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Impact of Pranayama's on Pulmonary Function Test: A comparative Study

Mayuri Patil[a]*, Leena Chaudhary[b], Rajesh Patil[b],
[a]School of Environmental and Earth Sciences, KBC North Maharashtra University, Jalgaon, India
[b]Yoga Guidance Centre, KBC North Maharashtra University, Jalgaon, India

Abstract
Pranayama is breathing method that have significant physiological effects on the lungs, heart, and mind peace. The comparative study was carried out on three groups performing different pranayama namely Bhastrika,Suryabhedan and Anulom- Vilom. They were assessed for pulmonary function in which FVC(Force Vital Capacity), FEV1(Forced Expiratory Volume in One second), and PEFR(Forced Expiratory Flow Rate) tests were recorded according to standard protocol using a Medspiror spirometer as a determinant of pulmonary function. The results obtained were analysed for statistical significance using mini tab software followed by Wilcox on ranked signed test, paired t test, Moods Median test, and a significance level of $p<0.05$ was considered. After 12 weeks of pranayama practice,Bhastrika pranayama was observed to be more effective than Suryabhedan and Anulom-Vilom pranayama to improve pulmonary function parameters. FVC, FEV1 and PEFR values were highly improved in Bhastrika group ascompared to other two groups.

Keywords: Pranayama, FVC, FEV1, PEFR, Pulmonary function test

1.Introduction:

World Lung Day September 25,2022, focused on the slogan "Lung Health for All". This day was intended to raise awareness of the effects of the coronavirus disease (COVID-19) and the burden of major respiratory diseases worldwide, particularly in low- and middle-income countries (LMICs).The significance of early detection and inequality reduction was the day's key message which was in sync with the objectives of the Global Initiative for Chronic Obstructive Lung Disease (GOLD) goals**[1].**These include enhancing global chronic obstructive pulmonary disease (COPD) diagnosis and treatment. COPD is one of the three leading causes of death globally, affecting one in ten adults**[2].** It contributes significantly to global health disparities and is more severe in areas where these disparities are more pronounced. World Lung Day serves as a reminder that lung disorders ought to be treated more efficiently. Research is urgently needed with a focus on primary prevention and early detection to develop therapies and management strategies to mitigate symptoms and limit or stop disease progression.

Lung illness results in 7.6 million deaths annually, causing severe effects and disability for many more people. According to the Global Burden of Disease Study 2017, a nations sociodemographic index is a major factor influencing mortality and loss of health from respiratory disorders**[3].**The two most common chronic respiratory disorders are chronic obstructive pulmonary disease (COPD)and asthma. In 2015, these illnesses were placed 8th (COPD) and 23rd (asthma) in terms of the burden of disease as determined by disability-adjusted life years (DALYs), respectively. These illnesses were among the top 20 global conditions that cause disability**[4, 5].**Chronic obstructive pulmonary disease (COPD), asthma Allergic Rhinitis (AR), and rhinosinusitis are chronic diseases that impacts the lungs airways and other structures. Chronic respiratory disorders account for 4% of all chronic diseases worldwide. These diseases have a significant negative influence on patients' quality of life (QoL), level of disability, and level of productivity which results in burden on economy of the country**[6].**

Developing nations like India are simultaneously burdened by communicable and non-communicable diseases **[7].** Due to the large disparities in morbidity and mortality among Indian states, chronic respiratory illness, especially chronic obstructive pulmonary disease (COPD) and asthma are

of relevance **[8].** Also, most notable factors that contributes to the burden of diseases is loss of productivity and expenses of medication **[9]**.According to the World health Organization, about 3% of all diseases in the world are caused by air pollution. Also, literature states that India is the primary sufferer in indoor air pollution and that 4-6% of the country's disease burden is owing to air pollution**[10]**. It is demanding to change and manage the environment threats. While one can very easily adjust their immune system and respiratory system to be strong enough to endure these dangers. As compared to the other methods available to increase respiratory capacity, Yoga and Pranayama stands out as the best intervention **[11]**.

Yoga is regarded as the cornerstone of any population's health care and delivery system since it has the potential to significantly reduce 43% of health care utilisation**.[12].** The Indian government promotes the practice of traditional medicine since it helps to treat a sizable portion of the population quickly and affordably. Additionally, the effectiveness of these alternative treatments compared to the conventional system is being verified using current methodology.**[13].**It is most advantageous and affordable kind of exercise for the general public which is now being practiced **[14].**Yoga a spiritual and ascetic practise with a three-thousand-year history, has recently become more well-known as a complementary and alternate medicine (CAM) **[15].**Yoga aimed to promote harmony among a person's bodily, mental, emotional, and spiritual well-being. Yoga postures and practices are employed in therapeutic yoga to cure medical conditions and avoid, decrease, or eliminate limitations brought on by physical, emotional, psychological, or spiritual suffering.[**16].** The two primary components of yoga in today's world are "asana" (physical postures) and "pranayama" (breathing exercises) **[17].**

'Breathing sustains life',the word pranayama can be interpreted as Prana (energy of life),Yana (control) and Ayama (extension)means control of "energy of life" or extension of prana **[18]**.Pranayama consists of variety of breathing exercise to expand the respiratory system deliberately, methodically, and vigorously. Though pranayama increases lung capacity and blood oxygenation,variousdiseases can also be prevented with its treatment. There are three fundamental steps of yogic breathing exercises it entails long, continuous flow of air into the lungs (puraka/inhalation), the release of oxygen-depleted air from the lungs to the atmosphere (recheka/exhalation), holding of breath in between (kumbhaka) **[19].**

Numerous studies are available showing the effect of pranayama on pulmonary functions. One study compared the effects of slow and fast pranayama on cardio-respiratory factors and discovered that slow pranayama raised respiratory pressures and respiratory endurance **[20]**.A recent pilot trial incorporated yoga training for only 7 days and found no appreciable change in FVC and FEV1 values **[21]**. One study looked at the results of 10 weeks yoga and pranayama exercise which revealed an improvement in FEV1, FVC,breath holding time and maximum breathing capacity of lungs**[22].** Based on many other studies we may infer that a minimum of 4 weeks of training is required for meaningful improvements in FEV1 and FVC parameter **[23].**

Ironically,there is lack of literature on the comparative effects of different pranayama's and particularly finding the most effective pranayama in improving the pulmonary function test.It was necessary to determine whether and to what extent long term pranayama practice enhances respiratory function. The primary objective of this research is to determine how 12 weeks of pranayama exercise affects the endurance of young healthy subjects in terms of their FVC, FEV_1 and PEFR.This research attempted to study comparative effects of three different pranayama on pulmonary parameters. The findings of this study highlight the benefits of pranayama in enhancing respiratory capacity and the significance of consistent pranayama practice.

2. Material and Methods:

2.1 Type of research

The study is designed with three experimental group practicing different pranayama. The pre-post applications of pranayama were considered to examine the change in the lung functions.

2.2 Study design

The purpose of this study was to assess the impacts of three different pranayama exercises on healthy young female students between age group of 18 to 24 years for 10 minutes daily for 12 weeks. The pranayama exercise that was employed as an intervention were namely- Bhastrika pranayama (Bellows Breath), Surya Bhedana Pranayama (Right Nostril Breathing), and Anulom Vilom Pranayama (Alternate Nostril Breathing).

2.3 Participants and study setting

The research study was carried out at the Yoga Guidance Centre, KBC North Maharashtra University, Jalgaon, MH, India. Data collection was according to Consolidated Standards of Reporting Trials guidelines. The present study was approved by institutional ethical committee (No.IEC/DUPMCH/2023/17). Along with this, written consent form was also collected from all the participants. Subjects who were in good health and agree for research practice of pranayama regularly were chosen for this study. Total 101 subjects were enrolled for this study. After assessing, 41 subjects were excluded who failed to meet the inclusion criteria of the study. Finally, a total of 60 subjects were found to be eligible for this study. A certified yoga trainer instructed and supervised each participant and then participants were randomly assigned in three different groups.Group 1 practicing only Bhastrika pranayama consists of 22 subjects, Group 2 practicing only Suryabhedhan pranayama, consists of 20subjects, and Group 3 practicing only Anulom- Vilom pranayama consists of 18 subjects (Fig. 1)

Keeping in mind the stated inclusion and exclusion criteria, a thorough health history was collected.

- Inclusion Criteria:

a. Subjects who are not engage in any other form of exercise.
b. Healthy non-smokers who don't have cardio respiratory disorders.

- Exclusion Criteria:

a. Subjects having active sports training history or prior yoga practice.
b. Subjects with serious medical conditions like tuberculosis, hypertension, diabetes, mellitus, cardiovascular diseases, bronchial asthma.
c. Subjects who have undergone major surgery in the recent past.
d. Subject who has been majorly infected by COVID-19

All subjects were informed about the intervention techniques, subjects rights, objectives of the study advantages and potential outcomes. Those who failed to correctly perform breathing techniques, desired to stop and participated in less than 15 % intervention were also excluded from this study **[24].**

2.4 Randomisation and allocation

Eligible subjects(n=60) were divided into three groups using simple random sampling. Participants in Group 1 were (n=22), group 2 (n=20), and group 3 (n=18) were allotted. The interviewer collecting pre and post data were not informed about the study group intervention techniques.

2.5 Outcome measuring tools.

2.5.1 Spirometry (Pulmonary Function Test)

For diagnosis and monitoring of respiratory disorders like pulmonary fibrosis, asthma and Chronic Obstructive Pulmonary Diseases (COPD) pulmonary function test are important. The interpretation of pulmonary function test necessitates expertise in respiratory physiology and must be performed keeping in light the patient's history and examinations findings. Air that can be inhaled and expelled is measured using a spirometer[**25]**.

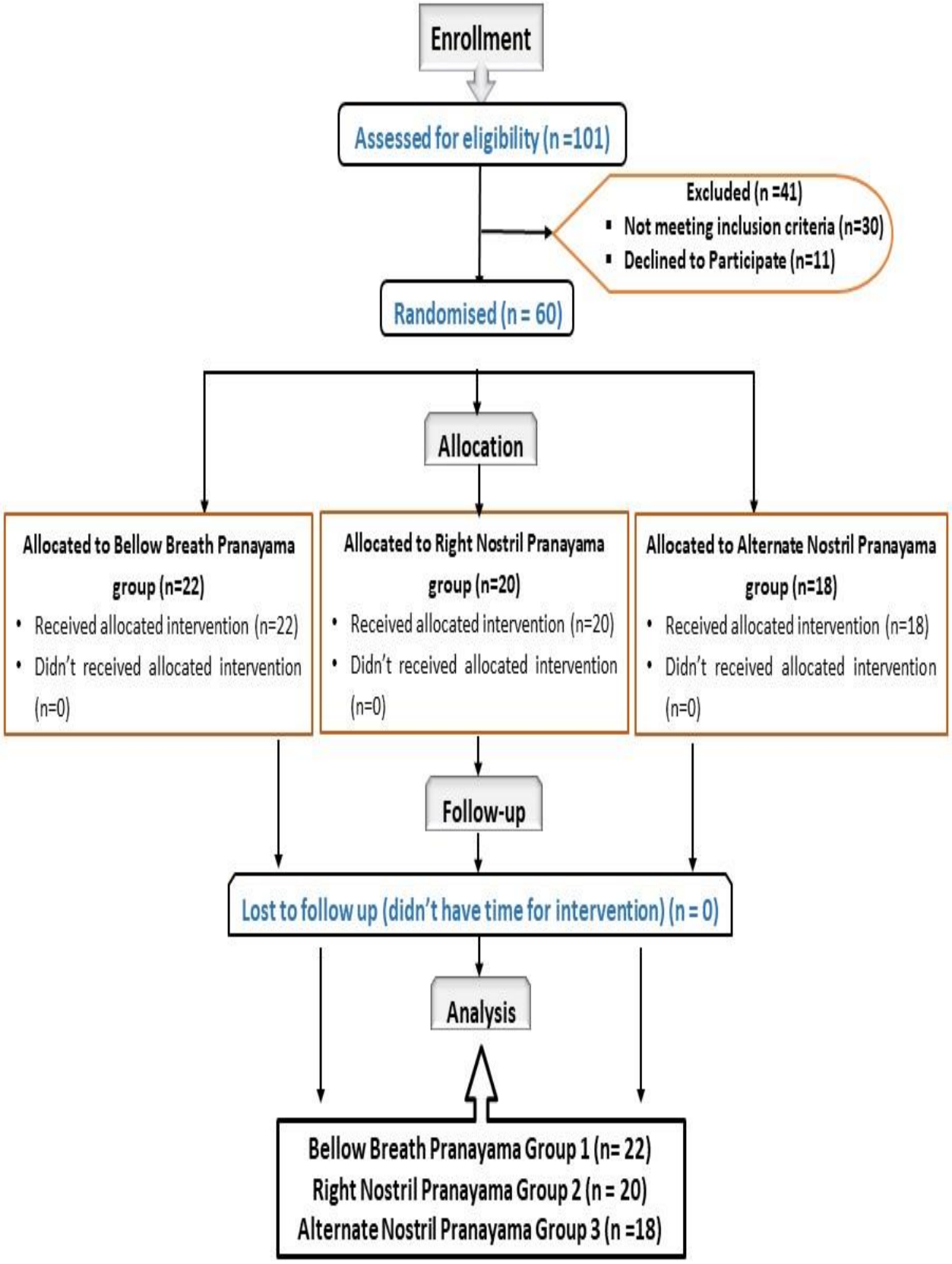

Figure: 1. The CONSORT Chart of the study

The participants were subjected to perform lung function test using the spirometer (Medspiror, Recorder and Medicare Systems, India). Age, weight, and height of the subjects were incorporated into the spirometer prior to the test. Depending on age and height, the spirometer gives predicted value and observed value can be obtained after performing the test. Pre and post values can be obtained by Medspiror which employsa series of prediction equations as follow.**[26]**

FEV1 (L)	0.027H - 0.010A - 1.99
FVC (L)	0.037H - 0.007A - 3.18
PEFR (L/sec)	0.055H – 0.031A - 1.35

Where,

H - height (cm)

A - age (years)

FEV1 - Forced Expiratory Volume in one second. When doing a forced vital capacity effort, it is the amount of air exhaled in one second.

FVC - The maximum amount of air that can be expelled after a maximal inhalation effort is known as forced vital capacity.

PEFR - Peak Expiratory Flow Rate (PEFR) is the amount of air that can be forcedly expelled during the FVC.

The subjects were introduced to spirometer along with thorough explanations and demonstration were given. The pulmonary function test was performed before and after 12 weeks of the intervention.The subjects were asked to inhale maximally and exhale forcefully into the spirometer transducer as fast and long as possible. To ensure the consistency of results the procedure is repeated at least three times with minimum 6 seconds of exhalation **[27].**

The real values of pulmonary parameters (FVC, FEV1 and PEFR) depends on maximum amount of inspiration and expiration of the subjects. For data processing the highest values were used from three trials of showing maximal inhalation and exhalation efforts **[28].**

Rhythmic alterations to physiological processes were observed to be connected to alterations in performance hence to prevent potential variance, all the tests were performed between 8.00 am to 9.00 am at the same time of the day **[29].**

2.5.2 Health Survey Questionnaire

In epidemiological research,questionnaire is most frequently used to evaluate perceptions of one'shealth **[30].** The Respiratory Medical Evaluation (OSHA) Questionnaire was employed for collection of datawere modified into local language**[31][32]**. The questionnaire included9 questions on socio demographic characteristics of the subject such as age, gender, height, weight,education level, habits of smoking or tobacco consumption and 8 main questions related to state of having any respiratory problems, frequent coughing, chest pain, irritation in throat, anxiety were included. Also,symptoms and diagnosis of any disease or recently infected due to COVID-19, taking any type of medication were also included in the questionnaire for detailed data collection.

2.6 Description of Intervention

The practice of the pranayama is not easy for inexperienced pranayama practitioners. Hence before starting the intervention,three days of introductory training were given to each participant.Participants were guided for 30 minutes a day by yoga instructor for correct practice of pranayama. Each training session were having only 10 participants at a time to allow individualized and careful training **[33].**

All participants were asked to sit in any relaxed meditative asana.Subjects were asked to perform three rounds of only the specific pranayama allotted to them daily for 10 minutes, under the supervision of certified yoga trainer **[33].**

The three types of pranayama's allotted to the groups were as follows:

- ***Bhastrika Pranayama (Bellows breath):***

Bhastrika is a Sanskrit word meaning bellows. The breathing technique used in Bhastrika pranayama is like blowing of bellows as possible to the practitioner and then inhale by right nostril and exhale by left nostril only in each round.This pranayama isfast paced breathing techniques involving forcefully

breathing and exhaling so that our body receives the maximum amount of oxygen. It strengthens abdominal and diaphragm muscles **[34].**

- ***Surya Bhedan pranayama (Right Nostril breathing):***

In this breathing technique, only the right nostril is used for inspiration and the left nostril is used for expiration. It is repeated in the same manner each time. It differs from the anulom - vilom in which inspiration and expiration are alternately carried out through each nostril. It speeds up the metabolism and prevent the weight loss **[19].**

- ***Anolom - Vilom (Alternate Nostril breathing):***

It is a type of breathing cycle involving alternate nostrils i.e., if air is inhaled from one nostril and then it is exhaled from another nostril. For instance, if breathing done from right nostril, then left nostril is kept closed. After full inspiration the right nostril is closed and exhalation in done through left nostril. Now after full expiration, inspiration will be performed by left nostril keeping the right nostril closed, and after full inhalation, now the expiration will be done with right nostril. Thus, during any exhalation and inhalation action only one nostril is used. Hence this technique is therefore called as "Alternate Nostril Breathing" **[19].** Although, each round starts with left nostril and ends with also left nostril only.

2.7 Data assessment

Data analysis was performed on Pulmonary function Test (PFT) parameters. The statistical analysis of generated data was performed in Minitab software. Statistical test named Wilcox on signed ranks test (where data is not normally distributed) and students paired t test (where data is normally distributed) were used to evaluate the difference in pre and post values of PFT variables. Also,f or multiple comparison another statistical analysis was performed using Mood's median test. This test is nonparametric and analogous to One way ANOVA (parametric test).Using this test, comparison of post mean values of PFT parameters between and within the experimental groups were performed. P value of < 0.05 were considered statistically significant in this study.

3. Results:

The present comparative study consisted of 60 subjects that formed three different groups practicing three different pranayama's. The anthropometric details consisting measurements of mean age, weight, height, and BMI have been depicted in Table 1.

Table 1: Anthropometric parameters of the subjects

Parameters	Groups practicing different pranayama's (breathing exercises)		
	Bellows breath (Group 1)	**Right Nostril Breathing (Group 2)**	**Alternate nostril Breathing (Group 3)**
	Mean (S.D)	***Mean (S.D)***	***Mean (S.D)***
Age (Years)	21.7 ± 0.65	21.8 ± 1.01	22 ± 0.81
Weight (Kg)	48.05 ± 9.31	47.53 ± 10.71	47.93 ± 5.07
Height (cm)	155.75 ± 6.85	156.4 ± 6.73	156.12 ± 5.94
BMI	19.68 ± 2.75	19.38 ± 3.76	19.81 ± 3.17

where,
Kg: kilograms
cm:Centimeters
BMI: Body Mass Index
S.D: Standard Deviation

Table 2: Groupwise percent change in Pulmonary parameters from pre-test to post - test				
Pranayama	**Factor**	**Type**	**Mean ± SD**	**% Increase**
Bhastrika (Bellow Breath) (Group 1)	FVC	Pre	1.67 ± 0.46	25.74
		Post	2.10 ± 0.45	
	FEV1	Pre	1.53 ± 0.54	32.67
		Post	2.03 ± 0.56	
	PEFR	Pre	3.76 ± 1.79	19.14
		Post	4.48 ± 1.34	
Suryabhedan (Right nostril breathing) (Group 2)	FVC	Pre	1.80 ± 0.38	9.44
		Post	1.97 ± 0.41	
	FEV1	Pre	1.75 ± 0.38	7.4
		Post	1.88 ± 0.40	
	PEFR	Pre	4.23 ± 1.31	8.7
		Post	4.60 ± 1.13	
Anulom- Vilom (Alternate nostril breathing) (Group 3)	FVC	Pre	1.94 ± 0.42	1.03
		Post	1.96 ± 0.36	
	FEV1	Pre	1.81 ±0.53	4.97
		Post	1.90 ±0.35	
	PEFR	Pre	4.46 ±1.28	1.79
		Post	4.54 ±1.10	

The effect of pranayama on various lung functions are shown in Table in 2.

FVC (Forced Vital Capacity)

The Bhastrika pranayama (group 1) intervention showed increasing trend in FVC value. The pre - test FVC mean values were 1.67 ± 0.46 which when compared to post - test FVC mean values 2.01 ± 0.45 showed drastic increased from pre to post FVC values i.e., by 25.74%. Whereas, when the same comparison was performed for pre- post FVC values for (group 2) it was increased by 9.44% and (group 3) showed increased by 1.03%.

FEV1 (Forced Expiratory Volume in 1 second)

The Bhastrika pranayama (group 1) intervention showed increased in FEV1 values. The pre- test FEV1 values were 1.53 ± 0.54 which when compared to post-test FEV1 values 2.03 ± 0.56 showed increased by 32.67%. When the same comparison between pre and post mean values were performed the % increase in FEV1 values of (group 2) was7.4% while for (group 3) it showed 4.97% increase in the post values.

PEFR (Peak Expiratory Flow Rate)

The Group 1 pranayama subjects also showed increased in PEFR values. The pre mean PEFR value was 3.76 ±1.79 which when compared with the post PEFR values were found to be increased by 9.44%. Similarly (group 2) also showed increased by 8.7 % and (group 3) showed increased by 1.79%.

The result shows, that there was more significant increase in FVC, FEV1 and PEFR values of subject performing Bhastrika pranayama (Bellows breath) as compared to other two pranayama. Also,Suryabhedana (Right nostril breathing) pranayama showed improvement in PFT values as compared to Anulom Vilom (Alternate nostril breathing). Hence it was observed that Bellows breath pranayama was more effective in improving the PFT values.

Additionally,when the statistical analysisby applyingWilcoxon ranked signed test performed, it was observed that there was significant difference in the pre and post values of Group 1 and Group 2 ($p < 0.05$). Whereas there was no significant difference in pre and post values of Group 3 after application of pranayama ($p > 0.05$). Hence Group 1 and group 2 were found to be more effective in terms of pre and post comparison(Table 3).

Table 3: Groupwise Comparison of pulmonary parameters

Pranayama	Factor	Type	Mean	Test applied	P-value	Decision	Remark	Layman's term
Bellow Breath (Group 1)	FVC	Pre	1.67	Wilcoxon Signed rank test	0.00002	H_0 rejected	Statistically Significant	Post is effective than Pre
		Post	2.10					
	FEV1	Pre	1.53		0.00002	H_0 rejected	Statistically Significant	
		Post	2.03					
	PEFR	Pre	3.76		0.00081	H_0 rejected	Statistically Significant	
		Post	4.48					
Right nostril breathing (Group 2)	FVC	Pre	1.80	Wilcoxon Signed rank test	0.00004	H_0 rejected	Statistically Significant	Post is effective than Pre
		Post	1.97					
	FEV1	Pre	1.75		0.00070	H_0 rejected	Statistically Significant	
		Post	1.88					
	PEFR	Pre	4.23		0.01999	H_0 rejected	Statistically Significant	
		Post	4.60					
Alternate nostril breathing (Group 3)	FVC	Pre	1.94	Wilcoxon Signed rank test	0.07107	Fail to reject H_0	Statistically insignificant	No difference between Pre and Post
		Post	1.96					
	FEV1	Pre	1.81		0.153	Fail to reject H_0	Statistically insignificant	
		Post	1.90					
	PEFR	Pre	4.46	Paired t- test	0.2958	Fail to reject H_0	Statistically insignificant	
		Post	4.54					

*(Conclusion are drawn based on $p < 0.05$)

Also, for comparison the mean post PFT values of more than two groups, Moods Median test were selected. Output obtained using thistest for comparison of PFT parameters between different groups is shown (Table 4). The result showed that there was significant difference between all three groups in terms of post values of FVC and FEV1, but no significant difference in PEFR post values of any group. In addition to this, post value within each group were compared and statistically significant difference was observed in all PFT parameters of all three groups (Table 5).

Table 4: Comparison of PFT parameters between the groups

PFT parameter	Pranayama Group	p-value	Decision	Remark
FVC	Group 1	0.025	H_0 rejected	Statistically significant
	Group 2			
	Group 3			
FEV1	Group 1	0.039	H_0 rejected	Statistically significant
	Group 2			
	Group 3			

PEFR	Group 1	0.530	Fail to reject H_0	Statistically insignificant
	Group 2			
	Group 3			

*(Conclusions are draw based on p < 0.05)

Table 5: Comparison of PFT values within the group

Pranayama Group	PFT parameter	p-value	**Decision**	**Remark**
Group 1	PVC	<0.0001	H_0 rejected	Statistically significant
	FEV1			
	PEFR			
Group 2	PVC	<0.0001	H_0 rejected	Statistically significant
	FEV1			
	PEFR			
Group 3	PVC	<0.0001	H_0 rejected	Statistically significant
	FEV1			
	PEFR			

*(Conclusions are draw based on p < 0.05)

The results obtained were plotted and compared among the selected groups between the mean PFT values of Pre and Post-test for FVC, FEV1 and PEFR, it was observed that there was more significant difference in post PFT values of Group 1 than Group 2 and Group 3. (Fig 2).

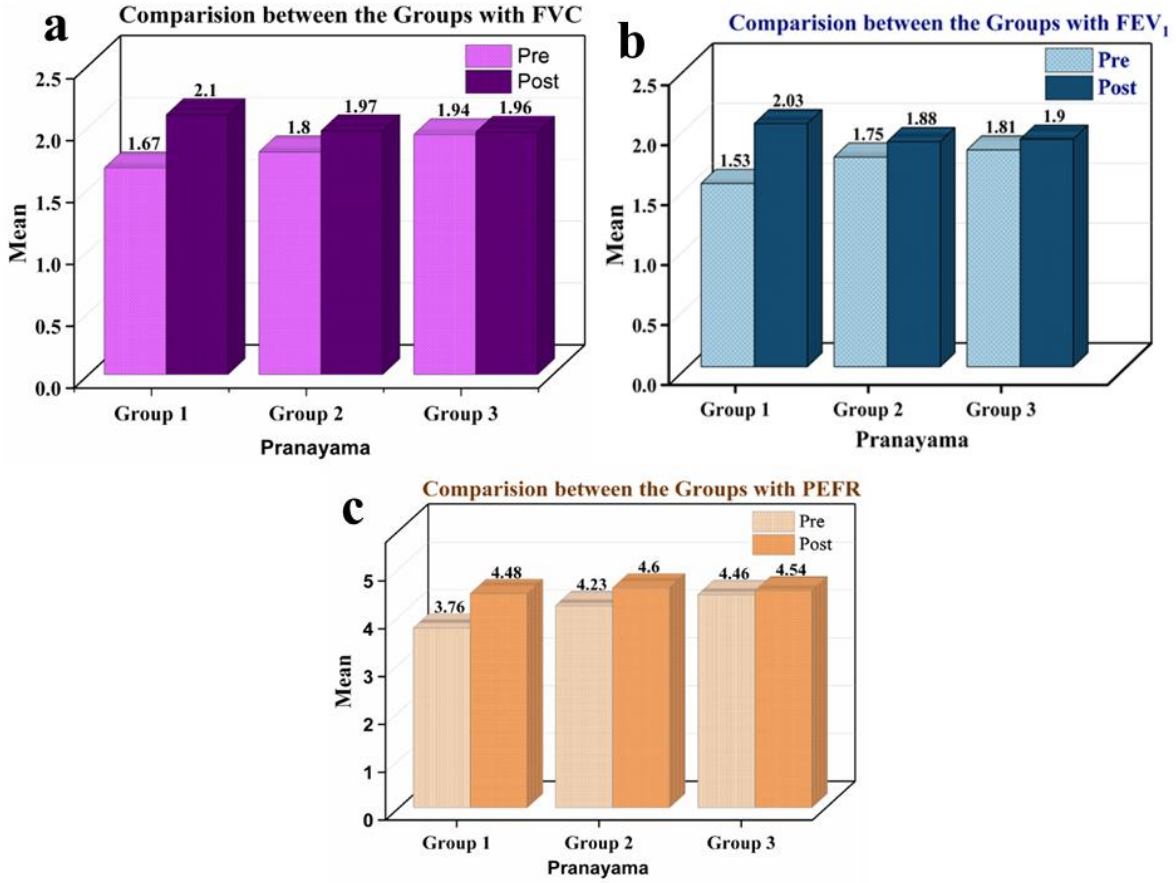

Figure 2: Comparison of between the groups of PFT parameters a. Comparison between the groups with FVC b. Comparison between the groups with FEV_1 c. Comparison between the groups with PEFR

4. Discussion:

The ancient science of yogic breathing practices pranayama brings harmony in mind and body One can make respiration rhythmic by voluntarily controlling their breathing. As a result, pranayama is the art of managing the breath. It entails wide range of mental, physical, and spiritual task**[35].** Pranayama aids in changing breathing habits and patterns by bringing breathing into conscious awareness **[36].**

The present data indicates that after 12 weeks of regularly practicing pranayama have significantly improved the values of FVC, FEV1 and PEFR. These findings were supported by reported literature**[37][38]**. One study describes that significant improvement in FVC, PEFR and MVV was seen after 6 weeks of pranayama training [38]. Chhibber R, et al reported significant improvement in values of FVC and PEFR at 6^{th} and 12^{th} week of pranayama training in healthy females **[39].**

The PFT parameters like FVC, FEV1 and PEFR shows statistically significant improvement (Table 2) when compared with baseline data. Also, the groups practicing Bhastrika and Suryabhedan pranayama have statistically significant improvement in their PFT values.

Practicing Pranayama causes the diaphragm to rise above its normal level. As a result, the efficient movement of the diaphragm, enhances its strength and lung vitality **[40]**.Whereas Bhastrika pranayama, the abdominal and inter costal muscles are isometrically contracted and expanded, which results in increase in the values of FVC and FEV**[41]**.One can make respiration rhythmic by voluntarily controlling their breathing. As a result, pranayama is the art of managing the breath. When activated, these receptors cause inhibition of inspiratory neurons, which prevents inspiration, and alter

blood flow through the lungs and thus improves ventilatory functions**[42]**.The compliance of the lung thoracic system increases, and the airway resistance decreases during breathing exercise.It is thought that the maximum deflation of the lungs is a crucial physiological stimulus for the release of surfactant and prostaglandins into the alveolar spaces. This process may increase lung compliance and reduce air flow resistance.And therefore, in pranayama, the effective diaphragm movement may result in an improvement in FEV1 and FVC**[43 to 45].** It has also been found that regular yogic exercises in sedentary subjects was nearly like swimming in increasing their pulmonary functions when practiced for 12 weeks**[46].**

Spirometry is the most reliable and efficient technique for evaluating lung function tests.FEV1 is the rate at which breath is expelled from the lungs in the first second. It reflects the flow- resistive abilities to airflow in airways larger than 2mm in diameter**[47].** FVC is a measure of the elastic properties of the respiratory apparatus**[38]**. FVC has been regarded as a crucial element of health and survival. It is significant for the assessment of healthy individuals and patients with cardiovascular and respiratory conditions **[48].**It has been noted that regular practice of a range of asanas, consistently engage thoracic cavity muscles. This results in increased muscular activity and better FVC **[49][50]**. Whereas, in the present study, asanas were not practiced but all three groups were intervened with three different pranayama. From these results (Table 2), it was noticed that Bhastrika pranayama and Suryabhedan pranayama were found to be more significant than Anulom- Vilompranayama in terms of improving FVC.Hence the improvement in FVC and FEV1 values is due to strengthening of respiratory muscles which has increased elasticity of lungs due to regular practice of pranayama **[51].**

Numerous other studies revealed that practicing yoga increased PEFR. PEFRis a measurement of the resistance or changes in elastic recoil pressure of small airways **[38]**. It was observed that PEFR shown more significant improvement in group 1 performing Bellows breath pranayama as compared to other two groups. The reason behind this Bellows breath pranayama increases the depth of breathing by involving the use of small lung spaces, which is not possible in normal shallow and slow breathing. Forceful and deep breathing helps in expanding the lungs more than normal and slow breathing, which engage the previously closed alveoli. This enhances the air diffusion on surface area of respiratory membrane**[52]**. Therefore, significant improvement in the values of FVC, FEV1 and PEFR was more in Bellows breath pranayama as compared to right nostril and alternate nostril breathing techniques.

Although this study is in accordance with the findings of other studies in terms on effects of pranayama on healthy individuals, the present study has some differences. Many studies have reported effects of individual yoga asana, pranayama or meditation or combination of all, whereas this study involved a comparative study between three different pranayama's and its impact on lung functions.However, this study have some limitations: the selected sample size was small as the whole subjects were divided into three different groups. Hence, this study can be validated by increasing the sample size, combined effect of all the pranayama's as a fourth group and control group would have been more ideal.

5. Conclusion:

As a result of this study, it is evident that consistent pranayama practice over the course of 12 weeks improves FVC, FEV1, and PEFR in healthy persons.Also, it can be concluded that Bhastrika (Bellowsbreath) is comparatively more effective than Suryabhedan (Right nostrilbreathing) and Anulom -Vilom(Alternate nostril breathing) in improving pulmonary functions. This study supports the therapeutic benefits of pranayama and aligns with prior reports. The practice of pranayama can be a crucial component for a healthy lifestyle. Due to its accessibility, affordability, longevity, and safety, this ancient system of treatment is growing in popularity as a clinical discipline. It can be recommended as a supplement to or a substitute for conventional therapies for respiratory diseases. Yoga and pranayama have potential that help nations to deal with the global challenges and for the world to achieve **"Sustainable Development Goals (SDGs) 2030**" especially goal number three i.e., *good health and wellbeing.*

Disclosure statement

The author declares no conflict of interest.

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CRediT authorship contribution statement

Mayuri A. Patil: Conceived the study, Investigation,Conceptualization, Methodology, Formal analysis, Data curation, Investigation, Writing - original draft, Writing - review & editing, Visualization.

Leena Chaudhary: Conceptualization, Methodology, Formal analysis, Investigation, Writing - review & editing, Study administration.

R.I. Patil: Conceptualization, Reviewing and Editing, Supervision and Validation.

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