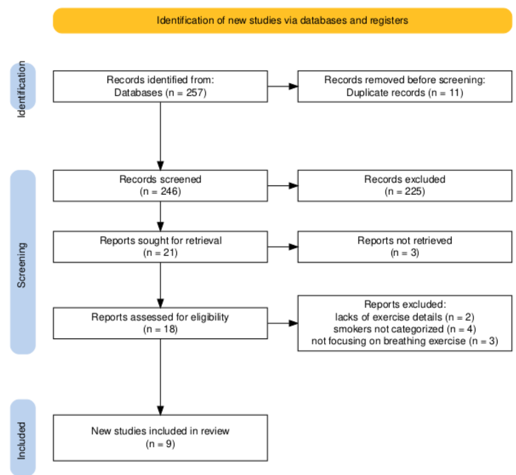



**Table 1 Summary of studies that show the effect of breathing exercises on smokers**

| Study | Participants | Methods | Duration | Measurements | Results | Conclusion |
|---|---|---|---|---|---|---|
| Hyun-Ju Jun et al.[9] (2016) | 30 elderly smokers | Divided into control, Feedback Breathing Exercise (FBE), and Balloon-Blowing Exercise (BBE) groups | 6 weeks | FVC, FEV1, FEV1/FVC, PEF, VC | Significant improvements in FVC, FEV1/FVC, PEF, and muscle activity after 4 weeks, but not maintained after 6 weeks | Continuous exercise is necessary to maintain the benefits. |
| Hyun-Ju Jun et al.[10] (2017) | 20 smokers and 20 non-smokers | Divided into FBE and BBE groups | 4 weeks | FVC, FEV1, FEV1/FVC, PEF, VC | Smokers had lower pulmonary function and muscle activity improvements compared to non-smokers. | Smoking reduces the effectiveness of respiratory exercises. |
| KyoChul Seo et al.[11] (2015) | 28 male smokers | Diaphragm respiration exercises vs. MOTOmed exercises | 4 weeks | TV, IRV, ERV, IC, VC | Significant improvements in TV, IRV, IC, and VC in the experimental group | Diaphragm exercises enhance pulmonary function |
| Tharani. G et al.[12] (2023) | 40 male smokers | Acapella device vs. diaphragmatic breathing exercises | 8 weeks | VC, FEV1/FVC ratio | Acapella group showed more significant improvements in VC and FEV1/FVC ratio. | Acapella exercises are more effective in increasing vital capacity. |
| Vadivelan Kanniappan et al.[13] (2020) | 100 male smokers | Balloon-blowing exercises vs. control | 8 weeks | Peak expiratory flow rate | Significant improvement in peak expiratory flow rate in the intervention group | Balloon-blowing exercises improve peak expiratory flow rate. |
| Awan et al. [14](2020) | 30 male smokers | Deep breathing exercises vs. control | 2 weeks | VC, IC, TV, ERV, FEV1, FVC | Significant improvements in all measured parameters | Deep breathing exercises improve lung functions in healthy smokers |
| Bostanci et al.[15](2019) | 42 male smokers and non-smokers | Inspiratory muscle training (IMT) vs. placebo | 4 weeks | FVC, FEV1, FEV1/FVC, MVV, SVC, IC, MIP, MEP | Significant improvements in respiratory muscle strength and pulmonary function, more pronounced in smokers | IMT significantly improves respiratory muscle strength and pulmonary function |
| Pişkin et al.[16](2023) | 12 smokers and 10 non-smokers | Deviced respiratory muscle exercises | 8 weeks | FVC, FEV1, PEF, FEV1/FVC | Significant improvements in all measured parameters, higher in smokers | Respiratory muscle exercises should be included in smoking cessation programs |
| Bhatnagar et al.[17] (2022) | 50 male smokers | Chest PNF vs. breathing exercises | 2 weeks | FVC, FEV1, FVC/FEV1, chest expansion | Significant improvements in pulmonary function and chest expansion, more significant in chest PNF group | Both techniques are effective in pulmonary rehabilitation. |

FBE: Feedback Breathing Exercise; BBE: Balloon-Blowing Exercise; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in 1 Second; PEF: Peak Expiratory Flow; VC: Vital Capacity; TV: Tidal Volume; IRV: Inspiratory Reserve Volume; ERV: Expiratory Reserve Volume; IC: Inspiratory Capacity; IMT: Inspiratory Muscle Training; MVV: Maximal Voluntary Ventilation; SVC: Slow Vital Capacity; MIP: Maximal Inspiratory Pressure; MEP: Maximal Expiratory Pressure; PNF: Proprioceptive Neuromuscular Facilitation

**Figure 2 Risk of bias graph**[18]

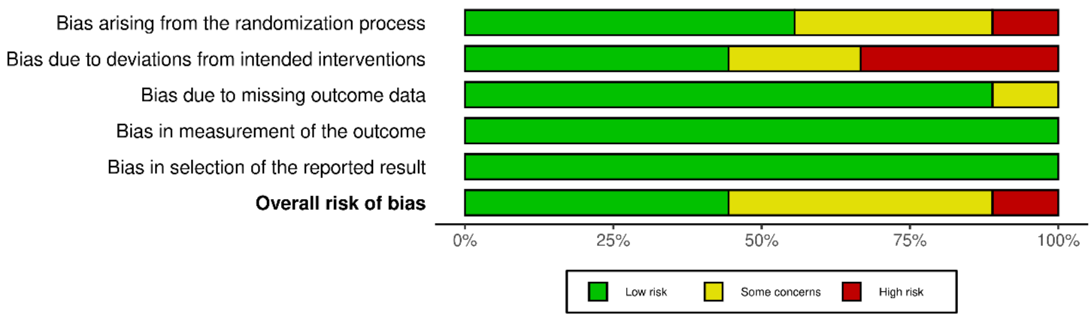
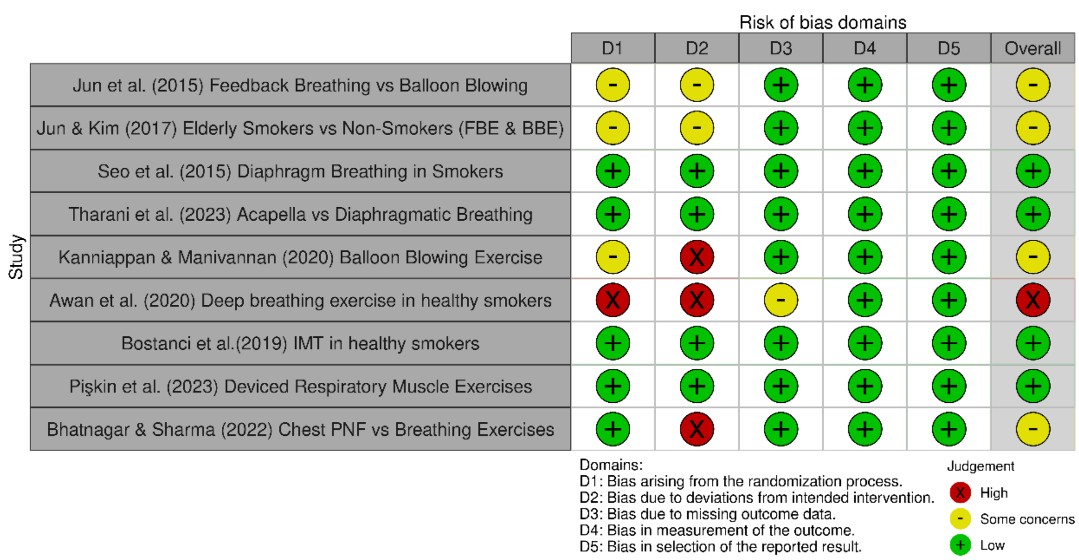



**Figure 3 Risk of bias summary**[18]




## DISCUSSION

Most included male subjects. The ages of subjects ranged from around 20 years to around 80 years. All studies showed improvements in pulmonary function after the implementation of these exercises. Most of the studies (7 out of 9) use the parameters of FEV1, FVC, FEV1/FVC, PEF, and VC as measurements for assessing the effect of various breathing exercises on smokers.[9,10,12,14–17]Three studies measured accessory muscle activity,[9,10,15] and one study measured chest expansion.[17] the effect of Balloon Blowing Training (BBT) was explained in 3 studies, feedback breathing training (FBT) in 1 study, deviced respiratory muscle exercise was used in two studies which showed greater improvements of pulmonary function than regular breathing exercise.[15,16]

Breathing exercises significantly impact the kinesiology and physiology of breathing by enhancing respiratory efficiency and muscle engagement. These exercises can alter breathing patterns, improve pulmonary function, and optimize the use of respiratory muscles, which can be beneficial for both healthy individuals and those with respiratory conditions.[19]

The diaphragm, along with the scalene and external intercostal muscles, is crucial for the thoracic cavity's expansion during inspiration. Such expansion results in a reduction of pressure within the thoracic region, thereby facilitating the influx of air into the pulmonary system from the relatively elevated atmospheric pressure external to the body. While active expiration during physical activity, such as workouts, demands the involvement of expiratory muscles. This musculature, which encompasses the internal intercostal muscles and the abdominal muscles, serves to reduce thoracic volume, thereby assisting in the expulsion of air and ensuring optimal ventilation efficacy in response to heightened respiratory demands.[20]

These exercises are designed to retrain the muscles involved in respiration, thereby improving overall pulmonary function and endurance, which enables better oxygen delivery, particularly in individuals with impaired lung conditions.

Hyun Ju et al.[9] demonstrate that both feedback breathing training (FBT) and balloon-blowing exercise (BBE) significantly improve pulmonary function in elderly smokers. Although improvements were noted after four weeks, the study observed that these effects were not sustained after six weeks without continued intervention.[9] This suggests that ongoing exercise is necessary to maintain the benefits. Hyun Ju et al. also investigated the impact of breathing exercises on both smokers and non-smokers. Although the study showed improvement in both smokers and non-smokers, the extent of improvement varies between the two groups.[10] Smokers showed lower measurements of FEV1, FEV1/FVC, PEF, and VC compared to non-smokers throughout the observation time. It suggests that while respiratory exercises can aid in improving pulmonary function, they may not entirely counteract the damage caused by smoking.[10] This highlights the importance of not only engaging in respiratory exercises but also addressing smoking cessation as a crucial component For enhancing lung health and overall well-being. Both studies also measured the activity of the accessory respiratory muscle, which was enhanced after subjects received exercises.[9,10] This increase in accessory muscle activity indicates that respiratory exercises can play a significant role in Strengthening the muscles involved in breathing, which may lead to improved overall lung function and increased endurance for both smokers and non-smokers.[9,10]

Balloon-blowing exercises also improve PEFR in smokers by enhancing and strengthening the respiratory muscles that maintain airway patency, increasing lung capacity, and facilitating more effective air exchange and improving respiratory efficiency.[13] By keeping the proper position of the spine and expanding the zone of apposition, the diaphragm can perform its respiratory role more effectively, resulting in improved peak expiratory flow rate (PEFR).[21]

Awan et al[14] observed the combination of pursed lip breathing, diaphragmatic breathing, and powered breathing exercises in healthy smokers. The results showed a marked improvement in vital capacity, inspiratory capacity, tidal volume, expiratory reserve volume, forced expiratory volume, and forced vital capacity. Results indicated significant improvements, suggesting that deep breathing exercises enhance lung function by increasing respiratory muscle strength and improving alveolar ventilation.[14]

The exercises help expand the diaphragm fully, allowing more air to be inhaled, which increases the stamina and flexibility of the respiratory muscles. This leads in improved breathing, increased oxygen saturation, and enhanced overall lung function.[22] The exercises are economical in terms of energy spent on breathing and help remove dead space ventilation, thereby improving alveolar ventilation. Pursed-lip breathing (PLB) helps maintain airway openness and reduces respiratory muscle workload. PLB promotes deeper, slower breathing, improving inspiratory capacity.[23]

Diaphragmatic breathing optimizes the use of the diaphragm, thereby lowering the breathing rate and oxygen demand.[24] Deep breathing exercises enhance alveolar ventilation and reduce dead space ventilation by increasing parasympathetic activity and improving lung compliance.[24] Deep breathing gradually increases the duration of inspiration, allowing the respiratory center to acclimatize to higher levels of carbon dioxide (PCO2) and lower levels of oxygen (PO2).[25]

This adaptation can stimulate chemoreceptors in the medulla oblongata, which are sensitive to changes in blood oxygen levels, further promoting parasympathetic activity. Performing deep breathing exercises, especially those that emphasize diaphragmatic breathing, can lead to a favorable outcome in the chest wall's compliance through the regulation of the autonomic nervous system. By augmenting parasympathetic nervous system activity and diminishing the levels of stress hormones, deep breathing facilitates muscular relaxation and enhances the mechanics of respiration, thereby enabling improved expansion of the thoracic cavity.[25,26]

Smoking has been shown to affect respiratory muscle strength and endurance through several underlying mechanisms. These effects are primarily due to the direct impact of cigarette smoke on muscle tissue, systemic inflammation, and oxidative stress.[27]

A study by Kyo-Chul Seo et al. utilizes diaphragm respiration exercises that focus on strengthening the diaphragm muscle, thereby enhancing inspiratory muscle function and increasing thoracic mobility.[11] This Approach not only improves overall lung function but also contributes to better oxygenation and ventilation, ultimately leading to an enhanced quality of life for patients with respiratory disorders. The benefits of diaphragmatic breathing are evident in improved pulmonary function parameters, including peak expiratory flow rate, forced vital capacity, and forced expiratory volume.[28–30]

Bhatnagar et al.[17], examining the comparative impacts of chest proprioceptive neuromuscular facilitation (PNF) and deep breathing exercises on respiratory function, revealed considerable improvements within the chest PNF cohort following a two-week intervention period. The forced expiratory volume in one second (FEV1) shows an increase of 18%, with the forced vital capacity (FVC) rising by 5%, and chest expansion demonstrating notable improvement across various thoracic levels. These findings suggest that chest PNF may enhance respiratory performance by improving thoracic mobility and activating stretch reflexes to facilitate respiration.[17]

Chest PNF (Proprioceptive Neuromuscular Facilitation) refers to a specialized exercise paradigm designed to enhance the mobility and elasticity of the pectoral muscles, thereby improving respiratory capacity by stimulating the muscular structures that encompass the thoracic cavity and rib cage. The foundational mechanism acts via proprioceptive feedback, where the actions of stretching and contracting these muscular structures communicate signals to the central nervous system, thereby improving respiratory patterns. In addition, Chest PNF engages the stretch reflex, a physiological defense mechanism that heightens the intensity and rate of inhalation, mitigating muscular tension and encouraging more fluid, deep breaths.[31]

Tharani. G et al.[12] compared the effect of device respiratory therapy using the Acapella technique and diphragmatic breathing exercises. While both Acapella and diaphragmatic breathing exercises have their merits, acapella exercises have a pronounced impact on increasing lung volume in smokers by improving vital capacity, preventing airway collapse, strengthening respiratory muscles, and enhancing lung recruitment and airway clearance. The study suggested that using a one-way valve system allows patients to exhale against resistance, promoting beneficial and enhanced airway clearance.[12]

The Acapella device, an oscillating positive expiratory pressure (OPEP) apparatus, functions by generating resistance during exhalation to facilitate mucus clearance and enhance airflow; predominantly utilized in patients undergoing cardiac surgery and those with pulmonary diseases, its efficacy positions it as a potential adjunctive therapy for smokers experiencing diminished cardiopulmonary function.[32–34]

Pişkin et al. involved 22 adults, comprising 12 smokers and 10 non-smokers, to examine the outcomes of 8 weeks of devised respiratory muscle exercises conducted at a workload of 40% maximum inspiratory pressure (MIP). Considerable improvements were observed in every respiratory function analysed (MIP, FVC, FEV1, PEF, FEV1/FVC) in both groups, with smokers exhibiting a distinctly higher enhancement in the FEV1/FVC ratio.

Bostanci et al.[15] examine the effect of Inspiratory Muscle Training (IMT) on pulmonary function and respiratory muscle strength in healthy smokers. Results showed a significant improvement in respiratory muscle strength and pulmonary functions (MIP, MEP, FVC, FEV1, MVV, SVC, and IC), more so in the smokers' group than in the non-smokers. The study found that implementing IMT not only enhanced muscle performance but also contributed to a reduction in the adverse effects of smoking on respiratory health, which could be linked to alterations in the lung microbiome and muscles, requiring them to work against resistance during inhalation. This mechanism mirrors the fundamental principles of skeletal muscle strengthening through progressive overload, serving as the basis for adaptive muscular changes over time.[38]

Repeated exposure to resistive loading leads to increased muscle strength and endurance, it also improves fatigue resistance of the diaphragm and related musculature. This physiological adaptation is critical for enhancing respiratory efficiency and reducing the sensation of breathlessness, particularly in individuals with compromised pulmonary function, such as those with a history of smoking.[39]

## CONCLUSION

A wide range of respiratory muscle training techniques, including IMT, devised respiratory muscle exercises, BBT, FBT, Acapella, PLB, diaphragmatic breathing, and chest PNF, have consistently demonstrated significant improvements in pulmonary function across diverse populations. Most studies reported enhancements in FEV1, FVC, FEV1/FVC ratio, PEF, and vital capacity, with interventions like IMT and deviced muscle exercises notably increasing maximal inspiratory pressure (MIP) and lung volumes. Smokers, while benefiting from these exercises, generally showed lower baseline values compared to non-smokers, suggesting that respiratory exercises, while beneficial, cannot fully reverse smoking-induced damage. The importance of sustained, ongoing training was emphasized, as benefits tended to diminish without continued practice.

Overall, these findings highlight respiratory muscle training as an effective, non-pharmacological intervention for improving lung function, with added emphasis on combining these therapies with smoking cessation strategies for optimal respiratory health.

The data acquired from this review are essentially limited by multiple considerations, including the specific research framework, the relatively small number of subjects, and the specific practices enacted during the intervention phase. Given these obstacles, future research must emphasize the importance of conducting high-standard randomized controlled trials (RCTs) that focus on long-term follow-up evaluations to assess the sustained effects of the interventions being studied. By focusing on these methodological advancements, future research will be better equipped to produce robust and widely applicable outcomes that can significantly enhance the current understanding in this domain.

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