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Research Article

Influence of a Novel Nostril Breathing Technique on Lung Function among Experienced Practitioners of Yogic Breathing

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Abstract

Objective: Lung function is a significant indicator of one's health status and there is sufficient evidence demonstrating how Yogic breathing improves it among regular practitioners. However, it is unclear whether additional improvement is observed, by learning an entirely new breathing technique. We hypothesized that lung function improves further with a novel nostril breathing technique.

Methods: Prospective observational study with 80 regular adult experienced practitioners of breathing technique Sudarshan Kriya Yoga (SKY) who learnt a novel nostril breathing technique named Bhogar Pranayama (BP), during an 8day program with outcome measure being changes in lung function indices, Forced Expiratory Volume in first second (FEV1), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR).

Results: Mean FEV1 improved from 2.565 to 2.630 liters ($p < 0.001$), mean FVC 3.08 to 3.256 liters ($p < 0.001$) and mean PEFR 413.24 to 447.36 liters/min ($p < 0.001$) respectively. FEV1 improved much more in participants above 50 years as compared to younger subjects. FVC showed significant improvement (171 ml) in older participants with 10 or more years practice than less experienced and younger practitioners (98 ml).

Conclusion: FEV1, FVC, and PEFR, all showed statistically significant improvement with Bhogar Pranayam in normal healthy adults previously practicing Yogic breathing regularly, with improvement observed within all age groups and genders, including long term practitioners aged above 50 years. Regular practice of this novel nostril breathing technique can be of potential benefit for better lung function maintenance, reducing lung function decline in elderly and also among patients with respiratory disorders, obstructive airway diseases in particular.

Keywords: *Yogic Breathing; Lung Function; Breathing Exercise; Sudarshan Kriya Yoga; Yogic Practitioners*

Abbreviations

SKY: Sudarshan Kriya Yoga; BP: Bhogar Pranayama; ANB: Alternate Nostril Breathing; ASTM: Automatic Self-Transcending Meditation

Introduction

Integrative medicine focuses on utilizing and combining appropriate conventional and non-mainstream therapeutic approaches to maintain health and well-being. One of the most popular and well-researched interventions is Yoga [1], being practiced worldwide with more acceptance and also found to be safe and effective [2]. The scientific inquiry on yoga's health effects has grown considerably in the past few decades, with more rigorous studies being published [3-6]. The three widely investigated modes in yoga are pranayama (voluntary breath modulation or yogic breathing), asanas (yogic postures) and meditation.

The mechanism of breathing involves complex neural interactions. Though primarily an autonomic physiological activity, the breath can also be modified voluntarily. The science of yogic breathing, mentioned in ancient Indian scriptures dating back to more than 3000 years, explains the influence of various breath modifications on the body and the mind. Conscious breath control may bring the sympathetic and the parasympathetic nervous systems into harmony and there is supporting evidence that pranayama alters the brain's information processing, including the autonomic system, limbic system and cortex [7-9]. A detailed review of the neurophysiologic mechanisms of slow deep breathing explains how the patterns of pulmonary afferent activity during breathing can contribute to physiological relaxation by neural induction [10]. The health impacts of yoga and pranayama are well described in numerous reviews [11,12]. A widely studied and unique breathing intervention that has aroused worldwide interest is Sudarshan Kriya Yoga (SKY), comprising of breathing exercises inclusive of a specific rhythmic controlled breathing maneuver performed in a sequential manner. SKY, which also includes yoga asanas and meditative components, has shown to have a significant physiologic and psychological impact in various published studies [13,14]. Another well-researched pranayama technique is alternate nostril breathing (ANB) which involves breathing through one nostril at a time while closing the other nostril manually [15]. ANB influences various physiological processes, the autonomic nervous system balance, neurocognitive and cardiorespiratory functions in particular [16]. It is also important to note that, even in nostril breathing techniques, there are multiple variations based on the inhalation exhalation ratio, breath-holding time and side of the nostril used.

Yogic postures (asanas) studied at length have shown useful psychophysiological effects both in healthy and in people compromised by musculoskeletal and cardiopulmonary diseases [13,17]. The other widely researched complementary intervention is Meditation, which is shown to improve various bodily functions [18,19], increasingly being accepted as an effective modality for stress reduction and to improve well-being among chronic illness patients [20-22].

Lung function is a significant indicator of one's health status, notably the respiratory, cardiovascular, and neurohormonal wellbeing [23]. Commonly measured indices of lung function are Forced Expiratory Volume in the first second (FEV1), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rates (PEFR). The NHANES study, the Buffalo health study, and the Whitehall-II cohort study have clearly demonstrated that poor lung function, often characterized by low FEV1, is a well-established predictor of mortality [24-26]. Inflammation is considered to play a significant role in mediating the lung function and mortality association [27] although other multiple processes may be linked too. Different breathing techniques, when practiced alone or in combination with yogic exercises and meditation, have been shown to improve respiratory health, with ample literature evidence that these interventions improve lung function [28-31]. A systematic review of Yoga practice to determine improvement in pulmonary function in apparently healthy individuals found positive results in all except one study [32]. Most studies focused on improvement after a few weeks of yoga and/or pranayama in normal healthy adults with no previous practice history [33,34]. Studies have also shown improvement in patients with asthma [35-39], chronic obstructive pulmonary disease (COPD) and with cardiovascular diseases [40-43].

Though there is enough evidence demonstrating how regular practice of yoga and breathing exercises improves lung function, it is not certain if there will be an additional improvement observed when these practitioners learn a completely new breathing technique. We hypothesized that lung function improves further with a novel nostril breathing technique and also intended to analyze if age, gender and duration of previous practices have any impact.

Materials and Methods

Participants: Healthy adults who are regular practitioners of Yogic breathing (SKY) for more than 3 years, were enrolled for the 8-day program. The criteria for regularity were taken as practicing SKY and meditation (Automatic Self Transcending Meditation - ASTM) 3 or more days in a week. We excluded participants with a history of active or chronic respiratory diseases, uncontrolled hypertension, associated cardiovascular diseases, diabetes mellitus, thyroid disorders, and present or past smokers. We selected a sample of 80 adults

between the ages of 20 to 70 years (37 females and 43 males) for the final analysis and they all fulfilled the American Thoracic Society (ATS) criteria for normal spirometry i.e. FEV1, FVC and PEFR > 80% of predicted and above the Lower Limit of Normal (LLN) values.

Nostril breathing technique: The study intended to observe for further improvement in lung function among previous practitioners, after they underwent an 8-day comprehensive residential program conducted at the Art of Living International Center, Bengaluru, India. The main component of the program was Bhogar Pranayama (BP), a unique nostril breathing technique, cognized many centuries ago by an ancient saint, Bhogar who lived in Southern India. BP was introduced to participants for the first time and this involves the process of inhalation from left nostril for a count of 2 followed by a breath-holding stage for 4 counts, then exhalation for 1 count through the right nostril, finally ending with breath-holding for 4 counts (2:4:1:4 sequence), before repeating the same sequence to complete a total session time of 5 minutes. The participants were taught BP by experienced teachers of yoga and pranayama, on the day 1 of the course and the correctness of technique was corroborated well. Since they already had the practice of doing the SKY breathing processes earlier, it was fairly easy for them to learn a new breathing method. All of them completed 12 such sessions in a day, adding up to a total daily duration of around 60 minutes. Their schedule also comprised of daily practice of SKY, yogic postures and ASTM.

Study procedure: The Ethics Committee of Sri Sri Institute for Advanced Research, Bengaluru, India approved the study. The participants' lung function was measured by Spirometry (Spiro USB of Care Fusion Medical) and performed by trained volunteers under the active and direct supervision of an experienced pulmonologist. A filled questionnaire was collected along with participants' written consent (They were given 1 hour to read and sign the consent form) before the initial spirometry. The testing was repeated at the end of the 8-day program. The study followed the necessary safety and quality control measures, including good clinical practice guidelines as per the Helsinki protocol.

Statistical analysis: The primary outcome measure was a change in the lung function indices FEV1, FVC, and PEFR. Using the spirometry recorded data of pre and post values, expressed as means ± standard deviations, a detailed analysis was done. The data analysis observing for any differences based on age, gender, duration of yogic practices, and body mass index (BMI) was also performed by using the SAS Version 9 statistical software (SAS Institute, Cary, NC). Statistical significance was determined based on a p-value < 0.05.

Results

Effect of breathing intervention on lung function of total participants: The study group consisted of 80 participants with a mean age of 44 ± 10 years. There were 43 males (54%) with a mean age of 42.81 ± 10.86 years and 37 females (46%) with a mean age of 46.3 ± 9.22 years (p = 0.125). The lung function indices FEV1, FVC, and PEFR, were analyzed in detail before and after the 8-day program (Table 1).

Measure	Pre	Post	Mean Difference	% change	P value
FEV1	2.565 ± 0.65	2.63 ± 0.68	0.065	2.53%	0.000440
FEV1 % predicted	94.5 ± 11.68	96.789 ± 11.56	2.289	2.42%	0.000050
FVC	3.089 ± 11.56	3.256 ± 0.82	0.167	5.41%	0.000000
FVC % predicted	95.11 ± 0.82	100.64 ± 0.81	5.530	5.81%	0.000000
PEFR	415.76 ± 0.81	447.36 ± 11.08	31.600	7.60%	0.000000
PEFR % predicted	94.93 ± 11.08	102.74 ± 11.68	7.810	8.23%	0.000000

Table 1: *Analyzes the 3 main lung function parameters FEV1, FVC and PEFR.*

The Mean FEV1 changed from 2.565 Liters(L) to 2.630L, an improvement of 65 ml ($p < 0.001$), the mean FVC from 3.08L to 3.256L, an improvement of 167 ml ($p < 0.001$) and PEFR mean improved from 413.24 L/min to 447.36 L/min, a difference of 34.13 L/min ($p < 0.001$). The FEV1 improved from 2.09L to 2.16L in females and from 2.98L to 3.03L in males, while FVC improved from 2.50L to 2.66L in females, from 3.60L to 3.76L in males. The PEFR improved from 330.87 L/min to 371.16 L/min and from 484.12 L/min to 512.93 L/min in females and males respectively, both showing similar improvement, with no significant gender difference noted (NS) (Table 2).

Measure	Pre		Post		Improvement in ml		Mean Difference improvement by gender	P value
	Male	Female	Male	Female	Male	Female		
FEV1	2.9763	2.0862	3.032	2.163	55.7	76.8	21.0	0.577
FVC	3.599	2.496	3.765	2.665	166.0	169.0	3.0	0.931
PEFR	484.12	336.32	512.93	371.16	28.8	34.8	6.0	0.564

Table 2: *Shows the improvement in lung function among male and female participants.*

Lung function improvement in different age groups: We divided the participants into 3 groups based on age: 20 - 30 years, 30 - 50 years and 50 - 70 years, to observe for any differences (Figure 1a and 1b). In the 20-30 years group, FEV1 improved by 66 ml and for PEFR, a mean difference of 27.6 L /min ($p > 0.05$). The FVC, however, showed a significant mean difference of 80 ml ($p < 0.05$). In the other two groups, all indices showed a statistically significant difference with FEV1 having improved much more among those above 50 years (mean difference of 85 ml) compared to 56 ml in those less than 50 years ($p < 0.05$).

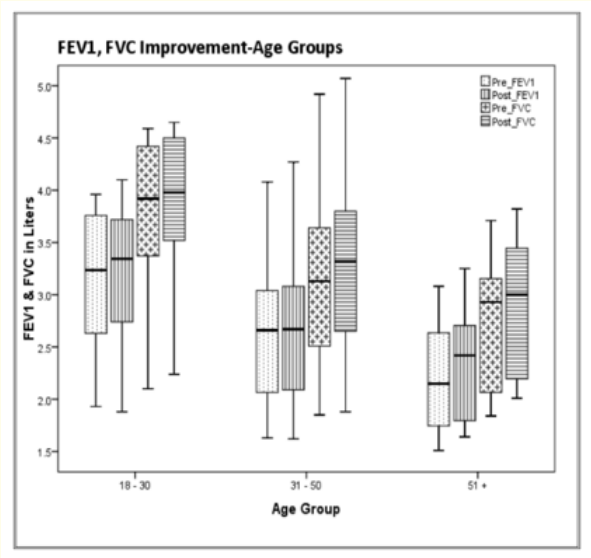

Figure 1a: *Shows the improvement in FEV1 and FVC by age group.*

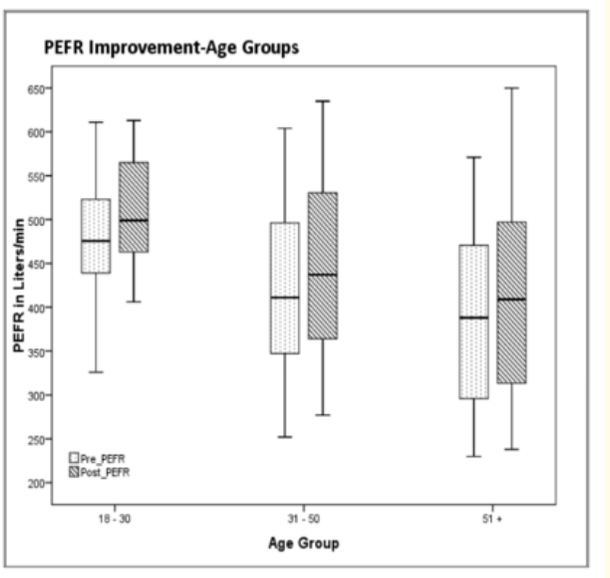

Figure 1b: *Shows the improvement in PEFR by age group.*

Influence of previous years of practice on lung function: We also analyzed the lung function indices based on participants' years of practice. Overall, each of the 3 indices improved significantly among the practitioners (Figure 2a and 2b). Even among the more experienced (> 10 years practice), despite having already higher values prior to the course, there was a significant improvement in all measures. There was also a significant difference in FVC among experienced practitioners in the above 50 years age group when compared to those practicing less than 10 years and aged below 30 years (171 ml versus 98 ml, a 73ml change with $p < 0.0001$) (Figure 3).

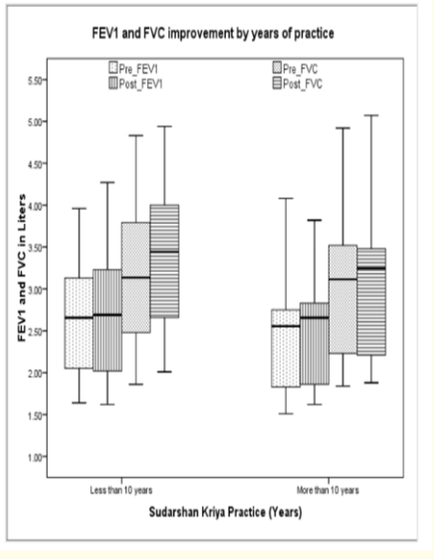

Figure 2a

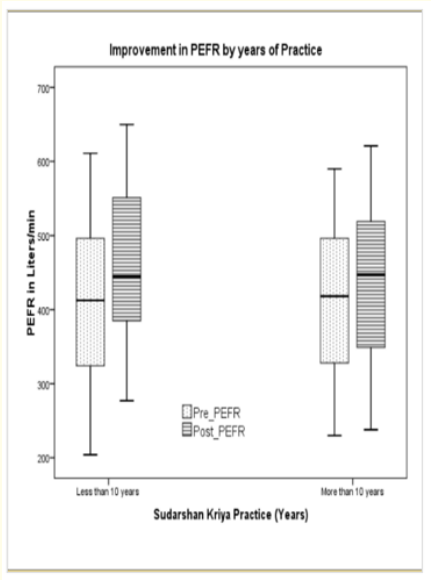

Figure 2b

Figure 2: *Shows improvement in FEV1, FVC (a) and PEFR (b) based on the years of practice.*

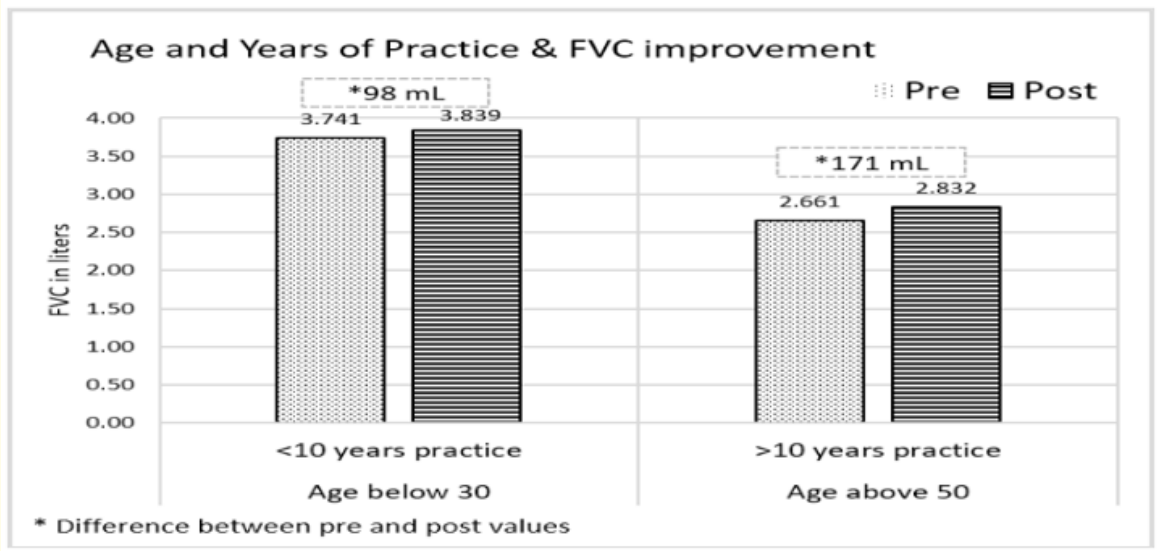

Figure 3: *Shows improvement in FVC by age and years of practice. This comparison is specifically done for participants above 50 and below 30.*

Influence of BMI on lung function: Based on the body mass index (BMI), participants were categorized into 4 groups - group 1. below 20, group 2. 20 to 24.9, group 3. 25 to 29.9 and group 4. above 30. In relation to BMI, the participants in groups 2 and 3 both showed statistically significant improvement ($p < 0.05$) (Figure 4a and 4b).

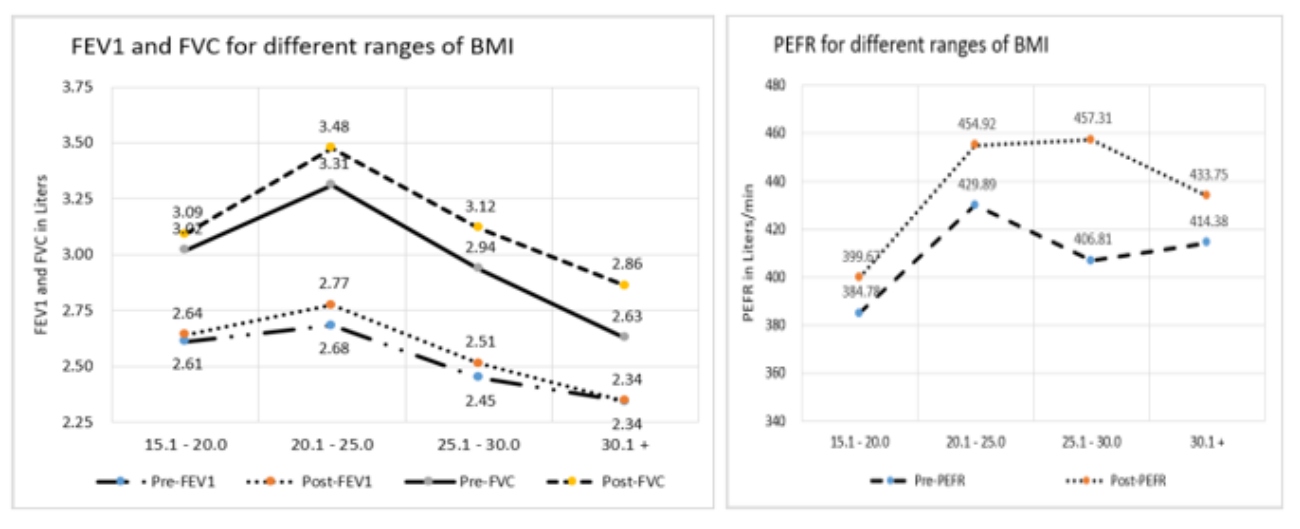

Figure 4: *Shows improvement in FEV1, FVC and PEFR for different ranges of BMI.*

Discussion

We demonstrated in this study that all measured lung function indices FEV1, FVC and PEFR showed statistically significant improvement among the participants, who learned for the first time a unique novel nostril breathing technique. Though this is in agreement with previous studies on yogic practices showing lung function enhancement [44-46] to the best of our knowledge, there is no literature evidence suggesting that further improvement in lung function can be noticed with the introduction of a completely new breathing technique among healthy adults, already experienced in such practices. Despite the participants already having high mean predicted values (> 94%) for all lung function indices before the program, yet there was a statistically significant improvement overall. There are indeed some studies that showed such improvement in lung function with yogic techniques among trained athletes, swimmers, and martial arts exponents [47].

There was a statistically significant improvement in both males and females, in all measured indices, with no difference between them, though few studies have observed some variable effects with other exercises [48,49]. Most of the participants had normal BMI range and even in the 25 to 30 BMI group, there was a significant improvement of all indices. This correlates well with the previous studies' observation that BMI up to 30 does not influence lung function [50].

Lung function improvement in the elderly

The improvement in lung function was much more substantial among the practitioners above 50 years (a mean difference of 85 ml in FEV1) compared to a mean difference of 56 ml in the less than 50 years age group. Similar training in elderly participants aged

65 and above has previously shown improvement in lung volumes and capacities [51]. Other studies also showed positive outcomes among various age groups, including the elderly with some suggesting that the benefits of yoga may exceed those of the conventional exercise interventions for health status, aerobic fitness, and strength in the elderly [52,53]. The lung function reduces gradually as one ages [54,55] and interventions that may potentially reduce this decline can be of great benefit for the elderly population in keeping up better respiratory and cardiovascular health. This was demonstrated in a 25-year Finnish follow-up study, associating physical activity with a slower decline in pulmonary function and with lower mortality, thus recommending exercise in middle-aged and elderly people [56]. We, therefore, propose that in addition to improvement in lung function as shown in previous studies, yogic breathing interventions may also impact positively the slowing of normal yearly lung function decline in regular elderly practitioners. The FVC improved much more among participants above 50 years and with more than 10 years of practice, as compared to those below 30 years with the lesser practice. Though, one is likely to expect that these long-term practitioners may not show noticeable improvement since their lung function would have already peaked, all the measures improved significantly in our study.

Nostril breathing techniques and lung function

A systematic literature review of various clinical trials on ANB [15] showed that in seven out of eight studies that primarily evaluated its effects on pulmonary function tests (PFTs), PEFR increased significantly. Other PFTs including FVC, FEV1 also improved after regular practice of ANB [57]. The mechanisms leading to this improvement include increased utilization of physiological dead space, small airways opening, enhanced respiratory muscle strength by increased inflation and deflation of the lungs and chest, relaxation of smooth muscles in the larynx and tracheobronchial tree modulating the airway caliber, thereby reducing airway resistance and clearance of airway secretions [15,16].

Bhogar Pranayama (BP), learned and practiced for the first time in our study is unique in terms of the inhalation exhalation ratio and the duration of each breathing cycle. It is similar to another well studied pranayama technique, the Chandra Bhedana Pranayama (CBP) [58] where the inhalation is always initiated from the left nostril and exhalation through the right in a 1:2 ratio, with or without pauses between both phases of respiration. However, BP, though it has left nostril inhalation and right nostril exhalation like in CBP, differs in terms of both the inhalation and exhalation phases being followed by breath retention phases in a 2:4:1:4 sequence. Moreover, both these maneuvers are in an actual sense, not ANB techniques, since there is no alternation in the nostrils for inhalation and exhalation. This may likely have a distinctive positive influence on lung function as compared to earlier ANB processes, though we could not do this comparison in our present study. Hence, it remains to be seen how randomized controlled studies, which we intend to do in the future, designed with this potentially effective novel nostril breathing technique, with no previously reported literature evidence, and also in comparison with other ANB techniques, will have an impact when studied for a longer duration of at least 2 to 3 months.

Influence of breathing techniques on lung function and possible mechanisms

In addition to factors like age, sex, race and height, lung function is also influenced by lung elasticity, lung recoil, and chest elasticity balance, thoracic and abdominal muscle strength, individual posture, etc [59]. These factors could play a major role in the pulmonary function improvement observed with yoga and breathing practices. Slow deep breathing influences diaphragmatic action in particular and facilitates greater excursion. Magnetic Resonance Imaging (MRI) studies have shown a positive correlation between the degree of diaphragmatic movement and lung volumes [60]. Altering the pattern of breathing may influence airway smooth muscle dynamics leading to bronchodilation [61], alveolar distention and recruitment. Lung inflation near total lung capacity is a major physiological stimulus for lung surfactant release [62] and prostaglandins into the alveolar spaces. Respiratory muscle training has been shown to enhance performance in healthy individuals with greater improvements in less fit individuals and in sports of longer durations. There is literature evidence of meaningful improvement in lung function with yogic techniques even among previously trained athletes, martial arts

exponents and athletes [47]. During pranayama practice, regular inspiration and expiration for prolonged periods facilitate maximum inflation and deflation of lungs, causing strengthening and increased endurance of respiratory muscles, thereby influencing lung function [63]. The stretch receptors reflex decreases the tracheal and bronchial smooth muscle tone activity, leading to decreased airflow resistance and increased airway caliber, thus improving lung function. Slow deep breathing also induces a significant improvement in ventilation efficiency by increasing oxygen saturation among healthy participants exposed to high altitude [64] most likely by reducing dead space and increasing alveolar ventilation.

Most of the earlier series studied periods of practice for more than 6 weeks, whereas some noted that changes become more evident after 10 weeks and more relevant in people without previous experience in yoga [32,65]. While no study has so far looked at the ideal practice duration among practitioners with adequate prior experience, this study demonstrates that even a comprehensive program as short as 8 days, if the intervention is effective, can have a significant influence on their lung function. A similar study done earlier on SKY showed a statistically significant improvement in FVC within 1 week of learning the process for the first time [35].

Study Limitations

This study has some limitations. First, there was no comparative group practicing other physical exercises or relaxation methods, against this sample of highly motivated volunteers. Second, we could not perform elaborate pulmonary function tests, including lung volumes, inspiratory and expiratory pressures, breath-holding time, lung diffusion, etc. Third, since the participants also practiced some other processes along with the alternate breathing technique, like yogic postures and meditation, they could have been the confounding factors with an influence on the lung function measures. However, since these practices had already been a part of their regular routine previously at least for few years, unlike the newly learnt BP, they may not have a measurable impact. Fourth, this program was conducted for a very short duration of 8 days, and further, follow up of participants would have been very helpful, to assess for long term benefit. Finally, since the participants' previous experience varied from 3 years to as long as 20 years, it needs to be seen if there will be notable differences based on the duration of practice when followed up for a longer time. Hence, larger and long-term randomized control trials are required in the future.

Conclusion

There was a statistically significant increase in the lung function indices FEV1, FVC and PEFR after an 8-day comprehensive course that included learning a novel nostril breathing technique among normal healthy adult practitioners of SKY. This improvement was observed across all age groups and gender, including long-term practitioners and those above 50 years. More research is needed to understand how yogic breathing methods can elicit beneficial health outcomes. These are cost-effective and easy to perform interventions, which can positively influence the body physiology. We believe that regular practice of such techniques maintains better lung function in healthy adults and facilitates a reduction in lung function decline. This may have positive implications in the community with the potential for such techniques to act as an active and effective adjunctive therapeutic modality in managing chronic respiratory illnesses, obstructive airway diseases in particular.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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