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EFFECTS OF DIAPHRAGMATIC BREATHING EXERCISE AND ANULOM VILOM ON PFT, PEFR AND BREATH HOLDING TIME IN GRADE 1 HYPERTENSIVE ADULTS: A COMPARATIVE STUDY

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ABSTRACT

Background: Hypertension is a major global health concern and is associated with impaired pulmonary function and autonomic imbalance. Breathing-based interventions such as diaphragmatic breathing exercises and Anulom Vilom pranayama have been shown to improve respiratory mechanics, autonomic regulation, and overall cardiopulmonary efficiency. However, comparative evidence on their effectiveness in hypertensive individuals remains limited.

Aim: To compare the effectiveness of diaphragmatic breathing exercises and Anulom Vilom pranayama on pulmonary function parameters and breath-holding time in individuals with grade 1 hypertension.

Methods: A comparative study was conducted on 100 participants with grade 1 hypertension, randomly assigned into two groups: Group A (n=50) received diaphragmatic breathing exercises, and Group B (n=50) practiced Anulom Vilom pranayama for four weeks. Pre- and post-intervention assessments included Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), Peak Expiratory Flow Rate (PEFR), and Breath-Holding Time (BHT). Data were analysed using appropriate statistical tests, with significance set at $p < 0.05$.

Results: Both groups demonstrated significant improvements in FVC, FEV_1, PEFR, and BHT following the intervention ($p < 0.05$). However, diaphragmatic breathing exercises produced significantly greater improvements compared to Anulom Vilom. Group A showed superior gains in FVC, FEV_1, PEFR, and BHT ($p < 0.05$), while the FEV_1/FVC ratio remained statistically non-significant in both groups.

Conclusion: Both diaphragmatic breathing exercises and Anulom Vilom pranayama effectively enhance pulmonary function and breath-holding capacity in individuals with grade 1 hypertension. However, diaphragmatic breathing exercises demonstrate greater overall efficacy.

Keywords: Diaphragmatic Breathing Exercise, Anulom Vilom, Pulmonary Function Test, PEFR, Breath Holding Time, Pranayama

INTRODUCTION:

Hypertension is a leading global health risk and a major contributor to cardiovascular morbidity and mortality, accounting for a substantial proportion of deaths due to stroke and ischemic heart disease. In India, nearly one-third of adults are affected, with higher prevalence observed in urban populations. As a chronic condition, hypertension predisposes individuals to long-term complications involving the heart, kidneys, brain, and other vital organs. While its cardiovascular consequences are well established, the effects of hypertension on pulmonary function have received limited attention. Emerging evidence indicates that chronic hypertension may impair respiratory mechanics by reducing pulmonary elasticity and increasing interstitial lung fluid, leading to decreased pulmonary function parameters such as FVC, FEV_1, and PEFR.

Non-pharmacological interventions remain a cornerstone of hypertension management. Breathing-based therapies, including diaphragmatic deep breathing and yogic practices, have shown promising effects in improving autonomic balance, lowering blood pressure, and enhancing pulmonary function. This study aims to evaluate the association between hypertension and pulmonary function and to assess the effectiveness of diaphragmatic deep breathing as an adjunctive therapeutic intervention.

Objective: 1) To study the effects of 4 weeks of diaphragmatic breathing exercises on PFT using spirometer, PEFR using Wrights peak flow meter and breath holding time using stopwatch in grade1 hypertensive adults.
2)To study the effects of 4 weeks of Anulom vilom on PFT using spirometer, PEFR using Wrights peak flow meter and breath holding time using stopwatch in grade1 hypertensive adults.
3)To study and compare the effects of 4 weeks of diaphragmatic breathing exercises and Anulom vilom on PFT, PEFR and breath holding time in grade1 hypertensive adults.

METHODOLOGY

This study was designed as an experimental, comparative study and was conducted in an urban healthcare setting. The target population consisted of adults aged 25–40 years with Stage 1 hypertension. The total duration of the study was one year.

Sampling Method and Sample Size

A convenience sampling method was initially used to identify potential participants. From this pool, simple random sampling was employed to select the final sample. The study included 100 participants.

The sample size was estimated using G*Power 3.1.4 software, based on the following statistical assumptions:

- Level of significance (α): 0.05
- Statistical power (1–β): 80%
- Effect size: 0.20

Method of Selection

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

• Adults 25–40 years of age diagnosed with Grade 1 hypertension.

• Both male and female individuals.

• Individuals who were on first-line antihypertensive treatment.

• Adults performing minimal physical activity, as assessed by the International Physical Activity Questionnaire (IPAQ).

Exclusion Criteria

Participants were excluded based on the following conditions:

• Individuals with a recent myocardial infarction (MI).

• Those with acute respiratory illnesses, including sinusitis

•Individuals diagnosed with uncontrolled hypertension.

• Those with chest wall or spinal deformities.

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PROCEDURE

Ethical committee clearance was obtained from the institutional committee. All participants were screened according to the inclusion and exclusion criteria. Those fulfilling the criteria and willing to participate were briefed about the nature of the study in the language best understood by them and written consent was obtained. They were encouraged to ask questions and doubts about the study if they had any.

Subjects were randomly divided in two groups by random chit method. Participants baseline parameters like HR, RR, BP, PFT, PEFR, breath holding time were noted. Group A was given Diaphragmatic breathing exercises in Sukh-asana (sitting position) for 10 mins twice a day 5times/week for 4 weeks. Group B was given Anulom Vilom exercise in Sukh-asana (sitting position) for 10 mins twice a day 5times/week for 4 weeks. Post 4 weeks intervention parameters were taken. Data was collected and statistical analysis for the same was done using appropriate tests.

Group A Diaphragmatic Breathing Exercise- This was performed in Sukh-asana. Individuals were instructed to relax and then keeping one hand on the chest and other on epigastric region inhale slowly and as deep as possible through the nose and then exhale slowly through the nose. This was given for ten repetitions 3 sets twice a day 5 times /week[26]

Group B Anulom Vilom-In Sukh-asana the individual was instructed to close right nostril using thumb and inhale through the left nostril. Exhalation was through the right nostril closing the left nostril with ring finger. This was given in the ratio of 1:2 for 3-5 mins twice a day 5times/week.[27]

Figure 1-Subject performing Diaphragmatic Breathing Exercise

Figure 2-Subject performing PFT

STATISTICAL ANALYSIS

Collected data was entered in Microsoft excel spreadsheet. The Mean and Standard Deviation was calculated for each demographic parameter as well as each outcome measure.

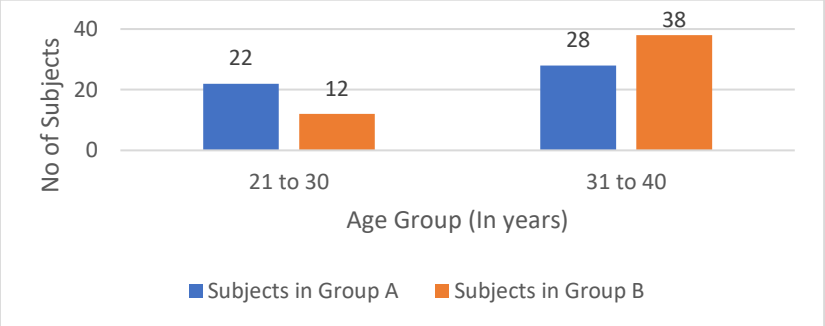
Data distribution was analyzed to determine the appropriate statistical tests. If the distribution was normal, the Shapiro-Wilk test was applied. Within-group comparisons were made using the paired t-test, while between-group comparisons employed the unpaired t-test. For non-normal distributions, the Wilcoxon Signed-Rank test was used for within-group analysis, and the Mann-Whitney U test was used for between-group comparisons. A p-value less than 0.05 was considered indicative of statistical significance

RESULTS

Table No 1: shows the demographic Data of Group A and B.

Demographic Data		Group A	Group B
Age	21 to 30	22	12
	31 to 40	28	38
Gender	Female	29	35
	Male	21	15

Graph 1: Demographic data of Group A and B



Graph 1 a): Gender distribution

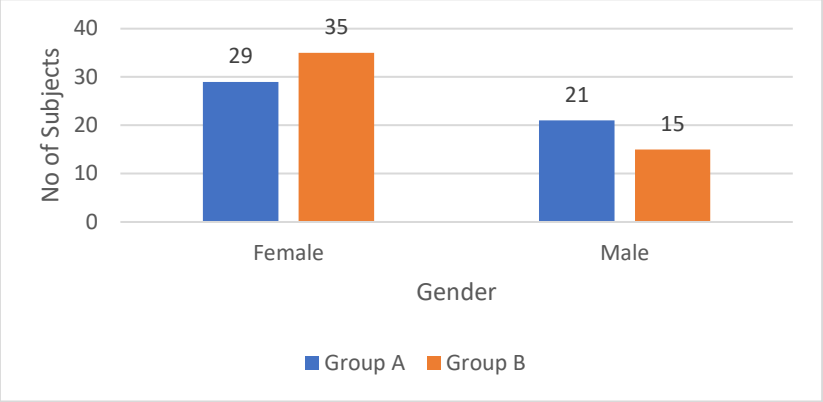
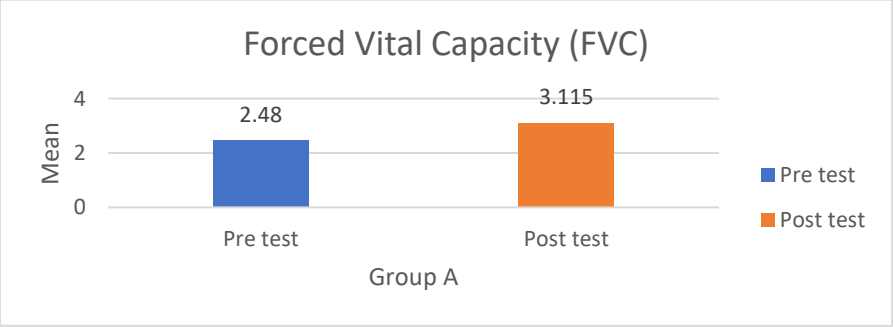


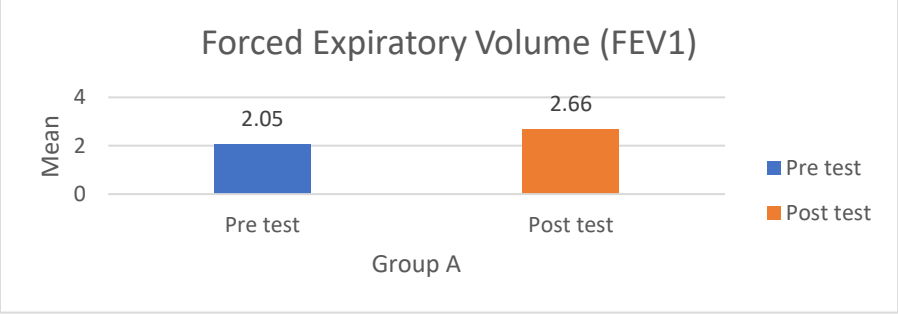
Table No 2 Pre and Post Comparison of diaphragmatic breathing exercise on Pulmonary Function Tests.

Parameter	Type	Mean	S.D	P value	Remark
FVC	Pre	2.48	0.706	0.001	Statistically significant
	Post	3.115	0.665		
FEV1	Pre	2.052	0.67	0.001	Statistically significant
	Post	2.66	0.548		
FEV1/FVC	Pre	83.38	8.129	0.089	Statistically insignificant
	Post	85.22	5.35		

Graph 2 Pre and post FVC comparison in Group A



Graph 2 a) Pre and post FEV1 comparison in Group A



Graph 2b) Pre and post FEV1/FVC comparison in Group A

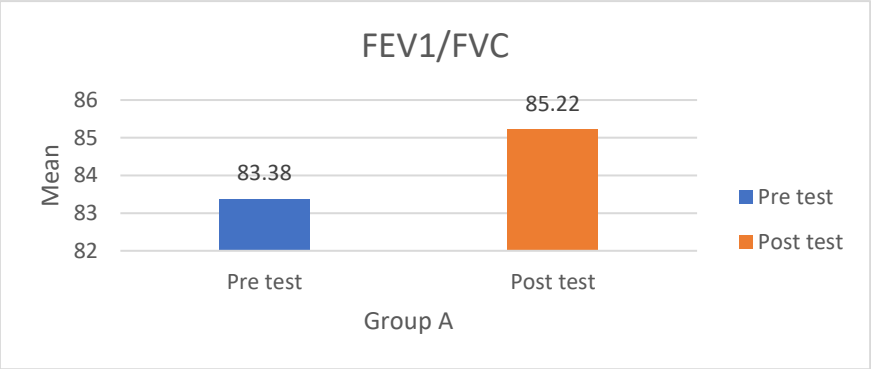


Table No. 3 Pre and Post Comparison of diaphragmatic breathing exercise on Peak Expiratory Flow Rate.

Parameter	Type	Mean	S.D	P value	Remark
	Pre	337.5	94.96	0.001	Statistically significant
	Post	383.8	99.15		

Graph 3 Pre and post Peak Expiratory Flow Rate comparison in Group A

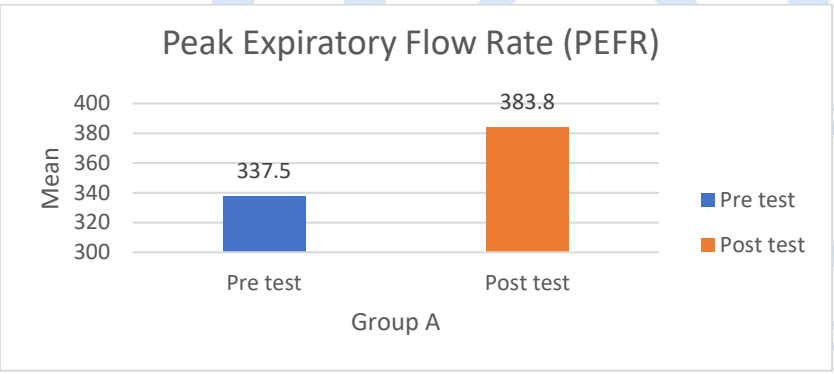


Table No.4 Pre and post BHT comparison in Group A

Parameter	Type	Mean	S.D	P value	Remark
BHT	Pre	32.90	2.675	0.001	Statistically significant
	Post	34.64	2.431		

Graph 4 Pre and post Breath Holding Time comparison in Group A

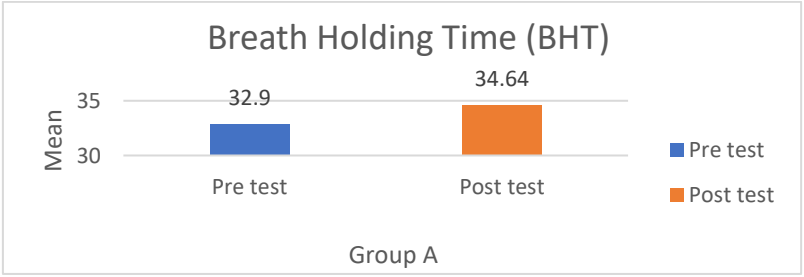
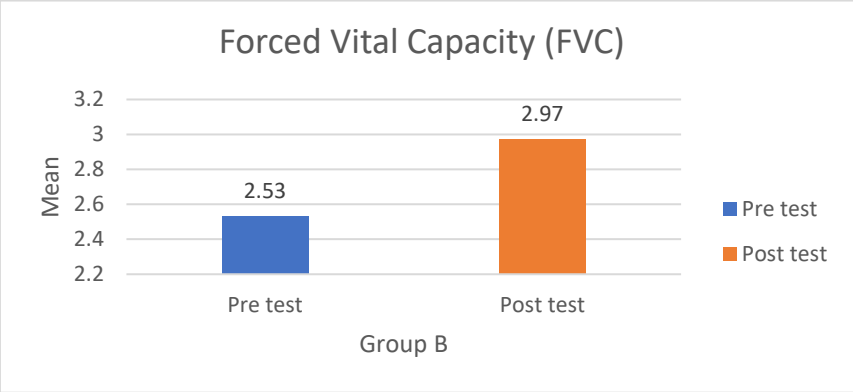


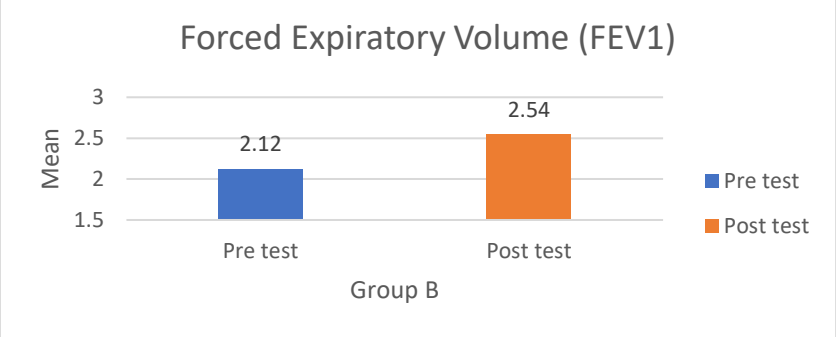
Table No 5 Pre and Post Comparison Anulom vilom on Pulmonary Function Tests

Parameter	Type	Mean	S. D	P value	Remark
FVC	Pre	2.531	0.773	0.001	Statistically significant
	Post	2.977	0.823		
FEV1	Pre	2.122	0.674	0.001	Statistically significant
	Post	2.544	0.661		
FEV1/FVC	Pre	84.80	4.15	0.407	Statistically insignificant
	Post	85.50	4.90		

Graph 5 Pre and post FVC comparison in Group B



Graph 5a Pre and post FEV1 comparison in Group B



Graph 5 b Pre and post FEV1/FVC comparison in Group B

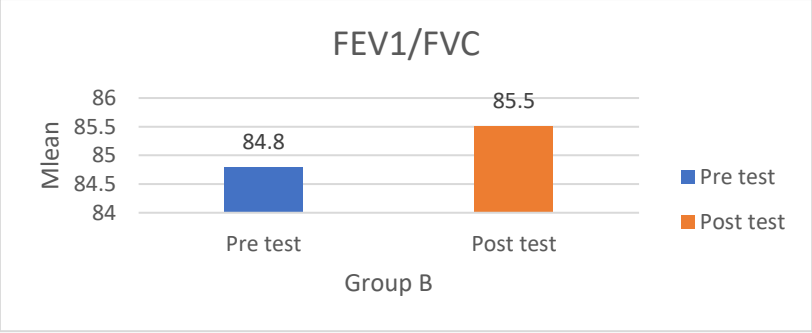


Table No. 6. Pre and post peak expiratory flow rate comparison in Group B

Parameter	Type	Mean	S.D	P value	Remark
PEFR	Pre	345.6	96.76	0.001	Statistically significant
	Post	373.2	89.45		

Graph 6 Pre and post peak expiratory flow rate comparison in Group B

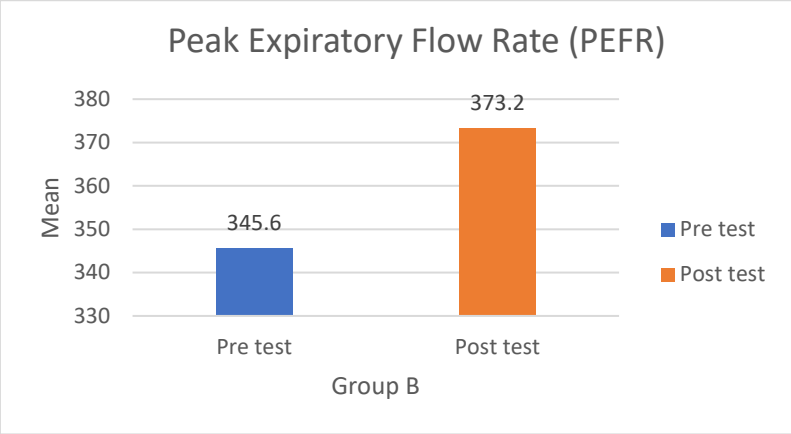


Table No. 7 Pre and post breath holding time comparison in Group B

Parameter	Type	Mean	S.D	P value	Remark
BHT	Pre	34.88	3.16	0.001	Statistically significant
	Post	36.08	2.53		

Graph 7 Pre and post breath holding time comparison in Group B

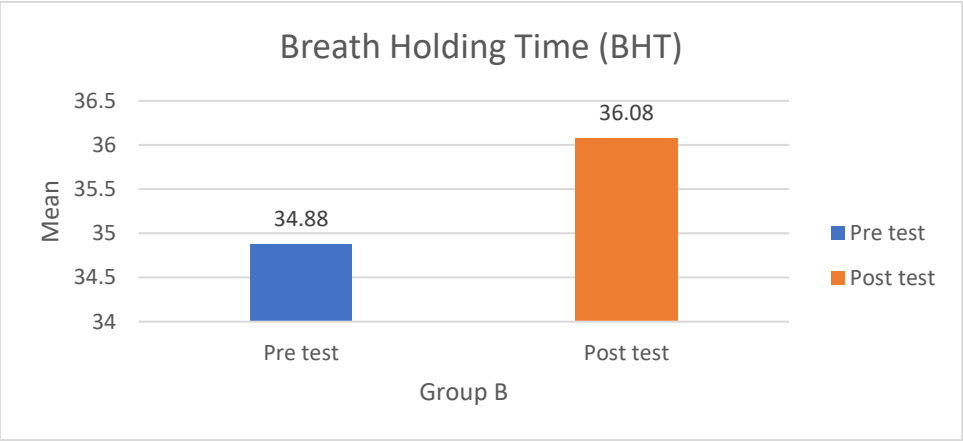
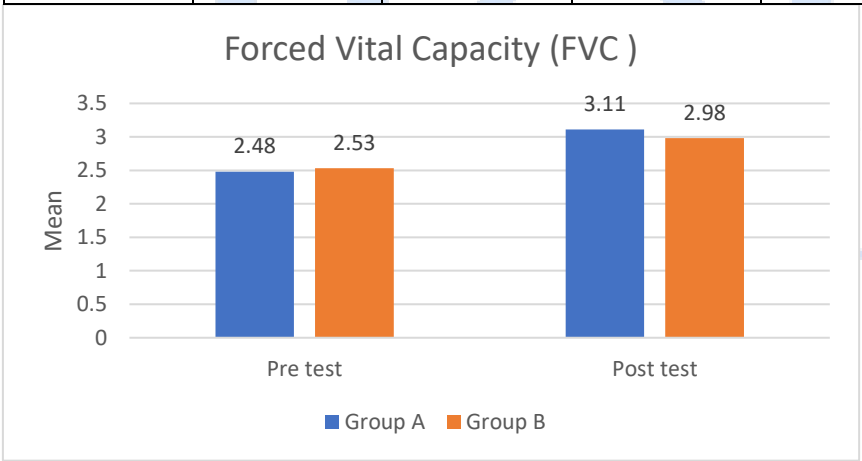


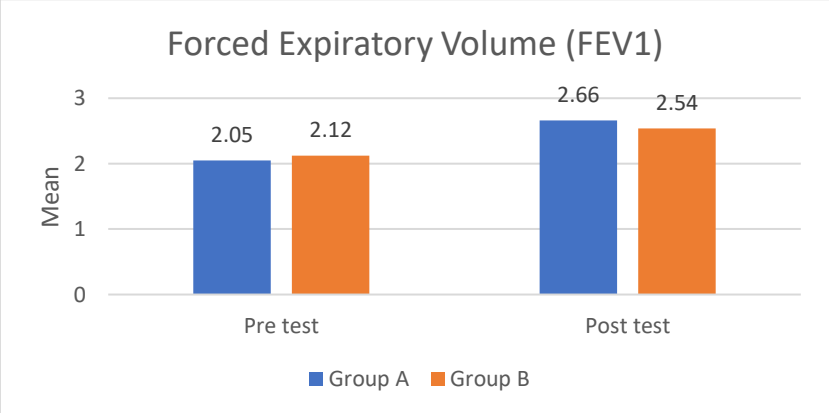
Table No. 8 Pre and post comparison Of Pulmonary Function Tests, Peak Expiratory Flow Rate, Breath Holding Time in Group A and Group B

	Group	Mean difference	S.D	P test	Remark
FEV1	Group A	-0.607	± 0.491	0.038	Statistically significant
	Group B	-0.421	± 0.388		
FVC	Group A	-0.635	± 0.449	0.037	Statistically significant
	Group B	-0.446	± 0.398		
PEFR	Group A	-46.20	± 37.79	0.001	Statistically significant
	Group B	-27.60	± 15.85		
BHT	Group A	-1.74	± 1.00	0.02	Statistically significant
	Group B	-1.20	± 1.19		

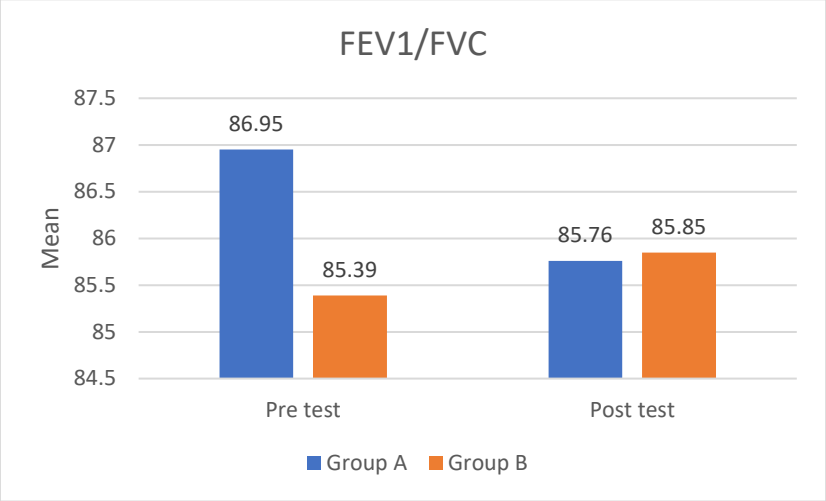
Graph 8 Pre and post FVC comparison in Group A and Group B



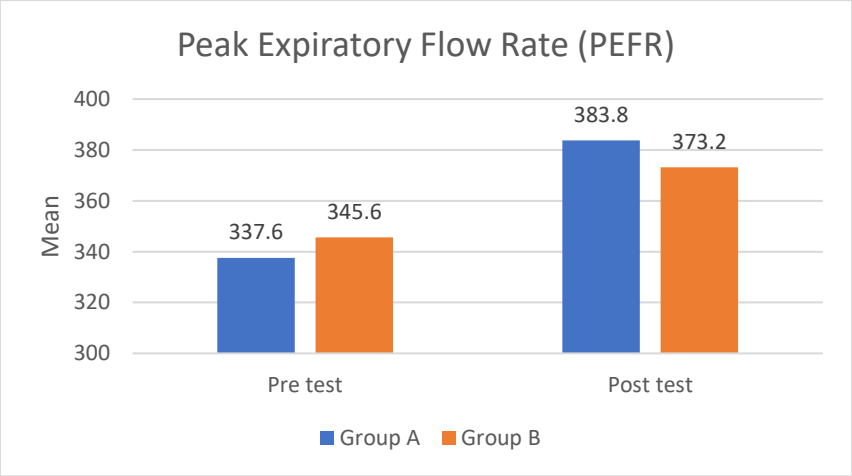
Graph 8 a Pre and post FEV1 comparison in Group A and Group B



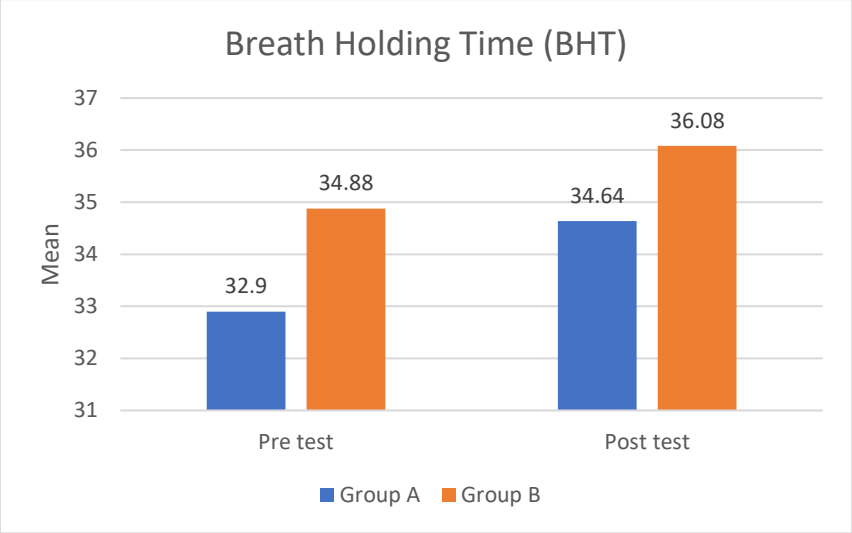
Graph 8 b Pre and post FEV1/FVC comparison in Group A and Group B



Graph 8 c Pre and post peak expiratory flow rate comparison in Group A and Group B



Graph 8 d Pre and post breath holding time comparison in Group A and Group B



DISSCUSSION

The present comparative study investigated the effectiveness of diaphragmatic breathing exercises (DBE) and Anulom-Vilom pranayama on pulmonary function parameters and breath-holding capacity among individuals with Grade 1 hypertension. Both interventions demonstrated statistically significant improvements in forced

vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow rate (PEFR), and breath-holding time (BHT) after four weeks. However, the improvements were more pronounced in participants practicing diaphragmatic breathing exercises, indicating its superior efficacy compared to Anulom-Vilom.

The findings in Group A (DBE) are in agreement with the work of Chukwu et al., who reported significant increases in FVC, FEV_1, FEV_1/FVC, and PEF after six weeks of DBE training. These improvements can be attributed to enhanced respiratory muscle strength, increased chest and abdominal expansion, and greater diaphragmatic excursion. Such physiological adaptations result in improved ventilation, oxygenation, and reduced airway resistance. Mayuni et al.[28] also emphasized that repeated diaphragmatic breathing enhances tidal volume, reduces functional residual capacity, and increases oxygen uptake by optimizing diaphragmatic activation during respiration.

In the current study, the FEV_1/FVC ratio for DBE did not show statistically significant improvement, a finding consistent with Sajal Halder's research, where significant gains in FEV_1 and FVC did not translate into significant changes in the FEV_1/FVC ratio[29]. This suggests that while lung volumes improved, the pattern of airway resistance remained largely unchanged.

Participants in Group B (Anulom-Vilom) also demonstrated significant improvements in FVC and FEV_1, which corroborates the results of Shelke et al. who noted that pranayama enhances respiratory muscle efficiency, improves alveolar ventilation, and reduces airway resistance. The slow, deep inspiration characteristic of Anulom-Vilom increases alveolar recruitment, while controlled expiration improves the effectiveness of respiratory muscle function and oxygen diffusion.

Both DBE and Anulom-Vilom significantly improved PEFR. The enhanced PEFR in Group A can be attributed to stronger expiratory muscles, improved lung emptying, and increased lung expansion, as described by Astuti et al. and Kartikasari et al[30]. In Group B, the PEFR improvements align with Krishnamurthy et al., who observed that pranayama reduces airway resistance and enhances respiratory muscle endurance, contributing to improved expiratory capacity.[31]

Significant improvements in BHT were observed in both groups. For DBE, increased BHT may be explained by improved lung inflation, better training of pulmonary stretch receptors, and greater tolerance to breath-holding, consistent with the findings of Sivakumar et al. Similarly, the improvements in Group B support studies by Patil, Pandey, and Vyas, which suggest that pranayama enhances autonomic regulation, improves stretch receptor adaptability, and increases chemoreceptor tolerance to hypoxia and hypercapnia, resulting in prolonged breath-holding capacity.[32,33]

The comparative analysis (Table 8) clearly demonstrates that DBE produced greater improvements in FVC, FEV_1, PEFR, and BHT than Anulom-Vilom. These findings are consistent with those of Alaparthi et al. and Shukla et al., who reported that DBE improves diaphragm excursion, alveolar recruitment, and overall respiratory biomechanics more effectively than other breathing techniques.[34,35] Because DBE targets the

primary muscle of inspiration—the diaphragm—it facilitates more efficient lung inflation, decreased use of accessory muscles, and enhanced breathing patterns.

Given the higher mean differences and p-values below 0.05, the null hypothesis is rejected. The study concludes that diaphragmatic breathing exercises are significantly more effective than Anulom-Vilom pranayama in improving pulmonary function and breath-holding time among individuals with Grade 1 hypertension.

Conclusion of Hypothesis Testing

The mean differences across Groups A and B, along with statistically significant p-values (<0.05), support rejection of the null hypothesis. This confirms a significant difference between the two interventions, with diaphragmatic breathing exercises demonstrating greater improvements in pulmonary function (FVC, FEV_1, PEFR) and breath-holding time compared to Anulom Vilom

LIMITATIONS

1. The study's limitations include it's no follow up and its exclusive focus on middle-aged individuals.
2. Pharmacological treatment of Hypertensive was not considered

CLINICAL IMPLICATIONS

It can be used as an adjunct along with pharmacotherapy, hypertension can be reduced by performing simple breathing exercises regularly. This exercise does not need any special equipment and major training to patients. So, this kind non-pharmacological therapy will help to reduce stress, improve cardiovascular function and respiratory function.

CONCLUSION

This study concludes that diaphragmatic breathing exercise and anulom vilom are equally effective in improving pulmonary function tests, peak expiratory flow rate, breath holding time in grade 1 hypertensive adults. But diaphragmatic breathing exercise was somewhat more effective than anulom vilom.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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