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Effect of Selected Pranayama Practice on Pulmonary Function Tests In Adult Volunteers: A Prospective Interventional Study

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Abstract
Background: Pranayama is an ancient breathing technique that originates from yogic practices in India. It's a panacea to the modern stress world. Pranayama is the art of controlling the life force of breath. It rejuvenates the body, achieved through the art of breathing which controls our breath with different styles and lengths and has a direct bearing on the basal metabolic rate and the span of longevity. Pranayama is acknowledged to improve lung function and cardiac health.
Objectives: The present study evaluates the effect of 10 days and 30 days of pranayama practice on pulmonary functions in adult volunteers.
Methods: 40 healthy male volunteers of the age group between 18 – 30 were included in this study. The participants practiced pranayama like pranava, nadisuddhi,kapalabhati, bhastrika, and savitri pranayama,1 hour daily, for 6 days per week, for a total of 30 days of duration. Pulmonary function tests were recorded before the practice of pranayama and after 10 days of practice and followed after 30 days of pranayama practice for the same group of individuals.
Results: Pulmonary function parameters were gradually increased after 10 days of practice and 30 days of practice. Among the pulmonary parameters, the Forced vital capacity (FVC), Forced Expiratory Volume in 1st second (FEV1), and Maximum ventilation volume (MVV) and also the FEVI/FVC% were found to be statistically significant ($P<0.0001$).
Conclusion: In this study, the adult volunteers practiced selected pranayama techniques. The practice of pranayama increased the pulmonary function parameters like FVC, FEV1, FEV1/FVC, and MVV for a minimum period of 10 days to 30 days. Hence pranayama may be adopted as the best lifestyle modification to prevent lung diseases and to improve lung function.

Keywords: Yoga, pranayama, Pulmonary function tests, Pranav, Nadi Shuddhi, kapalabhati, bhastrika, lung function.

Introduction

Yoga, a scientific-spiritual discipline is the ancient heritage of India that has given answers to spiritual and holistic search for perfect health and well-being. Yoga is commonly perceived and has become a very popular alternative medicine for its minimal expenditure and simplicity. A theoretical explanation of benefits attained by yoga was proposed by Streeter et al wherein yoga reduces the allostatic load in stress response systems such that optimal homeostasis is restored [1]. *Yogam* is the harmonization of mind and body, Whichhas various facets explained in Siddha literature has eight steps-*Astaangayogam*. and the main techniques that are useful to modern man are yoga asanapranayams, dharana, and dhyana. Pranayama is one of the eight limbs of yoga. Pranayama is an important breathing technique that helps to relax physical and mental health [2]. Pranayama is a conscious prolongation of inhalation, retention, and exhalation. Pranayam is the conscious awareness of breath and it refers to breathing exercises that remove physical and mental impediments in our bodies with the breath. The practice of pranayama plays a role in cardiovascular functions such as the regulation of rhythm, heart rate, and blood pressure. In the respiratory system, it increases the strength of respiratory muscles, clears the respiratory tracts, and supplies proper oxygen to the tissues. It increases cognitive function and reduces the effect of stress and strain on the body [3]. The pranayama practice may decrease the physiological dead space, henceforth reducing the work of breathing. It makes the diaphragm and abdominal muscles stronger and more efficient which facilitates pulmonary functions [4]. Pranayama has optimistic effects on disease conditions like chronic bronchitis, asthma, rhinitis, and other diseases like obesity, diabetes, hypertension, heart attack, allergy, anxiety disorders, and cancer [5]. The most commonly practiced pranayama techniques are Pranav and Nadisuddhi or Nadi Shodana. It reduces stress, improves oxygenation in the lungs, and relieves respiratory symptoms.Whereas in Bhastrika, breath is exhaled forcibly and quickly improves the respiratory system. Meanwhile,Kapalabhati is quick exhalation and natural inhalation. It cleans the

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respiratory tract and reduces diseases like asthma, respiratory troubles, allergies, sinusitis, etc. Pulmonary function test is a non-invasive, simple test that assesses, screens, and monitors respiratory function [6]. This study was planned to investigate the combined effect of Pranav, Nadisuddhi, Kapalabhati, Savitri pranayama, and Bhastrika during 10 days and 30 days of pranayama practice in adult male volunteers.

Methodology: This is a prospective interventional study conducted in the Department of Physiology at Dhanalakshmi Srinivasan Medical College and Hospital, Perambalur, Tamil Nadu. The study was initiated after obtaining the Institutional Human Ethical Committee's approval. Study procedures are explained to all the volunteers included in the study. The study was conducted after obtaining written informed consent from all the study participants. A total of 40 adult volunteers of the age group between 18 to30 were recruited for the study. The participants are selected, based on the proforma questionnaire which contains basic details like height, weight, and occupation. The study participants are recruited from training students, management, and office staff working in our Institution. All the participants were included in as study group and given pranayama intervention for a stipulated duration. The pranayama breathing practice includes Pranava, Nadishuddi, Kapalbhati, Bhastrika, and Savitri Pranayama training for 1 hour daily, for consecutive 30 days. The pre-intervention recording of the pulmonary parameters was done at the beginning of the practice. The next phase of the recording was done after 10 days weeks of the regular pranayama practice. The final recording was done at the end of days of practice of pranayama. The pranayama practice was done for around 50 - 60 minutes per day in the morning (6.30 am to 7.30 am),
Inclusion criteria:
Male adults of the age group between18 to 30 were included in the study.

Exclusion criteria:
- Females are excluded because of procedural constraints.
- Participants with exposure or practice of yoga for the past 6 months.
- Participants with diseases like asthma, COPD, emphysema, chest deformities, chest pain, cardiac diseases, hypertension, and diabetes are excluded
- Participants with smoking and/or alcohol consumption,
- Participants doing regular exercise or gym exercise.
- Athletes
- Treatment with beta-agonists or the Xanthenes group of drugs

The sample size calculated was based on the FVC value by Dinesh et al [7]. The estimated mean Alpha error was 0.05 and the estimated standard deviation was 0.17. The estimated sample size was 40, with an attrition rate of 10%.

Pranayama Breathing techniques
All the participants were assembled at a specific time in the evening between 6 to 6.30 am.The subjects were instructed to wear a loose dress and avoid heavy foods. Pranayama procedures were explained to all the study participants. After completion of warm-up training, they proceeded to pranayama breathing. The participants underwent the pranayama breathing practice under the supervision of a certified yoga trainer. The training continued for 30 days till the completion of the study. All pranayama practices were done in Padmasana posture.

Instructions for the practice of Pranav
The participants were instructed to sit in padmasana. Asked to close their eyes and instructed to keep their spine and head straight. Keep their index and thumb fingers touching each other in the 'Chin Mudra' position. The other fingers are instructed to keep straight and united. Then asked to take a deep breath into the lower chest and abdominal regions with a count for 4 seconds focusing on their normal breathing as they inhaled and exhaled and then asked to let out a breath with the sound AAAA.

Instructions for practice of Savitri pranayama
The participants are asked to Inhale for a 6-count (8 seconds) and then asked to hold their breath for a 3-count (4 seconds) and then asked to Exhale for a 6-count (8 seconds). Then instructed to Hold out for a 3-count (4 seconds) before the next breath. This cycle is repeated 9 times.

Instructions for the practice of Nadi Shuddhi Pranayama (Alternate nostril breathing)
The participants were instructed to close the right nostril with the right thumb inhale slowly through the left nostril and inhale air to fill their lungs. After inhalation, close the left nostril with the ring finger of the right hand. Then asked to open the right nostril, and exhale slowly. After complete exhalation, again inhale through the right nostril and close it with the right thumb. Open the left nostril, and breathe out slowly. This practice was done was done in a sitting posture for 5 minutes.

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Instructions for the practice of Kapalbhati:
Kapalabhati was done in a sitting posture. In Kapalabhati quick exhalation and natural inhalation are intended. Exhale and simultaneously contract the abdomen muscles with each exhalation. Normally exhalation takes 1/4 of the time of inhalation. This Practice was done for 3 – 4 minutes

Instructions for the practice of Bhastrika:
This practice mainly emphasis on thoracic not abdominal breathing activity. Subjects were asked to take a deep inspiration followed by rapid expulsion of breath following one another in rapid succession. This is called as "bellow" type of breathing. Each round consisted of 10 such "bellows." After 10 expulsions, the final expulsion is followed by the deepest possible inhalation. Breath is suspended as long as it can be done with comfort. The deepest possible exhalation is done very slowly. This cycle completes one round of bhastrika.

Evaluation of lung function
The assessment of the pulmonary function was tested by using theMedspiror model (computerized spirometry)a self-calibrating digital spirometer that fulfills the criteria for standardized lung function tests. The participants were requested to avoid Coffee, Cold beverages, and Energy drinks and also perform vigorous exercise for 30 min before recording of parameters. In the standing posture, a nose clip was attached, a mouthpiece was placed in the mouth closed the lips around the mouthpiece, and asked the subject to breathe normally. Participants were asked to Inspire completely and rapidly with a pause of <2 seconds at total lung capacity. They are requested to expire with maximal effort until no more air can be expelled while maintaining an upright posture. They were asked to repeat for a minimum of three times, and not more than eight for adults. The pulmonary functions test (PFT) parameters FEV1 and FVC were recorded (ATS & ERS guideline) [8].
Day 0 - Before starting the pranayama practice. i.e. on the day of the study, before the start of pranayama practice.
Day 10 - The assessment during the study was done on the 10th day of the pranayama practice.
Day 30- The end of the study was made on the 30th day of the pranayama practice.

Statistical analysis:
The pulmonary function parameters are recorded from study participants. The statistical analysis was done using the data obtained by a one-way repeated ANOVA test to compare the parameters. The p-value < 0.05 is considered as significant.

Result
These baseline characteristics show the participants such as height and weight BMI, blood pressure, pulse rate, and SPO_2 were measured (Table 1).

Table1. Baseline characteristics of the participants

Baseline characteristics	**Mean ± SD**
Age	24.7 ± 6.4
Height	166.2 ±+6.8
Weight	63.8 ± 14.4
Pulse Rate	79 ± 10.4
BMI	23.9 ± 3.8
SBP	114.8 ± 10.2
DBP	76.8 ± 9.2
SPO_2	98.1 ± 1.6

The pulmonary functions test was recorded from the participants. The data obtained from the PFT parameters are expressed as Mean ± SD and also their F values and p values are tabulated (Table 2).Forced vital capacity (FVC) before the practice of pranayama was 3.26 ± 0.4 after 10 days of practice 3.7 ± 0.52 and following the practice for 30 days 3.74 ± 0.44showed a gradual increase in FVC value shown as statistically significant (P< 0.001). Forced expiratory volume in 1st second (FEV1) showed an increased value, before the practice (2.74+0.5) and after 10 days of practice 2.49± 0.38

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followed by 30 days of pranayama intervention 3.46 ± 0.48. FEV1 value was also found significant ($p < 0.0001$). Forced expiratory volume in 1st second / forced vital capacity % (FEV1/FVC%) was before pranayama practice (83.6 ± 4.8)and after 10 days of training (85.2 ± 6.2) and at the end of 30 days of pranayama practice (88.8 ± 9.8). FEV1/FVC was found to be statistically significant ($P< 0.012$).

The Peak Expiratory Flow Rate (PEFR%) value was increased after 10 days and after 30 days of practice but was not statistically significant ($P<0.092$). Mean while, the maximum mid-expiratory flow 25 -75 (MEF 25 -75) ($P< 0.091$), Forced expiratory flow 75% (FEF75%), Forced expiratory flow 50% (FEF50%), and Forced expiratory flow 25% (FEF25%), values were not statistically significant ($P< 0.604$), ($P< 0.054$), ($P< 0.089$), respectively. Whereas the Maximum ventilation volume (MVV%) values before the practice (88.2 + 6.4) and after 10 days (100.8 + 5.8) followed by 30 days (111.3+14.4)) of practice showed a gradual increase in MVV values and also showed a statistically significant difference ($P<0.0001$)

Table 2. Effect of pranayama practice before practice, after 10 days, and 30 days of practice

Pulmonary function Parameters	**Before Practice (n = 40)**	**After 10 days of practice (n = 40)**	**After 30 days of practice (n = 40)**	**F. value**	**P. value**
Forced Vital capacity (L)	3.26 ± 0.4	3.7 ± 0.52	3.74 ± 0.44	31.8	0.001*
Forced expiratory volume in 1st second (L)	2.86 ± 0.5	2.49 ± 0.38	3.46 ± 0.48	114.2	0.001*
FEV1/FVC%	83.6 ± 4.8	85.2 ± 6.2	88.8 ± 9.8	5.11	0.012*
Peak expiratory flow rate (L/s)	6.01 ±1.5	6.11 ±1.4	6.67 ± 1.6	6.82	0.092
Mid maximum expiratory flow 25 -75 (L/s)	3.69 ± 1.1	3.78 ± 0.9	3.16 ± 0.8	2.18	0.091
Forced expiratory flow 25 (L/s)	1.8 ± 0.7	2.02 ± 0.8	2.11 ± 0.7	2.29	0.089
Forced expiratory flow 50 (L/s)	4.28 ± 1.3	4.35 ± 1.2	4.4 ± 1.8	0.807	0. 054
Forced expiratory flow 75 (L/s)	5.63 ± 1.7	5.88 ±1.8	5.59 ± 1.4	0.45	0.604
Maximum ventilation volume %	86.4 ± 6.1	99.7 ± 5.6	109.3 ± 13.8	25.1	0.001*

Discussion

The present study evaluates the effect of 10 days and 30 days of pranayama practice on pulmonary function tests. There was an increase in all the parameters like FVC, FEV1, FEV1/FVC%, PEFR, MEF 25-75, FEF25%, FEF50FEF75%, and MVV after 10 days and following 30 days of practice. Parameters FVC, FEV1, FEV1 /FVC % and MVV were found significant. A previous study conducted by Sivapriya et al had similar findings, The respiratory parameters FVC, FEV1, FEV1/FVC, and MVV showed a significant increase, similar to our study [9]. A study conducted by Sivakumar et al., reported that Forced vital capacity significantly increased after 2 minutes of deep breathing exercise for a week and observed a trend towards an increase in FEV1 and PEFR. Similar results were observed in this current study. An increase in FVC could be due to a possible increase in surfactant levels, as a result of deep inhalations. Even 2 minutes of deep

breathing might be good enough to bring about a significant release of surfactant, which will increase lung compliance during the Inspiratory phase of the lung [10]. Our results were consistent with those of other studies which were done by Yadav A et al. in 2009 [11], and in 2008 by Upadhyay KD et al [12].

The current study was done to assess the effect of pranayama practice on pulmonary function and showed a significant increase in FVC, FEV1, FEV1/FVC, and MVV, at the end of 10 days and followed by 30 days of pranayama practice to stimulate and balance all the systems of our body for the proper functioning of the lung functions. Danilo et al showed a significant result on FVC and FEV1 after yoga training for a shorter period. Although elderly subjects participated in their study, there was a significant improvement in the PEmax and PImax which were in the normal range. In their study,Bastrika, Kapalabhati, and Nadi Shuddhi Pranayama were used similar to the protocol that was performed in our study. All these training were used especially to increase the functions of inspiration and expiration muscles. Kapalabhati helps in improving the performance of the abdominal muscles involved in expiration. Bhastrika pranayama increases both expiratory as well as inspiratory muscle performance with enhanced capacity of the thoracic compartment to create negative and positive pressures in the process of respiration [13]. Another study by Madanmohan et al reported that the yoga training group achieved a significant improvement in pulmonary function tests, due to a possible increase in maximum expiratory pressure and minimum expiratory pressure. This indicates that the yoga training group improves the strength of the expiratory as well as inspiratory muscles [14]. A study by Bhargava MR et al. showed a statistically significant increased breath-holding time after the pranayama practice. The same study explained that during pranayama training, regular inspiration and expiration for a longer duration would lead to the acclimatization of central and peripheral chemoreceptors for both hypercapnia and hypoxia [15]. Acclimatization of the stretch receptors of the chest, the bronchial walls, and the alveoli increases the synchronization between the lung tissue and the cortex. The prolonged inhalation in pranayama leads to an increased breath-holding time [16,17].The future compass of study is the Pulmonary function tests along with diffusion capacity and total lung capacity shall be assessed in the pranayama breathing training.

Conclusion

In this study, 40 adult male volunteers practiced selected pranayama for 10 days and followed for 30 days of practice. The practice of pranayama increased the pulmonary function parameters like FVC, FEV1, FEV1/FVC, and MVV for a minimum period of 10 days to 30 days. The improvement in respiratory efficiency in this study especially the dynamic lung functions, though highly significant is less in magnitude. This resultant effect of pranayama can be used as a strengthening tool to treat many lung diseases like asthma, allergic bronchitis, tuberculosis, and many occupational diseases. The combined practice of asana and pranayama may produce a multi-system benefits than practicing pranayama alone.

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Conflict of interest

The authors have declared no conflict of interest

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Author's contribution

Dr Venkatesh and Dr Aravind Kumar designed the study, which involved data collection and manuscript writing, Dr Selvakumar was concerned in statistical analysis and publication support Dr Elavarasi guided the pranayama practice and was also involved in manuscript editing.

References

1. Streeter CC, Gerbarg PL, Saper RB, Ciraulo DA, Brown RP. Effects of yoga on the autonomic nervous system, gamma-aminobutyricacid, and allostasis in epilepsy, depression, and post-traumatic stress disorder. Med Hypotheses. 2012 May; 78(5):571-579. PMID: 22365651 DOI: 10.1016/j.mehy.2012.01.021
2. Kuppusamy M, Dilara K, Ravishankar P, Julius A. Ef-fect of BhrāmarīPrāṇāyāma Practice on Pulmonary Func-tion in Healthy Adolescents: A Randomized Control Study. Anc Sci Life. 2017 Apr-Jun;36(4):196-99.
3. Baljinder SB. Effect of anulomvilom and bhastrika pranayama on the vital capacity and maximal ventilatory volume. Journal of Physical Education and Sport Management. 2010 Jul 31;1(1):11-5.
4. Makwana K, Khirwadkar N, Gupta HC. Effect of short-term yoga practice on ventilatory function tests. Indian J PhysiolPharmacol. 1988 Jul 1;32(3):202-8
5. Saoji AA, Raghavendra BR, Manjunath NK. Effects of yogic breath regulation: A narrative review of scientific evidence. J Ayurveda Integr Med. 2019 Jan-Mar;10(1):50-8.
6. Rivero-Yeverino D. Spirometry: basic concepts Espi-rometría: conceptosbásicos. Rev Alerg Mex. 2019;66(1):76-84.

7. 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;8(1):22- 6.
8. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. Am J Respir Crit Care Med. 2019 Oct 15;200(8):e70–88.
9. Sivapriya D, Malani S, Thirumeni S. Effect of nadishodhana pranayama on respiratory parameters in school students. Recent Research in Science and Technology. 2010 Dec 15;2(11) .
10. Sivakumar G, Prabhu K, Baliga R, Pai MK, ManjunathaS. Acute effects of deep breathing for a short duration (2-10 minutes) on pulmonary functions in healthy young volunteers. Indian J PhysiolPharmacol. 2011 Apr 1;55(2):154-9.
11. Yadav A, Savita S, Singh KP. Role of the pranayama breathing exercises in the rehabilitation of coronary artery disease patients. Indian J of Traditional Knowledge. 2009; 3:455-508.
12. Upadhyay KD, Malhotra V, Sarkar D, Prajapati R. Effects of alternate nostril breathing exercises on the cardio-respiratory functions. Nepal Medical Coll J 2008; 10(1): 25-27.
13. Santaella DF, Devesa CR, Rojo MR, Amato MB, Drager LF, Casali KR, Montano N, Lorenzi-Filho G. Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: a randomized controlled trial. BMJ Open. 2011 May 24;1(1):e000085 .
14. Mandanmohan, Jatiya L, Udupa K, Bhavanani AB. Effect of yoga training on the handgrip, respiratory pressures, and pulmonary function. Indian J PhysiolPharmacol. 2003 Oct;47(4):387-92. PMID: 15266949.
15. Joshi LN, Joshi VD. Effect of forced breathing on the ventilatory functions of the lung. J Postgrad Med.1998; 44(3); 67-69.
16. Bhargava MR, Gogate MG, Mascarenhas. A study of BHT and its variations following Pranayamic exercises. The Clinician. 1982; 43-46.
17. Jerath R, Edry J, Barnes V, Jerath V. Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that can explain how slow deep breathing shifts the autonomic nervous system. Medical hypo. 2008; 67(3):56.