THE IMPACT OF ANULOMA VILOMA PRANAYAMA ON PULMONARY FUNCTION IN INDIVIDUALS WITH REDUCED LUNG RESERVE POST-COVID-19: A NARRATIVE REVIEW

ABSTRACT

Objective:

The primary objective of this literature review was to investigate the effects of Anuloma Viloma Pranayama (AVP) on individuals with reduced lung reserve resulting from COVID-19.

Introduction:

The COVID-19 pandemic has emerged as a significant public health crisis, often leading to severe respiratory complications in affected individuals. Patients frequently experienced dyspnea, which rapidly progressed to acute respiratory distress syndrome (ARDS), septic shock, and other critical conditions. These complications have been associated with diminished pulmonary function, reduced respiratory muscle strength, and a decline in activities of daily living (ADL) and quality of life (QoL).

Methodology:

A comprehensive electronic search of published research articles was conducted using databases such as Google Scholar, PubMed and others. The search aimed to identify studies evaluating the effects of AVP on individuals with compromised lung reserve due to COVID-19. Studies meeting the inclusion criteria, including randomized controlled trials, systematic reviews, meta-analyses, and pilot studies, were selected for this literature review.

Results:

This review explored the mechanisms through which AVP influences lung function and found that it significantly benefits COVID-19 patients by enhancing pulmonary reserve and improving their overall quality of life.

Conclusion:

The findings of this study suggest that AVP can serve as a complementary intervention to improve pulmonary reserve in COVID-19 patients. Regular practice of this breathing technique may help mitigate pulmonary complications and enhance overall well-being, with no reported adverse effects.

Keywords: *Anuloma Viloma Pranayama (AVP) and COVID-19","AVP and Respiratory dysfunction"," AVP and decreased pulmonary reserve".*

1. INTRODUCTION

The COVID-19 pandemic has emerged as a global public health crisis, prompting governments worldwide to implement lockdown measures and stay-at-home orders to curb its transmission [1]. Patients often develop dyspnoea or hypoxemia approximately one week after the onset of symptoms, with severe cases rapidly progressing to acute respiratory distress syndrome (ARDS), septic shock, and other life-threatening complications. Early studies indicate that individuals with severe pneumonia face a mortality rate as high as 61.5%, attributed in part to limited medical research and resources at the time [2]. Many survivors of COVID-19 experience persistent symptoms, including impaired pulmonary function, reduced muscular strength, activity limitations, anxiety, depression, neurocognitive dysfunction, and a diminished quality of life. These complications may persist for at least six months,

underscoring the critical need for effective rehabilitation programs to support patients and alleviate the burden on healthcare systems [3]. In elderly populations, community-acquired pneumonia has been associated with declines in activities of daily living (ADL), reduced quality of life (QoL), and diminished physical and cognitive performance. Respiratory illnesses and physical inactivity in older adults can further exacerbate conditions such as apraxia syndrome and recurrent pulmonary infections [4].

Yoga is an ancient Indian practice with deep historical roots. It is defined as *Chitta Vritti Nirodhah*, which translates to the cessation of the mind's fluctuations. In contemporary terms, this can be understood as a technique for achieving mental tranquillity [5]. In the Western world, yoga encompasses a wide range of disciplines, including physical postures (*asanas*), breathing techniques (*pranayama*), meditation or mindfulness practices, and relaxation methods [6]. Due to its holistic benefits, yoga has been increasingly integrated into pulmonary rehabilitation programmes as a recommended therapeutic activity [7]. The foundational text of yoga, Patanjali's Yoga Sutras, outlines an eightfold path (Ashtanga Yoga) for its practice. This includes *yama* (ethical conduct), *niyama* (self-discipline), *asana* (physical postures), *pranayama* (breath control), *pratyahara* (withdrawal of senses), *dharana* (concentration), *dhyana* (meditation), and *samadhi* (state of liberation) [8].

The term *prana*, derived from Sanskrit, translates to "breath," "respiration," or "life force," while *ayama* means "extension" or "control." Thus, *pranayama* refers to the practice of regulating and extending the breath [9]. Pranayama, a form of controlled breathing, involves slow, rhythmic patterns of inhalation and exhalation [10]. It consists of three primary phases: prolonged and gentle inhalation (*puraka*), exhalation (*rechaka*), and breath retention (*kumbaka*) [9]. Beyond its physical aspects, pranayama serves as a meditative practice that engages both the mind and the respiratory system [8].

Among the various breathing exercises under the umbrella of pranayama is *anuloma viloma*, commonly known as alternate nostril breathing [11]. The performance of AVP, for just five minutes a day, can yield immense benefits, regardless of age, gender or physical status. AVP is characterized by slow and controlled breathing through alternate nostrils. Numerous studies have examined the beneficial impact of AVP across various age groups. These studies have demonstrated that AVP practice can enhance respiratory function, improve microcirculation in the cardiac muscles, reduce anxiety and improve brain functioning [12].

For elderly patients recovering from COVID-19, improved respiratory function is a critical factor in maintaining activities of daily living (ADL) and enhancing quality of life (QoL) [4]. Given its potential benefits, this study aims to conduct a literature review to explore the effects of AVP on individuals with reduced pulmonary reserve due to COVID-19.

2. METHODOLOGY

A systemic literature was conducted on electronic data base of google scholar, PubMed, science direct using the terms “Anuloma Viloma Pranayama (AVP) and COVID-19","AVP and Respiratory dysfunction"," AVP and decreased pulmonary reserve". as key words. Results were filtered by the clinical trials.

2.1 Inclusion Criteria

- Patient diagnosed with COVID – 19.
- Both male and female were included.
- All the age groups.
- Any studies of yoga intervention that measured pulmonary reserve as primary dependent variable.
- Studies that include mechanism between pranayama and pulmonary reserve.

- All RCT using pranayama as a respiratory dysfunction treatment.

2.2 Exclusion Criteria

The studies were excluded in the narrative review if they were:

- Not based on the study.
- Abstracts and unpublished articles.

Table 1: SUMMARY OF LITERATURE REVIEW

Author and year	Study design	Methodology	Result	Conclusion
1. Rakesh Sarwal, Rajinder K. Dhamija (2021)	Randomised clinical experiment	A total of 280 HCPs were recruited and assigned to intervention and control groups. The intervention group practiced specially designed Pranayama modules twice daily for 28 days under the online supervision of Yoga instructors. The control group continued their normal daily routine	The intervention and control groups had comparable demographics and baseline characteristics. The study found a significant reduction in COVID-19 infection among the intervention group compared to the control group.	The study concluded that Pranayama could be an effective preventive measure against COVID-19 infection among healthcare professionals. The practice of Pranayama was associated with a lower incidence of COVID-19 infection and improved immune function.

		without Pranayama sessions.		
2. Kai Liu, Weitong Zhang, Yadong Yang (2020)	Randomised controlled trial	The trial involved 72 elderly patients with COVID-19. Participants were randomly assigned to either the intervention group or the control group. The intervention group underwent a 6-week respiratory rehabilitation program, which included breathing exercises, physical training, and psychological support. The control group received standard care without the rehabilitation program.	After 6 weeks, the intervention group showed significant improvements in pulmonary function (FEV1, FVC, FEV1/FVC%, DLCO%), 6-minute walk distance, and quality of life compared to the control group. The intervention group also reported better psychological well-being and reduced anxiety levels.	The study concluded that a respiratory rehabilitation program significantly improves respiratory function, mobility, quality of life, and psychological well-being in elderly patients with COVID-19. The findings suggest that such programs should be considered as part of the standard care for elderly COVID-19 patients.
3. Rajashree	Randomized,	Eighty-one coal	The yoga group	The findings indicate that the

Ranjita, Alex Hankey, H.R. Nagendra (2016)	waitlist-controlled, single-blind clinical trial.	miners aged 36-60 years with stable Stages II and III chronic obstructive pulmonary disease (COPD) were recruited. The yoga group received an Integrated Approach of Yoga Therapy (IAYT) module for COPD, which included asanas, loosening exercises, breathing practices, pranayama, cyclic meditation, yogic counselling, and lectures. The intervention was conducted for 90 minutes per day, 6 days a week, for 12 weeks.	experienced statistically significant reductions in dyspnoea and fatigue scores, as well as improvements in SpO2% and 6-minute walk distance compared to the control group. The findings indicate that the Integrated Approach of Yoga Therapy benefits coal miners with COPD by reducing dyspnoea, fatigue, and pulse rate, and improving functional performance and peripheral capillary oxygen saturation.	Integrated Approach of Yoga Therapy benefits coal miners with COPD by reducing dyspnoea, fatigue, and pulse rate, and improving functional performance and peripheral capillary oxygen saturation. Yoga can now be included as an adjunct to conventional therapy for pulmonary rehabilitation programs for COPD patients.

3. Results and Discussions

This literature review aimed to summarise the effects of AVP on individuals with diminished pulmonary reserve due to COVID-19. Notably, no prior research has exclusively focused on AVP in COVID-19 patients. The outbreak of COVID-19 in Wuhan, China, has garnered global attention. Pranayama may have a preventive impact by maintaining the health of the upper respiratory tract, thereby preventing the entry of the SARS-CoV-2 virus. Each component of the intervention module is anticipated to play a crucial role in reducing infection [1,2].

Unlike Chronic Obstructive Pulmonary Disease (COPD), COVID-19 does not necessarily cause lasting damage to the lung architecture. Patients in studies from both groups have shown spontaneous improvement in lung function parameters [3]. Following current therapy and discharge regimens, individuals with COVID-19 may develop persistent fibrotic lesions in the lungs, potentially compromising respiratory function. However, after six weeks of respiratory rehabilitation training, the study found significant improvements in pulmonary function. This improvement may be attributed to rehabilitation exercises for respiratory muscles, including intercostal muscles, accessory muscles, abdominal wall muscles, and other muscles essential for maintaining respiratory function [4].

Previous research has demonstrated that practicing AVP for three months reduces anxiety levels. The predominance of parasympathetic activity observed following yoga breathing instruction is associated with stress reduction [5].

Improvements in dyspnoea perception may be attributed to yogic training's reduction of sympathetic reactivity, which promotes bronchodilation by correcting aberrant breathing patterns and reducing muscular tension in the inspiratory and expiratory muscles. Enhanced breathing patterns may enlarge bronchioles, allowing more alveoli to be perfused effectively.

Pranayama stretches lung tissues, alleviating dyspnoea by reducing dynamic hyperinflation of the rib cage and improving gas exchange, as well as enhancing respiratory muscle strength and endurance and optimising thoraco-abdominal patterns of motion [7].

Any increase in the quantity of yoga breathing practice was associated with better symptom and quality of life (QoL) ratings, according to the yoga breathing dosage effect [8]. Patients who practised Pranayama in conjunction with radiation therapy reported feeling less worried, anxious, and frustrated [9]. Sukha Pranayama is a steady, rhythmical breathing technique that is said to promote baroreflex sensitivity while decreasing chemical reflex activity. It also lowers systolic and diastolic blood pressures, as well as heart rate among hypertensive individuals [10].

Due to the associated lymphopenia and the enhanced inflammatory response linked with increased renin-angiotensin system (RAS) activation in various organs, diabetics are more vulnerable to infection [13]. Hypertension, diabetes, cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), and cancer were linked to an increased risk of severe COVID-19, and CVD, COPD, CKD, cerebrovascular disease, and cancer were linked to an increased risk of mortality in COVID-19 patients [14]. It is proposed that the effect of SARS-CoV-2 on blood glucose, which may be connected to ACE2, be evaluated to justify the high incidence of diabetes in fatal patients. Shortness of breath and cough are common symptoms in asthma patients, and they are also prevalent in COVID-19 cases. According to the present findings of this meta-analysis, 8% of patients with COPD comorbidities are more likely to experience rapid disease progression than those without COPD [15].

However, it is important to acknowledge the limitations of meta-regression in exploring relationships between variables, which underscores the need for larger cohort studies to draw

more robust conclusions. Beyond indirect associations, dysfunction in the brain medullary cardio-respiratory or autonomic nervous systems could theoretically contribute to blood pressure and respiratory irregularities, potentially increasing susceptibility to opportunistic infections, both viral and bacterial. For instance, in post-stroke patients, a compromised cholinergic system has been shown to reduce pulmonary innate immunity, thereby elevating the risk of bacterial pneumonia. A notable limitation of this systematic review and meta-analysis is that a significant proportion of the included studies were pre-prints. Additionally, most of the research was retrospective in design and predominantly conducted in China [16].

Elevated D-dimer levels in COVID-19 patients indicate a persistent inflammatory and hypercoagulable state, serving as a poor prognostic marker associated with higher mortality rates [17]. Early in viral infection, respiratory epithelial cells are primarily affected, with epithelial changes and signs of viral activity dominating the pathology. In severe cases or patients with underlying risk factors, viral clearance is often delayed. Even in advanced stages of COVID-19, epithelial lung damage, pneumocyte hyperplasia, cellular atypia, and multinucleation—potentially indicative of viral cytopathic effects—further support this observation. The progression from low to high lung elastance may be influenced by multiple factors, including patient self-inflicted lung injury and ventilator-induced lung injury. A limitation of the available data is the inconsistent documentation of clinical details, such as laboratory results, radiographic findings, and treatment specifics, which were not uniformly reported across all cases [18].

The observed reduction in diffusion capacity may be attributed to pathological changes in the lungs. A high prevalence of impaired diffusion capacity (66%) was identified in severe COVID-19 patients, particularly those with elevated inflammatory markers, who are at greater risk of developing pulmonary fibrosis. A major limitation of this study is the considerable heterogeneity among the included studies, especially in the assessment methods

used. The criteria for diagnosing pneumonia severity varied across studies, with some relying on CT findings, others on COVID-19-specific guidelines, and some on the use of ventilatory support [19].

The clinical course of Coronavirus Disease 2019 (COVID-19) appears to be milder in children compared to adults, raising questions about the underlying reasons. Several hypotheses have been proposed. Children, particularly younger ones, are frequently exposed to viral infections, which may prime their immune systems to mount a more effective response to SARS-CoV-2. The lower incidence of severe COVID-19 in paediatric patients is unlikely to be explained by the absence of smoking, as smoking does not appear to play a significant role in the aetiology of COVID-19 in adults [20].

Our findings indicate that patients presenting with dyspnoea had a higher likelihood of mortality. Dyspnoea is a clinical manifestation of hypoxia and reduced lung function, underscoring the importance of healthcare professionals closely monitoring for this symptom to prevent disease progression and complications [21].

When the breathing interval is prolonged, respiratory-related vagal modulation is activated. Lower breathing rates have been shown to enhance high-frequency amplitude while reducing low-frequency amplitude, without altering the LF:HF ratio, R-R interval, or blood pressure. Slow breathing has been associated with improved baroreceptor sensitivity, increased hypercapnic chemosensitivity, and reduced hypocapnic chemosensitivity. According to Srivastav et al., lung expansion triggers a reflex response, where stretch receptors promote vasodilation in skeletal muscles and reduce systemic vascular resistance, thereby influencing blood pressure and resistance. Bharadwaj et al. reported that alternate nostril breathing (ANB) increased mucociliary activity in the respiratory epithelium of rhinosinusitis patients.

ANB also enhances systemic oxygenation and the surface area available for oxygen absorption, further supporting its therapeutic potential [22].

Joshi et al. demonstrated that six weeks of pranayama training improved ventilatory functions in healthy individuals, as evidenced by increases in forced vital capacity (FVC), forced expiratory volume in one second (FEV1), maximum voluntary ventilation (MVV), and peak expiratory flow rate (PEFR). Similarly, Sivakumar et al. observed acute improvements in pulmonary function test (PFT) values following deep breathing exercises (2-10 minutes) in healthy volunteers. Yadav and Das suggested that yoga enhances PFT values by strengthening respiratory muscles, clearing respiratory secretions, and optimizing the use of diaphragmatic and abdominal muscles. Additionally, Nadisodhana pranayama may improve PFT values by increasing thoracic-pulmonary compliance and inducing bronchodilation. Lung stretching during deep breathing stimulates pulmonary stretch receptors, which reflexively relax the smooth muscles of the larynx and tracheobronchial tree, likely reducing airway resistance by modulating airway diameter [23].

The efficacy of unilateral nostril breathing has been explored in clinical trials. Friedell conducted the first clinical trial in 1948, investigating alternating nasal breathing in 38 patients with rhinitis and sinusitis. The study found significant symptom relief and a reduced need for steroidal nasal sprays. As a modified form of nasal breathing, AVP enhances ciliary oxygenation by increasing surface oxygen availability and boosting nitric oxide (NO) production, which improves mucociliary function. Humming, a technique similar to AVP, has also been shown to increase NO levels in the nasal cavity. By enhancing both surface and systemic oxygen concentrations, AVP can effectively meet the ciliary demand for oxygenation [24].

In patients with chronic obstructive pulmonary disease (COPD), pranayama serves as both an adjunct therapy and a rehabilitation tool. This practice is a strategically designed, low-effort technique that becomes effortless with regular practice and is cost-free. Pranayama helps reopen nonfunctioning or blocked airways, promotes diaphragmatic breathing, and relieves strain on the diaphragm, the primary respiratory muscle. Abdominal breathing not only improves respiration and oxygenation but also enhances circulation. Deep and slow breathing aids in clearing secretions from diseased airways through enhanced ciliary activity, reducing inflammation in the respiratory passages [25].

Studies have demonstrated that pranayama practice leads to significant improvements in respiratory parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the FEV1/FVC ratio, and peak expiratory flow rate (PEFR). Additionally, it has been shown to reduce airway sensitivity, enhance respiratory muscle strength, and decrease absolute eosinophil counts in patients [22, 26].

While some studies have reported positive effects of yogic practices on lung function parameters, improvements in FVC, FEV1, and PEFR were minimal in our study after three months of yogic training. A rare case of pneumothorax induced by Kapalabhati pranayama has been reported, although no such complications were observed in our case study [27].

4. CONCLUSION

The coronavirus is a highly contagious virus that primarily targets the lungs, leading to significant morbidity and mortality worldwide. This study highlights the benefits of practicing AVP in alleviating respiratory complications in COVID-19 patients, such as reduced respiratory reserve, diminished lung capacity, fatigue, dyspnoea, chest discomfort,

anxiety, and related symptoms. Regular practice of pranayama not only promotes overall physical health but also supports optimal lung function.

5. LIMITATIONS

The objective of this study was to conduct a literature review on the effects of AVP in COVID-19 patients. The findings of this review suggest that while AVP can be systematically reviewed and analysed for its benefits in COVID-19 patients, other pranayama techniques such as Bhastrika and Kapalbhati may also be practiced regularly for their potential therapeutic effects.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

REFERENCE

1. Sarwal R, Dhamija RK, Jain K, Basavaraddi IV. Efficacy of Pranayama in preventing COVID-19 in exposed healthcare professionals: a randomized controlled trial.
2. Zhang S, Zhu Q, Zhan C, Cheng W, Mingfang X, Fang M, Fang L. Acupressure therapy and Liu Zi Jue Qigong for pulmonary function and quality of life in patients with severe novel coronavirus pneumonia (COVID-19): a study protocol for a randomized controlled trial. Trials. 2020 Dec;21(1):1-1.
3. Xia W, Zhan C, Liu S, Yin Z, Wang J, Chong Y, Zheng C, Fang X, Cheng W, Reinhardt JD. Effectiveness of a telerehabilitation program for COVID-19 survivors (TERECO) on exercise capacity, pulmonary function, lower limb muscle strength, and quality of life: a randomised controlled trial. medRxiv. 2021 Jan 1.
4. Liu K, Zhang W, Yang Y, Zhang J, Li Y, Chen Y. Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study. Complement Ther Clin Pract. 2020 May 1;39:101166.
5. Novaes MM, Palhano-Fontes F, Onias H, Andrade KC, Lobão-Soares B, Arruda-Sanchez T, Kozasa EH, Santaella DF, de Araujo DB. Effects of yoga respiratory practice (Bhastrika pranayama) on anxiety, affect, and brain functional connectivity and activity: a randomized controlled trial. Front Psychiatry. 2020:467.
6. Cramer H, Lauche R, Anheyer D, Pilkington K, de Manincor M, Dobos G, Ward L. Yoga for anxiety: A systematic review and meta-analysis of randomized controlled trials. Depress Anxiety. 2018 Sep;35(9):830-43.
7. Ranjita R, Hankey A, Nagendra HR, Mohanty S. Yoga-based pulmonary rehabilitation for the management of dyspnea in coal miners with chronic obstructive pulmonary disease: a randomized controlled trial. J Ayurveda Integr Med. 2016 Jul 1;7(3):158-66.

8. Dhruva A, Miaskowski C, Abrams D, Acree M, Cooper B, Goodman S, Hecht FM. Yoga breathing for cancer chemotherapy–associated symptoms and quality of life: results of a pilot randomized controlled trial. J Altern Complement Med. 2012 May 1;18(5):473-9.
9. Chakrabarty J, Vidyasagar MS, Fernandes D, Mayya S. Emotional aspects and pranayama in breast cancer patients undergoing radiation therapy: A randomized controlled trial. Asia Pac J Oncol Nurs. 2016 Apr 1;3(2):199-204.
10. Bidgoli MM, Taghadosi M, Gilasi H, Farokhian A. The effect of sukha pranayama on anxiety in patients undergoing coronary angiography: a single-blind randomized controlled trial. J Cardiovasc Thorac Res. 2016;8(4):170.
11. Andrews N. The effect of yoga as an adjunct to home-based exercise on pain, disability, and quality of life in people with chronic non-specific neck pain: A randomised controlled trial (Master's thesis).
12. Rationale of Anulom Vilom, the Practice of Alternate Nostril Breathing. Acta Sci Med Sci. 2024 June;8(7):176-184. DOI:10.31080/ASMS.2024.08.1858.
13. Corona G, Pizzocaro A, Vena W, Rastrelli G, Semeraro F, Isidori AM, Pivonello R, Salonia A, Sforza A, Maggi M. Diabetes is most important cause for mortality in COVID-19 hospitalized patients: Systematic review and meta-analysis. Rev Endocr Metab Disord. 2021 Jun;22(2):275-96.
14. Singh AK, Gillies CL, Singh R, Singh A, Chudasama Y, Coles B, Seidu S, Zaccardi F, Davies MJ, Khunti K. Prevalence of co-morbidities and their association with mortality in patients with COVID-19: a systematic review and meta-analysis. Diabetes Obes Metab. 2020 Oct;22(10):1915-24.

15. Javanmardi F, Keshavarzi A, Akbari A, Emami A, Pirbonyeh N. Prevalence of underlying diseases in died cases of COVID-19: A systematic review and meta-analysis. PLoS One. 2020 Oct 23;15(10):e0241265.
16. Pranata R, Huang I, Lim MA, Wahjoepramono EJ, July J. Impact of cerebrovascular and cardiovascular diseases on mortality and severity of COVID-19–systematic review, meta-analysis, and meta-regression. Journal of Stroke and Cerebrovascular Diseases. 2020 Aug 1;29(8):104949.
17. Pandey P, Savita Agarwal R. Lung pathology in COVID-19: A systematic review. Int J Appl Basic Med Res. 2020 Oct;10(4):226.
18. Polak SB, Van Gool IC, Cohen D, von der Thüsen JH, van Paassen J. A systematic review of pathological findings in COVID-19: a pathophysiological timeline and possible mechanisms of disease progression. Mod Pathol. 2020 Nov;33(11):2128-38.
19. Torres-Castro R, Vasconcello-Castillo L, Alsina-Restoy X, Solís-Navarro L, Burgos F, Puppo H, Vilaro J. Respiratory function in patients post-infection by COVID-19: a systematic review and meta-analysis. Pulmonology. 2021 Jul 1;27(4):328-37.
20. Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. Acta Paediatr. 2020 Jun;109(6):1088-95.
21. Qiu P, Zhou Y, Wang F, Wang H, Zhang M, Pan X, Zhao Q, Liu J. Clinical characteristics, laboratory outcome characteristics, comorbidities, and complications of related COVID-19 deceased: a systematic review and meta-analysis. Aging Clin Exp Res. 2020 Sep;32(9):1869-78.
22. Ghiya S. Alternate nostril breathing: a systematic review of clinical trials. Int J Res Med Sci. 2017 Aug;5(8):3273-86.
23. Dinesh T, Gaur GS, Sharma VK, Madanmohan T, Kumar KH, Bhavanani AB. Comparative effect of 12 weeks of slow and fast pranayama training on pulmonary

function in young, healthy volunteers: A randomized controlled trial. Int J Yoga. 2015 Jan;8(1):22.

24. Bhardwaj A, Sharma MK, Gupta M. Endoscopic evaluation of therapeutic effects of “Anuloma-Viloma Pranayama” in Pratishyaya wsr to mucociliary clearance mechanism and Bernoulli's principle. Ayu. 2013 Oct;34(4):361.
25. Gupta A, Gupta R, Sood S, Arkham M. Pranayam for treatment of chronic obstructive pulmonary disease: Results from a randomized, controlled trial. Integr Med (Encinitas). 2014 Feb;13(1):26.
26. Yüce GE, Taşcı S. Effect of pranayama breathing technique on asthma control, pulmonary function, and quality of life: A single-blind, randomized, controlled trial. Complement Ther Clin Pract. 2020 Feb;38:101081. DOI:10.1016/j.ctcp.2019.101081.
27. Katiyar SK, Bihari S. Role of pranayama in rehabilitation of COPD patients-a randomized controlled study. Indian J Allergy Asthma Immunol. 2006;20(2):98-104.