

ORIGINAL RESEARCH

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COMBINED EFFECT OF PNF STRETCHING WITH CHEST MOBILITY EXERCISES ON CHEST EXPANSION AND PULMONARY FUNCTIONS FOR ELDERLY

¹Gopi Parth Mehta²Vinod Babu .K³Akshata Akalwadi⁴Sai Kumar .N

ABSTRACT

Background: PNF stretching and chest mobility exercises found to be effective in elder patients, however the combined effectiveness of these techniques were unknown. The purpose of this study is to find the effect of Hold-relax PNF stretching technique for pectoralis muscle combined with chest mobility exercises on improvement of chest expansion and pulmonary function for elderly subjects.

Method: An Experimental study design, 30 subjects with age group above 60 years were randomized 15 subjects each into Study and Control group. Control group received Supervised Active Assisted Exercise Program while Study group received Hold-relax PNF Stretching for pectoralis muscle, Chest Mobility Exercises Program and supervised Active Assisted Exercise Program for a period of one week. Outcome measures such as chest expansion at axilla and xiphisternum and pulmonary function test such as FEV1, FVC and FEV1/FVC were measured before and after one week of treatment.

Results: Analysis using paired 't' test within the group found that there is no statistically significant difference within control group where as there is a statistical significant difference within study group. Comparative analysis of pre-intervention means shown that there is no statistically significant difference between the groups. Comparative analysis of post-intervention means shown that there is a statistically significant difference in means of Chest expansion, FEV1/FVC and there is no statistical significant difference in FEV1 and FVC between study and control groups.

Conclusion: It is concluded that one week of combined Hold-relax PNF stretching for pectoralis muscle with chest mobility exercises shown significant improvement in chest expansion and pulmonary function test such as forced expiratory volume and forced vital capacity than only active assisted exercise program for elderly subjects.

Key words: PNF stretching, chest mobility exercises, elderly, chest expansion, pulmonary function test, forced vital capacity, forced expiratory volume, hold-relax technique.

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CORRESPONDING AUTHOR

*²Vinod Babu .K, MPT, MD (A.M)

Assistant Professor,
K.T.G. College of Physiotherapy and
KTG Multispecialty Hospital,
Bangalore-560 091, India.

¹ MPT, (Shukla Gopi Atulkumar)

³ Associate Professor,

⁴ Professor & Principal.

K.T.G. College of Physiotherapy and
KTG Multi Specialty Hospital.

Bangalore. India.

Affiliated to Rajiv Gandhi University of
Health Sciences, Karnataka. India.

INTRODUCTION

People above 60 years of age are typically considered as 'old' and called 'elderly' population. In elderly lifetime accumulated disease burden, particularly cardiopulmonary diseases, Cardiovascular and respiratory diseases stand out as major causes of mortality. The proportion of deaths from pulmonary diseases have increased among the elderly compared to all deaths.^{1,2}

Aging is associated with a significant decrease in chest wall compliance that includes decrease in compliance of rib cage (upper thorax) and compliance of the diaphragm-abdomen compartment (lower thorax). The compliance can be referred as change in volume relative to change in pressure. Compliance of the respiratory system is 20% less in a 60-year-old geriatric subject compared with a 20-year-old adult.² Total respiratory system compliance includes lung and chest wall compliance.² As age increases musculoskeletal deterioration also increases, postural and skeletal changes that occur over time causes overuse of upper chest breathing patterns reducing lower rib expansion and reducing efficient pattern of diaphragmatic breathing. The kyphotic curvature of the spine and the anteroposterior diameter of the chest increase with aging. Thus, curvature of the diaphragm and its force-generating capacity decreases.³ Vertebral intersegmental motion gradually lost as the chest becomes fixed in elevation and flexion. Reduced range of thoracic extension contribute to tightness in the shoulder quadrant muscles.⁴ The combination of reduced elastic recoil and increased chest wall stiffness leads to a decrease in the forced vital capacity in older individuals.⁵

Suitable lengthening of soft tissue around the chest wall and respiratory muscles is required for efficiency of contraction force of respiratory muscles and chest movement.⁶ Conventionally, to increase flexibility of muscles, techniques such as passive stretching, PNF stretching, self-stretching, passive mobilization of joints, chest/thorax mobility exercises and massage are recommended.⁵

The patterns of movement associated with PNF are composed of multijoint, multiplanar, diagonal, and rotational movements of the extremities, trunk and neck.⁵ Various PNF stretching techniques based on Kabat's concept are: Hold Relax, Contract Relax, and Contract Relax Antagonist Contract etc.⁷ Hold Relax is utilized to activate properly when the agonist is too weak. The patient's restricted muscle is put in a position of stretch followed by an isometric contraction of the restricted muscle.

After the allotted time the restricted muscle is passively moved to a position of greater stretch. This technique utilizes the autogenic inhibition, which relaxes a muscle after a sustained contraction has been applied to it.⁷

Chest mobility exercises is one of many techniques and very important in conventional chest Physiotherapy for increasing chest wall mobility and improving ventilation. These techniques are divided into passive and active chest mobilization. Use of technique depends on the patient's condition. Either passive or active chest mobilizations help to increase chest wall mobility, flexibility, and thoracic compliance.⁶ The focus of the treatment is most commonly on improving the range and quality of thoracic extension and rotation and on increasing the mobility of thoracic ribs.⁴ The techniques of chest mobilization are composed of rib torsion, lateral stretching, back extension, lateral bending, trunk rotation, etc.

In geriatrics adaptive shortening and stiffness around the upper chest muscle quadrant and around the thoracic wall increases chest wall resistance and work of breathing, a method of reversing these changes is important to include in a management plan for Geriatrics.⁸ Therefore the Study with research question, does combined PNF stretching with chest mobility exercises have an effect on improving chest expansion and pulmonary function test for elderly people? There are no studies found in the literature that aim to find the effect of the upper chest muscle quadrant, chest wall mobility and flexibility for elderly subjects. Hence, the purpose of this study is to find the combined effect of Hold-relax PNF stretching with chest mobility exercises on pulmonary function test such as FEV1, FVC, FEV1/FVC ratio and chest expansion for elderly. It was null hypothesized that there will be no significant effect of combined Hold-relax PNF stretching with chest mobility exercise on improving chest expansion and pulmonary function test in elderly people.

METHODOLOGY

An experimental study design with two groups- Study Group and Control Group. As this study involved human subjects the Ethical Clearance was obtained from the Ethical Committee of KTG College of Physiotherapy and K.T.G. Hospital, Bangalore as per the ethical guidelines of Bio-medical research on human subjects. This study was registered under Rajiv Gandhi University of Health Sciences for subject for registration for dissertation with registration number 09_T031_47130. Subjects included in the study were with age group between 65-75 years,¹ chest expansion

less than 1.5 cms,⁹ FEV1/FVC < 0.70 and FEV1 ≥ 80%, ability to communicate and follow commands, who had independent mobility. Subjects were excluded with musculoskeletal disorders affecting upper limb, pathological condition affecting muscle, joint and bone Such as rheumatoid arthritis, severe osteoporosis, cardiovascular dysfunction (eg, ischemic heart disease, uncontrolled hypertension), associated conditions restricting chest expansion. (eg, obesity, severe scoliosis, ankylosing spondylitis), recent chest or abdominal surgery,⁵ pathology of spine such as disc protrusion, spondylolisthesis.

Subjects were recruited from KTG Hospital and various rehabilitation centers across Bangalore. The study was conducted at KTG Multi Specialty Hospital, Bangalore. Subjects who meet inclusion criteria were recruited by Simple random sampling method using closed envelopes, randomly allocated subjects into two groups. Subjects who meet inclusion criteria were informed about the study and a written informed consent was taken. Total 40 Subject (n=30), 15 in each group completed the study. Subjects were blinded throughout the treatment sessions, subjects from both the groups were not allowed to have any interaction to each other and the subjects were not aware of what kind of treatment they received and its effects. The duration of intervention was carried for one week, 5 sessions in a week

Procedure of intervention for Study group:

In this group, subjects were treated with PNF stretching, chest mobility exercise and supervised Active Assisted Exercise Program.

Chest mobility exercise^{4,6}- Each exercises listed below was repeated 6 times on each side with rest of period for 30 seconds in between. The intervention was carried out for one week with total of 7 sessions. Each Exercise was accompanied by breathing pattern. In neutral position of exercises, subjects were asked to exhale during flexion, turning or extension subject was asked to do inhale.

1. Rib torsion: (Figure-1) Subject in supine lying, therapist standing on opposite side facing subject, stretches right side of chest placing hands on one side of rib cage and giving opposite directional forces and same was performed on other side.
2. Passive lateral flexion of thorax in supine lying: Subject in supine, asked to fold hands or keep it by side of his body. Therapist then passively flexes subject thorax from head end of body on left and right side with slight over stretched at the end range alternately.

3. Passive lateral flexion in side lying on pillows: (Figure-2) Subject lying on one side on 2 pillows. Therapist stretches the upper side of thorax with shoulder abduction. The same exercise was repeated on other side.
4. Mobilization of facet joint of the thorax in supine lying: Subject in Supine lying with subjects arm folded in front, therapist keeping one hand on thoracic spine and other on anterior chest, performs thoracic side flexion and extension movements both on right and left side alternatively.
5. Direct rib stretching: Subject in supine lying with arms folded and hands clasped on back of neck, therapist performs flexion and extension of the subject thorax.
6. Costovertebral joint mobilization: Subject in supine lying, therapist performs passive lifting of the spine. It could be given unilateral or bilateral.
7. Trunk rotation in sitting position (Figure-3): Active and passive trunk rotation on both sides were performed. Exhalation in a forward position was carried out at the beginning of flexion, and rotation of the left side was performed laterally with inspiration.
8. Trunk side flexion in sitting position: Active and passive trunk side flexion on both sides were performed. Exhalation in a forward position was carried out at the beginning of flexion, and rotation of the left side was performed laterally with inspiration. Side flexion on left was accompanied by shoulder abduction of right hand and vice versa.



Figure-1: Rib rotation in supine lying



Figure-2: Side stretch on pillows



Figure-3: Trunk rotation



Figure-4: PNF Hold-relax Stretching



Figure-5: Measuring Chest Expansion

Figure-6: Measuring PFT

Hold-relax PNF stretching¹⁰:

The technique used in this study PNF technique of hold and relax stretching for isolated clavicular head of the pectoralis major muscle. Due to the hyperinflation and rigid thoracic walls in elderly, studies had shown that lengthening the clavicular head portion of the pectoralis major muscle was more likely to affect the restrictive component.

The subjects sitting on a chair with back support to keep spine in a neutral position and both their arms were comfortably extended and hands are placed behind the occipital region. The subject both arms was positioned in glenohumeral horizontal extension, and glenohumeral abduction and external rotation with elbow bent to perform stretch position of pectoral muscle (Figure-4). The subject was then asked to contract the pectoral muscles to move the limb in the the direction of glenohumeral horizontal flexion, in the maintained position of 80° to 90° of glenohumeral abduction and external glenohumeral rotation with elbow bent to meet the 50-60% of resistance applied by the Therapist. This isometric contraction was held for 6 seconds. The patient then relaxed and passive stretch in the opposite direction was applied. Each intervention was repeated 6 times with rest period 30 seconds. The session were given every day for one week.

Procedure of intervention for Control technique:

Subjects in this group received Supervised Active Assisted Exercise Program^{10,11} which was common program for both study and control group. The subject's arm was moved passively 3 times throughout a resistance-free ROM. This movement involved glenohumeral flexion and extension in approximately 25° of glenohumeral abduction with the elbow flexed. At the mid-range of glenohumeral flexion and extension, the subject's arm was supported and the subject was asked to try to bend the elbow to meet the resistance applied by the research assistant - therefore performing an isometric contraction of the biceps for 6 seconds. The subject was also asked to do trunk flexion, extension, lateral bending, rotation actively. Each

exercises was repeated 6 times on each side with rest period for 30 seconds in between. The intervention was carried out for one week with total of 7 sessions.

Outcome Measurements:

Chest expansion and lung functions was measured using inch tape and spirometry respectively before and after one week of intervention

Chest wall expansion (Figure-5): This method consisted of measuring the patient's chest circumference in standing at 2 levels of thorax: the axillary and the xiphisternam level. The subject was instructed to stand with the arms relaxed by the sides. The tape was placed around the circumference of the chest. To measure the upper thoracic excursion, tape was placed at the level of 5th thoracic spinous process and 3rd intercostal space at mid clavicular line. To measure the lower thoracic excursion, tape was placed at 10th thoracic spinous process and tip of xiphoid process. The measurements were taken at peak inhalation and an average of 3 trials was documented. The reliability of this technique shows an interclass correlation coefficient of 0.81 to 0.91 proving it reliable in clinical setting.^{12,13}

Pulmonary function tests (FEV₁, FVC, FEV₁/FVC):

The test procedure was explained to the subject. Also instruct and demonstrate the test to the subject, to include-Correct posture with head slightly elevated, inhale rapidly and completely through the mouthpiece, position of the mouthpiece (open circuit), exhale with maximal force. Subject was then asked to perform maneuver (close circuit method). Subject assumed the correct posture and nose clip was attached. Again subject was asked to place mouthpiece in mouth and close lips around the mouth piece. Subject was instructed to inhale completely and rapidly with a pause of <1 s at total lung capacity. Subject was than instructed to exhale maximally until no more air can be expelled while maintaining an upright posture. Instructions were repeated throughout the maneuver. The test was repeated for a minimum of three maneuvers and the best of the 3 measures was taken as the final measure. The machine used was standardized electronic desktop spirometer.^{14,15,16}

Statistical Methods

Descriptive statistical analysis was carried out in the present study. Out Come measurements analyzed are presented as mean ± SD. Significance is assessed at 5 % level of significance with p value was set at 0.05 less than this is considered as statistically significant difference. Paired 't' test as a parametric have been used to analysis the

variables pre-intervention to post-intervention with calculation of percentage of change. Independent 't' test as a parametric have been used to compare the means of variables between two groups with calculation of percentage of difference between the means. The Statistical software namely SPSS 16.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

The study was conducted on total 30 subjects (Table-1), in study Group there were 15 subjects with mean age 67.60 years and there were 8 males 7 females were included in the study. In control group there were 15 subjects with mean age 68.07 years and were 10 males 5 females were included in the study. There is no significant difference in mean ages between the groups.

In study group (Table-2), when the pre intervention to post intervention means were analyzed shown that there is a statistically significant change in means of Chest expansion and FEV1/FVC ratio within the groups with $p < 0.000$ with negative percentage of change showing that there is decrease in the post means. There is clinical significant improvement with medium to large effect size in study group. In control group (Table-3), when means were analyzed from pre intervention to post intervention shown that there is no statistically significant change in means of Chest expansion and FEV1/FVC ratio within the control group.

Comparison of pre-intervention means (Table-4) shown that there is no statistically significant difference in means and comparison of post-intervention means (Table-5) shown that there is a statistically significant difference in means of Chest expansion, FEV1/FVC between study and control groups.

Table 1: Basic Characteristics of the subjects studied

| Basic Characteristics of the subjects studied | | Study Group | Control Group | Between the groups Significance ^a |
|-----------------------------------------------|---------------------------|-------------------------|-------------------------|----------------------------------------------|
| Number of subjects studied (n) | | 15 | 15 | -- |
| Age in years (Mean ± SD) | | 67.60 ± 2.92 (65-75) | 68.07 ± 3.45 (65-75) | p = 0.289 (NS) |
| Gender | Males | 8 | 10 | P = 0.000** |
| | Females | 7 | 5 | |
| | Within Group Significance | P = 1.000(NS) | P = 0.000** | |
| Weight in Kgs | | 61.80 ± 12.77 (45-94) | 65.47 ± 9.92 (48-85) | P = 0.435 (NS) |
| Height in cm | | 159.73 ± 9.91 (145-178) | 163.60 ± 9.09 (150-180) | P = 0.183(NS) |

a. Pearson Chi-Square

Table 2: Analysis of Chest Expansion and pulmonary function test within study Group (Pre to post test analysis)

| STUDY GROUP | Pre intervention | Post intervention | Percentage change | t value ^a | df | Parametric Significance P value | 95% Confidence interval of the difference | | Effect Size (r) |
|------------------------------------------|--------------------------|--------------------------|-------------------|----------------------|----|---------------------------------|-------------------------------------------|--------|-----------------|
| | Mean ± SD (min-max) | Mean ± SD (min-max) | | | | | Lower | Upper | |
| Chest expansion at Axillary level in cms | 1.29 ± 0.15 (1.0- 1.5) | 1.45 ± 0.17 (1.2- 1.8) | 12.40% | -6.808 | 14 | P < 0.000** | -0.210 | -0.109 | + 0.44 (Medium) |
| Chest expansion at Xiphisternum in cms | 1.15 ± 0.18 (0.8- 1.5) | 1.25 ± 0.18 (1.0-1.6) | 8.69% | -2.646 | 14 | P < 0.019** | -0.181 | -0.018 | + 0.26 (Small) |
| FEV1 in liters | 2.06 ± 0.49 (1.44- 2.89) | 2.09 ± 0.50 (1.48- 2.95) | 1.45% | -5.134 | 14 | P < 0.000** | -0.049 | -0.020 | + 0.03 (Small) |
| FVC in liters | 3.01 ± 0.73 (2.09- 4.27) | 3.01 ± 0.74 (2.07- 4.29) | 00.00% | -0.688 | 14 | P = 0.503 (NS) | -0.013 | 0.007 | + 0.00 (Small) |
| FEV1/FVC | 0.68 ± 0.00 (0.67- 0.69) | 0.69 ± 0.01 (0.68- 0.72) | 2.16% | -4.795 | 14 | P < 0.000** | -0.016 | -0.006 | + 0.95 (Large) |

** Statistically Significant difference $p < 0.05$; NS- Not significant; a. Pared t test.

Table 3: Analysis of Chest Expansion and pulmonary function test within Control Group (Pre to post test analysis)

| CONTROL GROUP | Pre intervention | Post intervention | Percentage of change | t value ^a | df | Parametric Significance P value | 95% Confidence interval of the difference | | Effect Size (r) |
|-------------------------------------|---------------------------|--------------------------|----------------------|----------------------|----|---------------------------------|-------------------------------------------|-------|-----------------|
| | Mean ± SD (min-max) | Mean ± SD (min-max) | | | | | Lower | Upper | |
| Chest expansion Axillary in cms | 1.30 ± 0.11 (1.2- 1.5) | 1.30 ± 0.12 (1.2- 1.5) | 00.00% | -1.000 | 14 | P = 0.334 (NS) | -0.021 | 0.007 | 0.00 (Small) |
| Chest expansion Xiphisternum in cms | 1.10 ± 0.12 (0.8- 1.2) | 1.09 ± 0.12 (0.8-1.2) | -0.90% | 1.000 | 14 | P = 0.334 (NS) | -0.015 | 0.041 | +0.04 (Small) |
| FEV1 in liters | 2.17 ± 0.49 (1.52 - 3.02) | 2.17 ± 0.49 (1.52 -3.02) | 00.00% | 0.612 | 14 | P = 0.550 (NS) | -0.005 | 0.009 | 0.00 (Small) |
| FVC in liters | 3.20 ± 0.75 (2.20 - 4.43) | 3.20 ± 0.75 (2.21- 4.44) | 00.00% | -0.673 | 14 | P = 0.512 (NS) | -0.011 | 0.005 | 0.00 (Small) |
| FEV1/FVC | 0.68 ± 0.09 (0.66 - 0.69) | 0.68 ± 0.01 (0.66- 0.70) | 00.00% | 0.435 | 14 | P = 0.670 (NS) | -0.002 | 0.003 | 0.00 (Small) |

** Statistically Significant difference p < 0.05; NS- Not significant; a. Pared t test.

Table 4: Comparison of means of Chest Expansion and pulmonary function test between study and control Groups (PRE INTERVENTION COMPARISION)

| PRE INTERVENTION | Percentage of difference | t value ^a | Df | Parametric Significance P value | 95% Confidence interval of the difference | | Effect Size (r) |
|-------------------------------------|--------------------------|----------------------|----|---------------------------------|-------------------------------------------|-------|-----------------|
| | | | | | Lower | Upper | |
| Chest expansion Axillary in cms | -0.77% | -0.133 | 28 | P = 0.895(NS) | -0.109 | 0.096 | 0.03 (small) |
| Chest expansion Xiphisternum in cms | -4.44% | 0.804 | 28 | P = 0.428(NS) | -0.072 | 0.165 | 0.16 (small) |
| FEV1 in liters | -5.20% | -0.645 | 28 | P = 0.524(NS) | -0.487 | 0.253 | 0.11 (small) |
| FVC in liters | -6.11% | -0.717 | 28 | P = 0.479(NS) | -0.750 | 0.361 | 0.12 (small) |
| FEV1/FVC | 00.00% | 1.795 | 28 | P = 0.083(NS) | -0.000 | 0.011 | 0.00 (small) |

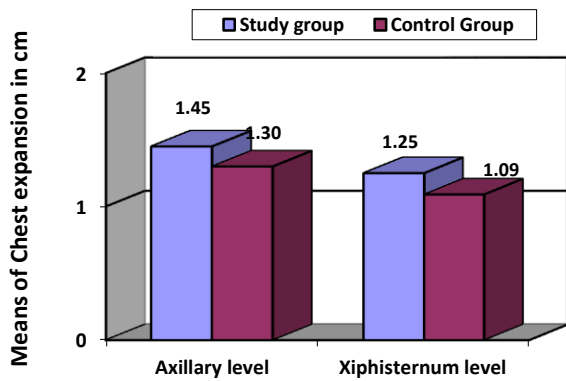
** Statistically Significant difference p < 0.05; NS- Not significant a. Independent t test

Table 5: Comparison of means of Chest Expansion and pulmonary function test between study and control Groups (POST INTERVENTION COMPARISION)

| POSTINTERVENTION | Percentage of difference | t value ^a | df | Parametric Significance P value | 95% Confidence interval of the difference | | Effect Size (r) |
|-------------------------------------|--------------------------|----------------------|----|---------------------------------|-------------------------------------------|-------|-----------------|
| | | | | | Lower | Upper | |
| Chest expansion Axillary in cms | 10.90% | 2.603 | 28 | P = 0.015** | 0.031 | 0.262 | 0.45 (Medium) |
| Chest expansion Xiphisternum in cms | 13.67% | 2.798 | 28 | P = 0.009** | 0.042 | 0.277 | 0.46 (Small) |
| FEV1 in liters | -3.75% | -0.440 | 28 | P = 0.663(NS) | -0.452 | 0.292 | 0.08 (Small) |
| FVC in liters | -6.11% | -0.707 | 28 | P = 0.485(NS) | -0.755 | 0.367 | 0.12 (Small) |
| FEV1/FVC | -1.45% | 4.026 | 28 | P = 0.000** | 0.008 | 0.026 | 0.44 (Medium) |

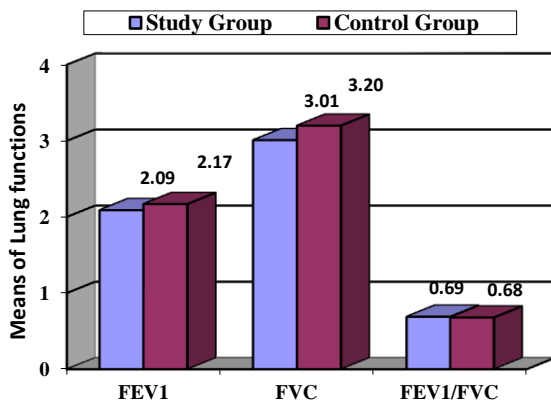
** Statistically Significant difference p < 0.05; NS- Not significant a. Independent t test b. Mann-Whitney Test

Graph 1: Comparison of means of Chest expansion between Study and Control Groups (POST INTERVENTION COMPARISION)



The above graph shows that there is a significant difference in means of Chest expansion when post intervention means were compared between study and control groups.

Graph 2: Comparison of means of Pulmonary function test between study and control Groups (POST INTERVENTION COMPARISON)



The above graph shows that there is no statistically significant difference in means of FEV1, FVC, there is a statistically significant difference in FEV1/FVC when post-intervention means were compared between study and control groups.

DISCUSSION

It is found from analysis that in study group following one week of PNF stretching technique combined with chest mobility exercises along with supervised active assisted exercises shown statistically significant greater percentage of change in improvement of chest expansion and pulmonary function than the control group who received only active assisted exercises shown no significant improvement in chest expansion and pulmonary function test.

In study group, the improvement in chest expansion and pulmonary function test within the group could be due to PNF stretching and chest mobility exercises along with supervised active assisted exercises received for one week. PNF technique includes Hold Relax that utilizes the agonist muscle when it is too weak to activate

properly. This technique based on the autogenic inhibition relaxes a muscle after a sustained contraction, agonist contraction has been applied to it and activates the opposing muscle to move the limb into a greater position of stretch. Golgi tendon organ facilitates the tight muscle to relax and allowed to lengthen through Golgi tendon reflex.⁷

Adaptive shortening and stiffness around the upper limb muscle quadrant increase chest wall resistance and work of breathing, a method of reversing these changes is the active method of treatment included in this study. It appears to be safe and effective in elderly patients. However, Michael T. Putt, et al in their controlled study provided evidence that hold-relax technique can improve the restrictive component in COPD, improve flexibility of the pectoralis major and possibly overcome some of the postural changes of COPD.¹⁰ Therefore in our study the improvement in outcome measures could be due to increase in pectoralis lengthening, shoulder quadrant muscles lengthening, and intercostal muscle lengthening. The theory of Laplace's law suggests that the length of muscle relates to the maximal force of either diaphragm or intercostal muscles, which affect ventilation in the lung. The studies have been shown that stretching of certain muscles around shoulder joint can increase vital capacity. Additionally, in this study we used chest mobility exercise. Active chest mobilizations help to increase chest wall mobility, flexibility, and thoracic compliance.⁶ Passive joint mobilization of cervical and thoracic joints such as apophysial, costotransverse, costochondral and sternochondral joints can improve joint mobility and reduce pain. Improved mobility allows an individual to breathe more effectively and deeply. The chest mobility exercises improves the biomechanics of chest movement by enhancing direction of anterior-upward of upper costal and later outward of lower costal movement, including downward of diaphragm directions and maximal relaxed recoiling of the chest wall helps in achieving effective contraction of each intercostal muscle.⁶ If chest mobility exercises are used with breathing exercise or respiratory muscle exercises it improves breathing pattern and pulmonary functions. The studies also showed that a stretching technique based on PNF is able to increase ROM in the chest and shoulder girdle and increase vital capacity in patients with COPD in the short term. The mean increase in VC from day 1 pre-intervention test to day 2 in the treatment group was 9.6%. Although in their study there was no carry-over after the 3-days watchout period.¹⁰

In control group, there was no improvement in chest expansion and pulmonary functions found within the group. In this group the treatment given was active assisted exercise as control treatment. Therefore the exercise used might not shown any effect in chest expansion and thoracic mobility.

Comparison of pre-intervention means shown that there is no statistically significant difference between the group and comparison of post-intervention means shown that there is a statistically significant difference in means of Chest expansion, FEV1/FVC between study and control groups. Pulmonary function, as measured by spirometry (FEV1 or FVC), is an important independent predictor of morbidity and mortality in elderly persons.⁶

The changes in PFT depends on patient's age, height and weight, which were not considered in this study.¹⁶⁻¹⁷ It is also possible that the number of repetitions and duration of intervention performed in this study may not have been sufficient to demonstrate a clinical effect.¹⁸ Respiratory muscle function is affected by the nutritional status, i.e. lean body mass and body weight. Respiratory muscle function is also affected by aging, either as a consequence of geometric changes in the rib cage, body weight, cardiac function, or through the age-related reduction in peripheral muscle mass and function.¹⁹

Therefore, based on the findings the present study found that there is a statistically significant effect of PNF stretching with chest expansion exercise program in improving chest expansion and pulmonary functions than active assisted exercise program alone. Hence, the present rejects the null hypothesis.

LIMITATIONS OF THE STUDY

1. Subjects with small range group between 65 to 75 years of age were considered for the study, thus results cannot be generalized to all the groups.
2. No follow-up was done after one week of intervention that would have helped to find further improvement and the maintenance of the improved outcome measures.
3. Advising home program during and after intervention was not considered.

RECCOMENDATION FOR FUTURE RESEARCH

1. Further long term follow-up studies are needed to find the effect of PNF stretching with chest mobility exercise in elderly with large sample size.
2. Future studies can be carried with other specific population such as COPD subjects and other chest mobility restricted conditions.

Conclusion

The present study concludes that one week of combined chest mobility exercise with Hold-relax PNF stretching for pectoralis major muscle shown significant improvement in chest expansion and pulmonary function test such as FEV1, FVC, FEV1/FVC ratio than only active assisted exercise program in elderly. It is recommended that clinically it is important to consider chest mobility exercise and PNF stretching program for elderly Subjects with age 65-75 years when the treatment effect is aiming to improve chest expansion and pulmonary function test.

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Conflicts of interest: None

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