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ORIGINAL ARTICLE

EFFECTIVENESS OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION EXERCISE ON PULMONARY FUNCTION AND CHEST EXPANSION IN POSTMENOPAUSAL WOMEN WITH ASTHMA

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ABSTRACT

Background and objectives of the study: Asthma is characterized by hyperactive airways that respond to various stimuli by widespread inflammation and airway narrowing. The incidence of respiratory symptoms is higher in postmenopausal women. Decreased estradiol level due to menopause reduces protective influence on lungs and increase vulnerability to asthma and newly onset asthma in postmenopausal women is marked by deficient response to anti-inflammatory treatment. This study was designed to investigate the effects of PNF exercises in improving pulmonary function and chest expansion in postmenopausal women with asthma. **Methods:** 30 subjects were recruited for the study through purposive sampling based on inclusion criteria. Participants were allocated to two groups, experimental group (n=15) and control group (n=15) randomly. Pre- test analysis was conducted for both groups for pulmonary function (FEV1, FEV1/FVC) using pulmonary function test and chest expansion measurement (Axillary level and xiphisternal level) using chest expansion measurement by inch tape. Experimental group received PNF exercises in addition to conventional exercises whereas; control group received conventional exercise for 4 weeks. Immediate post- test analysis was conducted. Paired t test and two sample t test was used for statistical analysis. **Results:** There was a significant difference in FEV1 (t= 2.505), FEV1/FVC (t= 2.505), chest expansion at axillary level (t= 2.312) and chest expansion at xiphisternal level (t= 2.406) between control and experimental group with level of significance $p<0.05$. **Conclusion:** The study concluded that significant improvement in pulmonary function and chest expansion after 4 weeks of PNF exercise training in postmenopausal women with asthma.

Keywords: Proprioceptive neuromuscular facilitation exercise, pulmonary function, Chest expansion.

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INTRODUCTION

Female hormones are essential part of women's life, and it is responsible for commencing puberty, and plays an important role in the stage of motherhood and provide cardio protective functions and bone health[1.] However, after mid-forties, almost all women, irrespective of their cultural background and health conditions, begin to experience physical, psychological and emotional disturbances.

Those turmoil coincide with a progressive decline of female hormones, estrogen and progesterone, culminating to a total shutdown from the ovaries, diagnosed as menopause[2.] During this period, women present difficulties in accurately describing physical, psychosocial, or sexual disturbances and report mainly hot flashes, nervousness, depression, insomnia, and general fatigue. These vast arrays of symptoms progressively worsen the well-being of women, and affect, consequently, their quality of life (QOL) on a daily basis[3.]

According to the World Health Organization (WHO) classification,[4] premenopausal women are those who have experienced regular menstrual bleeding within the last 12 months, perimenopausal women are defined as those women who have experienced irregular menses within the last 12 months or the absence of menstrual bleeding for more than 3 months but less than 12 months, and postmenopausal women are those who have not experienced menstrual bleeding for 12 months or more.

Women with iatrogenic menopause are those for whom periods have stopped as a result of medical or surgical intervention, for example, due to chemotherapy or radiation of ovaries, hysterectomy or oophorectomy, or both. The age at natural menopause is between 45 years and 50 years. Early menopause is defined as menopause occurring before the age of 45 years, while premature menopause occurs before the age of 40 years[5.]

In addition to natural and surgical menopause, chronic diseases such as diabetes, obesity, and inflammatory disorders are also associated with a loss or imbalance in ovarian hormone levels and, consequently, an increased risk of hypertension[6].

The cessation of menstruation has been examined in relation to several chronic diseases and health parameters, but little is known about its effect on lung function[7].

Estrogen and progesterone help in airway smooth muscle relaxation which decreases contractile response of respiratory muscles and estrogen also plays an important role in collagen production. In menopause, decreased level of estrogen and progesterone causes reduced muscle strength and reduced relaxation of bronchial smooth muscles and an increased compaction of thoracic spine due to osteoporosis[8.]

Continuing change in the structure and mechanics of connective tissue that comprise loss of elasticity, decreased back extensor strength and collapse of vertebral body due to low bone mineral density[9.] Accentuated kyphosis is a perceptible change which is higher in postmenopausal women[10.] Evidence suggest that postmenopausal women show a progressive increase in thoracic kyphosis which change the chest circumference measures[11.] Osteoporosis related kyphosis is correlated with some disablement in pulmonary function[12.]

The change in menopausal status is associated with development of respiratory symptoms and new onset asthma. asthma is an inflammatory condition of the airways,[13] in which systemic

inflammation is important in the pathophysiology, and sex steroids have an effect on the immune regulation, with estradiol showing both proinflammatory and anti-inflammatory properties[14]. The effects of estrogens on eosinophils and mast cells might be particularly relevant for asthma[15]. Decreasing estradiol levels because of menopause potentially reduce protective influences on the lungs and thereby increase susceptibility to asthma and respiratory symptoms[16]. Airway inflammation in postmenopausal asthmatic patient is differ from that of patient with earlier onset asthma, marked by deficient response to anti-inflammatory treatment, besides more frequent and severe exacerbations[17].

As this is progressive condition and can worsen the quality of life, the physiotherapy plays an important role for promoting good health by reducing breathlessness, improves chest mobility by various breathing exercises[18]. In the modern field, the advanced physiotherapy techniques of PNF are being applied as a means of stimulating response and strengthening muscles related to respiration. PNF mobility exercise aims in improving the pulmonary functions and the mobility of chest wall, trunk and shoulder[19]. As D1 and D2 flexion extension involves movement of shoulder which improves chest mobility and shows improvement in chest expansion and mobilizing secretions.

Chest wall muscles are being maximally stretched and the inspiration with trunk extension, shoulder flexion, abduction, and external rotation (D2 flexion) and the expiration with trunk flexion, shoulder extension, adduction and internal rotation (D2 extension). As the intercostals muscle and diaphragm contains sensory muscle spindles that respond to elongation. A signal is sent to spinal cord and anterior horn cells. These neurons signal make more muscle fibers to contract (recruitment) and thus increase the strength[20]. Intercostal stretching is an effective PNF technique helps in improving breathing pattern and respiratory muscle activity. The IC stretch enhances the chest wall elevation and increases chest expansion and diaphragm excursion to improve intra- thoracic lung volume which contributes to improvement in flow rate percentage[21].

Rationale of the study: Recent study on PNF exercise concluded that PNF exercise is effective in improving SPo2, R.R, FEV1/FVC in patients with chronic bronchitis[20]. However, postmenopausal asthmatic patient is differing from that of earlier onset asthma marked by deficient response to anti-inflammatory treatment[17].

According to the study conducted by A. Dijkstra et.al (2005), in women there was no effect on the decline in lung function since similar dose of inhaled corticosteroids were used in men and women[22] and the cessation of menstruation has been examined in relation to several chronic disease, but little is known about its effect on lung function[23]. Hence, this study aimed to find out the effectiveness of PNF exercise to improve parameters like pulmonary function and chest expansion in postmenopausal women with asthma.

Objectives

- To study the effectiveness of PNF exercise on pulmonary function in postmenopausal women with asthma.
- To study the effectiveness of PNF exercise on chest expansion in postmenopausal women with asthma.

METHODOLOGY

Aims And Objectives: The aim of the study is to find out the effectiveness of PNF exercise on pulmonary function and chest expansion in postmenopausal women with asthma.

- To study the effectiveness of PNF exercise on pulmonary function in postmenopausal women with asthma.
- To study the effectiveness of PNF exercise on chest expansion in postmenopausal women with asthma.

This was a study with Quasi - experimental study design with pre-test, post-test, and control group. Conducted in Outpatient physiotherapy departments of hospitals in Alappuzha. Sampling method was Purposive sampling with sample size of 30 samples of population who satisfied the inclusion and exclusion criteria were selected.

Inclusion Criteria: Absence of menstrual cycle for one year and above (without post-menopausal bleeding), Age between 55 to 65, Subject who uses bronchodilators for the past one month, No exacerbation of symptoms in the last 2 weeks, Subjects with moderate airway obstruction based on GOLD criteria: GOLD 2-Moderate, FEV1/ FVC< 0.70, 50% <FEV1<80% of predicted, Subjects with BMI within normal limits, Mean value of chest expansion lower than 1.75 inches (Axillary level) and 2.05 inches (xiphisternal level), Not having regular exercise and diet, No coexisting disease affecting ability to undertake exercise, Willingness to cooperate study.

Exclusion Criteria: History of cardiovascular, metabolic, neurological, and psychiatric disorders, Active or post cancerous disease (going on radiation or chemotherapy < 6 months), Upper limb fracture, deformity and disease that affect ROM, Induced menopause in condition like hysterectomy, ovariectomy, Subject who receives hormone replacement therapy, Associated conditions restricting chest expansion (Eg: Obesity, severe scoliosis, ankylosing spondylitis), Recent chest or abdominal surgery

Method of Data Collection: Thirty subjects who fulfilled the inclusion criteria were selected purposively and randomly assigned into two groups of 15 each. Group A (control group) and group B (Experimental group) subjects were explained about the exercise and informed consent forms were obtained from the participants. Medical prescription about the dosage of bronchodilator drugs, were collected from the concerned doctor. Height, weight, BMI, BP and HR of the subjects were measured to assure that they are clinically stable to participate in the study. Pre-test was conducted on both groups using pulmonary function test and taking upper and lower chest expansion measurement at two level, axillary level and xiphisternum level.

GROUP A (Control Group)

After a brief demonstration, group A subjects were undergone diaphragmatic breathing exercise and thoracic mobility exercises.

Diaphragmatic breathing exercise

The patient is in a relaxed, comfortable position where the diaphragm is assisted by gravity, such as the semi-fowler position. Hands are placed on the abdomen just below the costal margin above. The patient is asked to breathe in through the nose slowly and deeply. Ask patient to breathe out and feel the rib cage shifting downwards and inwards. As the patient breathes out, placed pressure in the ribs with

the palms of therapist's hands. Ask the patient to slowly relax and exhale through the mouth.

Thoracic mobility exercises:

Elevating the shoulders: In high sitting position patient is asked to slowly breathe in through nose and gradually raise both the shoulders, followed by slowly breathe out through mouth after taking a deep breath. Then relax and lower the shoulders.

Stretch the Back Muscle: In high sitting position patient is asked to hold both the hands in front of his/her chest. Then slowly breathe in through nose, move both the hands together to the front and down to stretch back muscles. Followed by slowly breathe out after deep inspiration and resume the initial position.

Lower Chest stretching: In high sitting position patient is asked to hold the towel end at shoulder height with both hands stretched out. Slowly move the arm in upward direction after taking a deep breath. Lower your hands and breathe usually after deep expiration.

Exercise programme was given with 10-12 repetitions for 25 to 30 minutes session, 3 days/ week for 4 weeks. Intermittent rest was given after every 10 minutes[24].

GROUP B (Experimental GROUP)

After a brief demonstration, group B subjects were undergone PNF exercise along with conventional physiotherapy.
Two pairs of diagonal patterns for upper extremity are D1 flexion and extension, D2 flexion and extension.

D1 Flexion:
Starting position: Positioned the upper extremity in shoulder extension, abduction, and internal rotation. Elbow extension. Forearm pronation. Wrist and fingers extension with hand about 8 to 12 inches from the hip.

Verbal command: Therapist apply a quick stretch to the wrist and finger flexors, instructed the participant to squeeze on therapist's fingers, turn palm up, pull arm up and across the participant's face as therapist resist the pattern.

Ending position: Completed the pattern with shoulder flexion, abduction, external rotation. Partial elbow flexion. Forearm supination. Wrist and fingers flexion.

D1 Extension:

Starting position: Begin as described for competition of D1 flexion.

Verbal command: Therapist apply a quick stretch to the wrist and finger extensors, instructed the participant to open the hand then push arm down and out.

Ending position: Completed the pattern in shoulder extension, abduction, internal rotation. Elbow extension. Forearm pronation. Wrist and finger extension.

D2 Flexion:

Starting position: Positioned the upper extremity in shoulder extension, adduction internal rotation. Elbow extension. Forearm pronation. Wrist and finger flexion. The forearm lies across the umbilicus.

Verbal command: Therapist apply a quick stretch to wrist and finger extensors, instructed the participant to open hand and turn it to their face, lift arm up and out, point thumb out.

Ending position: Completed the pattern in shoulder flexion, adduction, external rotation. Elbow extension. Forearm supination. Wrist and finger extension with the arm about 8 to 10 inches from the ear, thumb pointing to the floor.

D2 Extension:

Starting position: Begin as described for competition of D2 flexion.

Verbal command: Therapist apply quick stretch to wrist and finger flexors, instructed the participant to squeeze on therapist's finger and pull down and across their chest.

Ending position: Completed the pattern in shoulder extension, adduction, internal rotation. Elbow extension. Forearm pronation. Wrist and finger flexion. The forearm crosses the umbilicus[41].

The training session was given for 3 sets of 10 repetitions.

Chest PNF – Intercostal Stretch

The subjects were in a supine position. Therapist placed his/her open hands on the lateral surfaces on both sides of the 8, 9, 10, and 11th ribs of the subject. The therapist instructed the subjects by saying, "Take a deep breath". As the subjects' ribs moved upward and laterally, the therapist assisted the movement of the subjects' ribs to promote the subjects' respiration pattern. At the subjects' maximum inspiration, the therapist said, "Hold breath for five seconds" while dorso-medially applying soft manual resistance to the lower rib regions on both sides. When the subjects' breathed out, the therapist said, "Breathe out maximally". At this time, the subjects' ribs moved downward and medially.

At maximum expiration, the therapist pushed the lower rib regions on both sides upward while gathering the regions dorso-medially, and the therapist shook the region to assist with the discharge of the air remaining in the lungs. IC stretch is applied for 10 breaths with 1 minute rest and for 10 repetitions.

The total length of treatment time was about 35-40 minutes. The program performed 3days/week for 4 weeks.

Post – test was conducted on both groups using pulmonary function test (PFT) to measure FEV1 and FEV1/ FVC and chest expansion measurement to measure chest expansion at axillary level and xiphisternal level at the end of intervention phase. Pre- test and post – test data were analysed using paired t test and two sample t test as statistical tool.

Outcome Measures

1. Pulmonary function test
2. Chest expansion measurement

1.Pulmonary function test: Sitting position was used to prevent the risk of falling. Instructed the subjects to remove false teeth if present, because it prevents the subject from forming an effective mouth seal around the mouth piece. Normal or predicted ranges of values are obtained from large population studies of healthy subjects. Values are taken for age, height, sex, and where appropriate ethnicity. Subjects are asked to take a maximal inspiration and then to forcefully expel air for as long and as quickly as possible. The values of forced expiratory volume in 1second (FEV1) and FEV1/FVC were recorded. PFT performed 3 times to ensure that the results are reproducible and accurate.

2.Chest expansion measurement: A measuring tape was used to measure CE in centimetres (cm) at two levels of the rib cage. For upper CE, the anatomical landmarks used were the spinous process of fifth thoracic vertebrae, the middle of the clavicular line, and the third intercostal space. For lower CE, the anatomical landmarks used were the spinous process of 10th thoracic vertebrae and the xiphoid process. Prior to the thoracic measurements, subjects

were asked to "inhale slowly and rhythmically through the nose against the inch tape to open up the lungs as much as you can," and then the subjects were asked to "exhale through the mouth completely." CE measurement was taken at the end of the inspiration and expiration cycles, while the subject was in a standing position with their arms at the side of their body, examiner placed the "0" point of the measuring tape (starting tip) on the spinous process of the vertebrae. tape was secured by the index finger of the examiner between the subject's body and the tape without generating extra pressure. To calculate the CE value, the inspiratory diameter was subtracted from the expiratory diameter. It was performed 3 times and the mean of the 3 values were considered as the determinant of chest expansion.

Materials Used: Inch tape, Stopwatch, Data collection sheet, Consent form, Ball pen., BP apparatus, Pulse oximeter, Weighing machine

RESULTS

Comparison of the Pre and Post Pulmonary Function Test and Chest Expansion Measurement of the two groups

Table 1 Comparison of the Pre FEV1 Test of the two groups

Pre FEV1	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	0.80	0.10	0.273	28	0.786
Group B	15	0.81	0.10			**Not Significant**

There is no significant difference between the Pre FEV1 Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 0.273 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is less than the tabled value. This means that the FEV1 Test are not significant at 5% level. Hence, we accept the null hypothesis. That is, there is no significant difference between the Pre FEV1 Test of the two groups at 5% level of significance.

Table 2 Comparison of the Pre FEV1/FVC Test of the two groups

Pre FEV1/FVC	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	42.86	4.99	0.371	28	0.713
Group B	15	42.15	5.41			**Not significant**

There is no significant difference between the Pre FEV1/FVC Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 0.371 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is less than the tabled value. This means that the FEV1/FVC Test are not significant at 5% level. Hence, we accept the null hypothesis. That is, there is no significant difference between the Pre FEV1/FVC Test of the two groups at 5% level of significance.

Table 3 Comparison of the Pre-Chest Expansion-Axillary Level Test of the two groups

Pre Chest-Expansion	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	1.71	0.33	0	28	1 **Not Significant**
Group B	15	1.71	0.33			

There is no significant difference between the Pre-Chest Expansion Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 0 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is less than the tabled value. This means that the Chest Expansion Test are not significant at 5% level. Hence, we accept the null hypothesis. That is, there is no significant difference between the Pre-Chest Expansion Test of the two groups at 5% level of significance.

Table 4 Comparison of the Pre-Chest Expansion-Xiphisternal Level Test of the two groups

Pre Chest-Expansion	Number	Mean	S.D	Value of t statistic	d.f	Significance
Group A	15	3.01	0.31	0.115	28	0.909 **Not Significant**
Group B	15	3.00	0.33			

There is no significant difference between the Pre-Chest Expansion Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 0.115 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is less than the tabled value. This means that the Chest Expansion Test are not significant at 5% level. Hence, we accept the null hypothesis. That is, there is no significant difference between the Pre-Chest Expansion Test of the two groups at 5% level of significance.

Table 5 Comparison of the Post FEV1 Test of the two groups

Post FEV1	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	0.84	0.11	2.505	28	0.018
Group B	15	0.98	0.20			**Significant**

There is no significant difference between the Post FEV1 Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 2.505 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is greater than the tabled value. This means that the Post FEV1 Test are significant at 5% level. That is, there is a significant difference between the Post FEV1 Test of the two groups at 5% level of significance.

Table 6. Comparison of the Post FEV1/FVC Test of the two groups

Post FEV1/FVC	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	0.84	0.11	2.505	28	0.018
Group B	15	0.98	0.20			**Significant**

There is no significant difference between the Post FEV1/FVC Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 2.505 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is greater than the tabled value. This means that the Post FEV1/FVC Test are significant at 5% level. That is, there is a significant difference between the Post FEV1/FVC Test of the two groups at 5% level of significance.

Table 7 Comparison of the Post Chest Expansion-Axillary Level Test of the two groups

Post Chest Expansion	Number	Mean	S.D	Value of t	d.f	Significance
Group A	15	1.83	0.30			0.028
Group B	15	2.10	0.33	2.312	28	**Significant**

There is no significant difference between the Post Chest Expansion Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 2.312 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is greater than the tabled value. This means that the Chest Expansion Test are not significant at 5% level.

Table 8 Comparison of the Post Chest Expansion-Xiphisternal Level Test of the two groups

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre FEVI	0.80	15	0.10	2.241	14	0.812	0.042
Post FEVI	0.84	15	0.11				**Significant**
Pre FEVI - Post FEVI	-0.03	15	0.06				

There is no significant difference between the Post Chest Expansion Test of the two groups.

Interpretation: Here the value of t statistic (calculated value) is 2.406 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 28 are 2.048. That is the calculated value is greater than the tabled value. This means that the Chest Expansion Test are significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the Post Chest Expansion Test of the two groups at 5% level of significance.

Effectiveness of controlled group (Group A)

Table 9 Comparison of Pre FEV1 Test and Post FEV1 Test

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre FEVI	0.80	15	0.10	2.241	14	0.812	0.042 **Significant**
Post FEVI	0.84	15	0.11				
Pre FEVI - Post FEVI	-0.03	15	0.06				

The pre and post FEV1 Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 2.241 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre FEV1 Test and post FEV1 Test of the controlled group at 5% level of significance. Also the P-value for the t test is 0.042, which is less than 0.05. Hence the study is significant at 5% significance level. So we reject the null hypothesis. That is, there is a significant difference between the pre FEV1 Test and post FEV1 Test of the controlled group. That is, the post FEV1 Test are greater than the pre FEV1 Test.

The difference between the means of pre FEV1 Test and post FEV1 Test are -0.03 and the corresponding standard deviation is 0.06. Here the correlation value between pre FEV1 Test and post FEV1 Test is 0.812. This means that there is a positive correlation between pre FEV1 Test and post FEV1 Test.

Table 10 Comparison of Pre FEV1/FVC Test and Post FEV1/FVC Test

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre FEVI/FVC	42.86	15	4.99	2.703	14	0.998	0.017
Post FEVI/FVC	43.13	15	5.19				
Pre FEVI/FVC - Post FEVI/FVC	-0.27	15	0.39				Significant

The pre and post FEV1/FVC Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 2.703 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. That is, there is a significant difference between the pre FEV1/FVC Test and post FEV1/FVC Test of the controlled group at 5% level of significance. Also the P-value for the t test is 0.017, which is less than 0.05. That is, there is a significant difference between the pre EV1/FVC Test and post FEV1/FVC Test of the controlled group. That is, the post FEV1/FVC Test are greater than the pre FEV1/FVC Test.

The difference between the means of pre FEV1/FVC Test and post FEV1/FVC Test are -0.27 and the corresponding standard deviation is 0.39. Here the correlation value between pre FEV1/FVC Test and post FEV1/FVC Test is 0.998. This means that there is a strong positive correlation between pre FEV1/FVC Test and post FEV1/FVC Test.

Table 11 Comparison of Pre and Post Chest Expansion-Axillary Level

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre-Chest Expansion	1.71	15	0.33	3.833	14	0.920	0.002 Significant
Post Chest Expansion	1.83	15	0.30				
Pre CE - Post CE	-0.13	15	0.13				

The pre and post Chest Expansion Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 3.833 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. That is, there is a significant difference between the pre-Chest Expansion Test and post Chest Expansion Test of the controlled group at 5% level of significance. Also the P-value for the t test is 0.002, which is less than 0.05. Hence the study is significant at 5% significance level. So we reject the null hypothesis. That is, there is a significant difference between the pre-Chest Expansion Test and post Chest Expansion Test of the controlled group. That is, the post Chest Expansion Test are greater than the pre-Chest Expansion Test.

The difference between the means of pre-Chest Expansion and post Chest Expansion Test are -0.13 and the corresponding standard deviation is 0.13. Here the correlation value between pre-Chest Expansion Test and post Chest Expansion Test is 0.920. This means that there is a strong positive correlation between pre-Chest Expansion Test and post Chest Expansion Test.

Table 12 Comparison of Pre and Post Chest Expansion-Xiphisternal Level

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre-Chest Expansion	3.01	15	0.31	4	14	0.869	0.001 Significant
Post Chest Expansion	3.17	15	0.29				
Pre CE - Post CE	-0.16	15	0.15				

H0: the pre and post Chest Expansion Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 4 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre -Chest Expansion Test and post Chest Expansion Test of the controlled group at 5% level of significance. Also, the P-value for the t test is 0.001, which is less than 0.05. That is, there is a significant difference between the pre -Chest Expansion Test and post Chest Expansion Test of the controlled group. That is, the post Chest Expansion Test are greater than the pre -Chest Expansion Test.

The difference between the means of pre- Chest Expansion and post Chest Expansion Test are -0.16 and the corresponding standard deviation is 0.15. Here the correlation value between pre- Chest Expansion Test and post Chest Expansion Test is 0.869. This means that there is a positive correlation between pre- Chest Expansion Test and post Chest Expansion Test.

Effectiveness of Experimental Group (Group B)

Table 13 Comparison of Pre FEV1 Test and Post FEV1 Test

	Mean	N	Std. Deviation	Value of t	D.F	Correlation	Significance
Pre FEVI	0.81	15	0.10	2.241	14	0.827	0.000 Significant
Post FEVI	0.98	15	0.20				
Pre FEVI - Post FEVI	-0.17	15	0.13				

H0: the pre and post FEV1 Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 5.316 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre FEV1 Test and post FEV1 Test of the

experimental group at 5% level of significance. Also, the P-value for the t test is 0.000, which is less than 0.05. Hence the study is significant at 5% significance level. So, we reject the null hypothesis. That is, there is a significant difference between the pre FEV1 Test and post FEV1 Test of the experimental group. That is, the post FEV1 Test are greater than the pre FEV1 Test.

The difference between the means of pre FEV1 Test and post FEV1 Test are -0.17 and the corresponding standard deviation is 0.13. Here the correlation value between pre FEV1 Test and post FEV1 Test is 0.827. This means that there is a positive correlation between pre FEV1 Test and post FEV1 Test.

Table 14 Comparison of Pre FEV1/FVC Test and Post FEV1/FVC Test

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre FEVI/FVC	42.15	15	5.41	4.916	14	0.716	0.000 Significant
Post FEVI/FVC	47.25	15	5.23				
Pre FEVI/FVC - Post FEVI/FVC	-5.09	15	4.01				

H0: the pre and post FEV1/FVC Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 4.916 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre FEV1/FVC Test and post FEV1/FVC Test of the experimental group at 5% level of significance. Also, the P-value for the t test is 0.000, which is less than 0.05. That is, there is a significant difference between the pre FEV1/FVC Test and post FEV1/FVC Test of the experimental group. That is, the post FEV1/FVC Test are greater than the pre FEV1/FVC Test.

Table 15 Comparison of Pre and Post Chest Expansion-Axillary Level

	Mean	N	Std. Deviation	Value of t	d.f	Correlation	Significance
Pre -Chest Expansion	1.71	15	0.33	5.10	14	0.585	0.000 Significant
Post Chest Expansion	2.10	15	0.33				
Pre CE - Post CE	-0.39	15	0.30				

The pre and post Chest Expansion Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 5.10 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value. This means that the study of pre

and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre -Chest Expansion Test and post Chest Expansion Test of the experimental group at 5% level of significance. Also, the P-value for the t test is 0.000, which is less than 0.05. Hence the study is significant at 5% significance level. So, we reject the null hypothesis. That is, there is a significant difference between the pre- Chest Test and post Chest Expansion Test is 0.585. This means that there is a positive correlation between pre -Chest Expansion Test and post Chest Expansion Test.

The difference between the means of pre- Chest Expansion and post Chest Expansion Test are -0.39 and the corresponding standard deviation is 0.30. Here the correlation value between pre-Chest Expansion

Table 16 Comparison of Pre and Post Chest Expansion-Xiphisternal Level

	Mean	N	Std. Deviation	Value of t	D.F	Correlation	Significance
Pre -Chest Expansion	3.00	15	0.33	9.09	14	0.845	0.000
Post Chest Expansion	3.47	15	0.37				
Pre CE - Post CE	-0.47	15	0.20				Significant

H0: the pre and post Chest Expansion Test are equal.

Interpretation: Here the value of t statistic (calculated value) is 9.09 and the corresponding tabled value with significance level 0.05(5 percent) and degrees of freedom 14 are 2.145. That is the calculated value is greater than the tabled value.

This means that the study of pre and post values is significant at 5% level. Hence, we reject the null hypothesis. That is, there is a significant difference between the pre- Chest Expansion Test and post Chest Expansion Test of the experimental group at 5% level of significance. Also, the P-value for the t test is 0.000, which is less than 0.05. Hence the study is significant at 5% significance level. So, we reject the null hypothesis. That is, there is a significant difference between the pre- Chest Expansion Test and post Chest Expansion Test of the experimental group. That is, the post Chest Expansion Test are greater than the pre-Chest Expansion Test.

The difference between the means of pre -Chest Expansion and post Chest Expansion Test are -0.47 and the corresponding standard deviation is 0.20. Here the correlation value between pre -Chest Expansion Test and post Chest Expansion Test is 0.845. This means that there is a positive correlation between pre-Chest Expansion Test and post Chest Expansion Test.

Descriptive Statistics:

Table 17 Frequency Distribution of age of two groups

Age		Frequency	Percentage
Group A	50-60	9	60
	60-70	6	40
	Total	15	100
Group B	50-60	6	40
	60-70	9	60
	Total	15	100

Table 18: Frequency Distribution of Pre and Post FEV1 Test of two groups

Group		Pre	Post
Group A	Mean	0.80	0.84
	N	15	15
	Std. Deviation	0.10	0.11
Group B	Mean	0.81	0.99
	N	15	15
	Std. Deviation	0.10	0.20
Total	Mean((A+B)/2)	0.805	0.915
	N	15	15
	Std. Deviation ((A+B)/2)	0.10	0.16

Table 19: Frequency Distribution of Pre and Post FEV1/FVC Test of two groups

Group		Pre	Post
Group A	Mean	42.86	43.13
	N	15	15
	Std. Deviation	5	5.19
Group B	Mean	42.15	47.25
	N	15	15
	Std. Deviation	5.41	5.23
Total	Mean((A+B)/2)	42.51	45.19
	N	15	15
	Std. Deviation ((A+B)/2)	5.21	5.21

Table .20: Frequency Distribution of Pre and Post Chest Expansion-Axillary Level Test of two groups

Group		Pre	Post
Group A	Mean	1.71	1.83
	N	15	15
	Std. Deviation	0.33	0.30
Group B	Mean	1.71	2.10
	N	15	15
	Std. Deviation	0.33	0.33
Total	Mean((A+B)/2)	1.71	1.97
	N	15	15
	Std. Deviation ((A+B)/2)	0.33	0.32

Table 21: Frequency Distribution of Pre and Post Chest Expansion-Xiphisternal Level Test of two groups

Group		Pre	Post
Group A	Mean	3.01	3.17
	N	15	15
	Std. Deviation	0.31	0.29
Group B	Mean	3	3.47
	N	15	15
	Std. Deviation	0.33	0.37
Total	Mean((A+B)/2)	3.0	3.32
	N	15	15
	Std. Deviation ((A+B)/2)	0.32	0.33

DISCUSSION

The study aims to find out the effectiveness of proprioceptive neuromuscular facilitation exercise on pulmonary function and chest expansion in postmenopausal women with asthma.

30 subjects those satisfying the inclusion criteria were recruited for the study. Subjects were then allocated to two groups. Group A (Control group) and group B (Experimental group), 15 in each group. Each group was well explained about the procedure of the intervention. A written informed consent from each subject was obtained. Subjects in group A received conventional treatment, includes diaphragmatic breathing exercise and thoracic mobility exercises and subjects in group B received proprioceptive neuromuscular facilitation exercise along with conventional treatment. All subjects well tolerated the intervention given and no one was dropped out of the study. The outcome measurement was Pulmonary function test (PFT) and the Chest expansion (CE) measurement.

All outcome measurements were collected before and after the intervention protocol. Statistical analysis was done using paired t test and two sample t test. The results shows that there is significant improvement in post- test experimental group mean value of FEV1 from 0.81 to 0.98 shows high significance with the t value of 5.316 and p value 0.000 and FEV1/FVC post- test experimental group with a mean improvement value from 42.15 to 47.25 and show significance with t value 4.916 and p value 0.000. While chest expansion at axillary level post -test experimental group with mean value from 1.71 to 2.10 and show significance with t value 5.10 and p value 0.000 and chest expansion at xiphisternal level post- test experimental group with mean value from 3.00 to 3.47 shows high significance with t value of 9.09 and p value 0.000. The post test scores of PFT and CE measurement of control and experimental group were analysed using two sample t test. The data analysis showed statistically significant difference in the post scores of PFT and CE measurement of experimental group over control group at 5% level. So there is statistically significant improvement in pulmonary function and chest expansion in postmenopausal women with asthma who received proprioceptive neuromuscular facilitation exercise along with conventional treatment than control group who received conventional treatment alone. So, the null hypothesis is rejected, and alternate hypothesis is accepted.

Asthma is generally a benign disease. However, it is acknowledged that lung function may decline more rapidly than in healthy individuals, probably as the result of an ongoing chronic inflammatory airway disease. In asthma patient the shape of thorax, posture and lung volumes are often deviate from the normal. The rib cage is held in a position of hyperinflation. This is frequently associated with some degree of thoracic kyphosis.

The change in menopausal status is associated with development of respiratory symptoms and new onset asthma. Because estrogen and progesterone help in airway smooth muscle relaxation which decreases contractile response of respiratory muscles and estrogen also plays an important role in collagen production. In menopause, decreased level of estrogen and progesterone causes reduced muscle strength and reduced relaxation of bronchial smooth muscles. According with the observations of Kai Triebner et al (2015) Airway inflammation in postmenopausal asthmatic patient is differ from that of patient with earlier onset asthma, marked by deficient response to anti-inflammatory treatment[25].

After the intervention, pulmonary function and chest expansion outcomes improves in postmenopausal women with asthma. The therapeutic role of PNF pattern based on stretch-reflex theory in altering pulmonary functions. chest wall muscles are being maximally stretched and ribs are naturally opening up in butterfly technique where the inspiration with trunk extension, shoulder flexion, abduction and external rotation (D2 flexion) and the expiration with trunk flexion, shoulder extension, adduction and internal rotation (D2 extension)[26] Sang Yeol Lee (2020) examined the effects of Inspiration and Expiration Exercise Combined with Upper Extremity Proprioceptive Neuromuscular Facilitation and concluded that combined respiratory exercise with PNF upper extremity pattern showed a significant improvement in both FVC and PEF after 4 weeks of intervention in healthy subjects[27]. Consistent with this finding, Moreno et al. (2017) applied PNF upper

extremity patterns to healthy adults for four weeks and reported increased maximum inspiratory pressure (101cmH2O to 140cmH2O) and maximum expiratory pressure (107cmH2O to 155cmH2O) after four weeks[28]. Similarly, Areas et al. (2013) examined a 4-week randomized control trial and reported that a combined PNF upper extremity patterns with therapeutic resistant bands showed increased strength in respiratory muscles in healthy women. This increased strength in respiratory muscles may result from the involvement of accessory respiratory muscles (e.g. sternocleidomastoid, scalene, pectoralis, serratus anterior, or serratus posterior) during upper extremity movements[29].

In addition to PNF upper extremity pattern exercise, experimental group also received chest PNF- intercostal stretch. Intercostal muscle helps in upward and outward movement of the ribs which results in increasing antero-posterior diameter of the thoracic cavity[30]. It also helps both in inspiration and forced expiration. Therefore, this could have an impact on chest wall mobility and expansion in turn to ventilation. Morphologically intercostal muscle displayed a variation in fiber size and atrophy among obstructive lung disease subjects. Hence change in pulmonary functions parameters while performing IC stretching might benefit to a particular population. where respiratory compromise has been demonstrated due to poor IC muscle function[31].

Respiratory drive is regulated by information from sensory receptors within the airway, lungs and respiratory muscles as well as central and peripheral chemoreceptors. The respiratory muscle contraction and relaxation are control of GTO which is sensitive to muscle stretch (active or passive) due to this there is a firing discharge of muscle spindle, which give this message to CNS via alpha and gamma motor neurons which directly responsible for initiating muscle contraction[32]. IC stretch increases alpha motor neuron activity, causing the muscle fibers to contract and thus resist the stretching. Gamma motor neurons, which innervate intrafusal muscle fibers of muscle spindles regulate how sensitive the stretch is.

Application of stretch to the chest wall prior to inspiration increases the gamma motor neuron discharge and alpha motor neuron activity is enhanced[33]. It could also be argued that this altered ventilatory function may have resulted because of reflexive activation of the diaphragm by the ICs afferents that innervate its margins.

Study conducted by Payal gupta, Gopal Nambi et al. titled- Effect of Intercostal Stretch Technique and Anterior Basal Lift Technique on Respiratory Rate, Saturation of Peripheral Oxygen and Heart Rate among ICU Patients in 2014 concluded that IC stretch is more effective in reduction of respiratory rate and heart rate and improving oxygen saturation over anterior basal lift technique, because IC stretch enhances the chest wall elevation and increase chest expansion and diaphragm excursion to improve intrathoracic lung volume which contributes to improvement in flow rate percentage[34].

Therefore, based on the findings the present study found that there is a statistically significant effect of PNF exercise along with conventional treatment than conventional treatment alone in improving pulmonary function and chest expansion in post-menopausal women with asthma.

CONCLUSION

The study was to evaluate the effectiveness of proprioceptive neuromuscular facilitation exercise on pulmonary function and chest

expansion in postmenopausal women with asthma. Based on the statistical analysis, the result of the present study shows that there is statistically significant change in pulmonary function test and chest expansion measurement between pre -test and post -test in both control and experimental group.

Experimental group shows more improvement than control group in pulmonary function, FEV1 and FEV1/FVC using PFT and chest expansion in axillary level and xiphisternal level using CE measurement by inch tape. Thus, the study concludes that proprioceptive neuromuscular facilitation exercise is effective in improving pulmonary function and chest expansion in postmenopausal women with asthma.

Therefore, the study rejected the null hypothesis and accepts the alternate hypothesis

Ethical clearance: Ethical clearance has obtained from CPAS, School of Medical Education, Gandhinagar, Kottayam, Kerala, Reference number: MPTSA/EC/SME/GNR /2020/04, Dated: 29/11/2021.

Conflict of interest: There was no conflict of interest to conduct this study.

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