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# A study to determine the effect of respiratory proprioceptive neuromuscular facilitation (PNF) exercises on the pulmonary function in geriatric population: An interventional study

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**Abstract**
**Background and Purpose:** Geriatric people undergo with various age related changes, which hamper their performance and health. Pulmonary and cardiovascular changes are more crucial and pronounced among these changes. Accordingly, it was needed to develop techniques which help to improve their cardiovascular fitness and health related quality of life. The purpose of this study was to determine whether respiratory proprioceptive neuromuscular facilitation exercise improves the pulmonary function in geriatric population.
**Subjects and Methods:** 35 geriatric subjects with age of ≥ 60 years were selected and respiratory PNF exercise was given for 4 weeks for 20 minutes/session and 5 sessions/week. PFT parameters FEV1, FVC and FEV1/FVC ratio were assessed at starting and at the end of 4 weeks.
**Results:** Paired t test was used to assess the effectiveness of intervention. P value was set at <0.05. All the assessed PFT parameters were significantly improved post intervention.
**Conclusion:** The results of the study concluded that respiratory PNF exercise improves the pulmonary function in geriatric population.

**Keywords:** pulmonary function, respiratory PNF, geriatric population

## 1. Introduction
Average life expectancy increased dramatically from 50 years old in early 1900's to 80 years old in 2008. [1] Human body undergoes various structural, physiological and immunological changes with age which give rise to different complications. Among these complications, pulmonary disorders are more life threatening which consequently trigger secondary reduction in cardiovascular function. [2]
As humans' age increases, their lung elasticity, diaphragm and chest wall movement and chest expansion decreases. [3] Increased airflow resistance, hypoxemia or hyperinflation and respiratory muscles dysfunction are some of the characteristics of decreased lung function. [4] Exercise capacity also decreases as the effect of ageing. McClaran *et al.* (1995) studied effects of ageing on lung function at rest and during exercise in healthy older adults which shown 11% reduction in VO2 max in a group over a 6 year period. [5]
Declination of lung function with the age can be measured by PFT. It is used to measure the rate at which the lung changes its volume during forced breathing maneuvers. [6] Most commonly used parameters of PFT to assess lung function are dynamic flow rates i.e., forced expiratory volume in one second ($FEV_1$), forced vital capacity (FVC) and $FEV_1$/ FVC ratio, which are reported as % predicted compared with the individuals of same age, sex and height. [3]
Burr and his colleagues in a study about the lung function in elderly (> 62 years) concluded that $FEV_1$ and FVC decreases with age. [7] The declining rate of $FEV_1$ is 25-30ml / year starting at the age of 35-40 years and can double to 60 ml / year after the age of 70 years. [3] These declining PFT parameters show pulmonary dysfunction associated with reduction in chest wall compliance and increased air trapping. [3] This can be reversed by physical therapeutic approaches like thoracic mobilization and strengthening of respiratory muscles using PNF technique. [1]
Respiratory PNF is the technique which stimulates proprioceptive and tactile stimuli which produces consistent reflexive responses in the ventilatory muscles, which leads to expansion of the ribs, increased epigastric excursion and change in respiratory rate. [8] It is the technique which provides resistance to sternal and costal areas and correct respiratory problems itself by promoting alignment of respiratory muscles with respiratory rhythms. [9]
A study conducted by Dietz indicated that respiratory muscle strength can be improved through resistive exercise using PNF pattern. [10] An another recent study conducted by Seo and his colleagues also shown that respiratory muscles' strength and endurance can be improved by respiratory PNF exercise.[2] But still there is very limited research in this area up to now, especially for respiratory PNF technique aimed at improving pulmonary function test quality in geriatric population. So the purpose of this study was to examine the effectiveness of PNF respiratory pattern exercise in geriatric population.

## 2. Subjects and Methods
### 2.1 Subjects
The study subjects were 35 geriatric persons with age of ≥ 60 years, not having any congenital or acquired respiratory or cardiovascular disease, any deformity of chest, history of particular medical treatment to improve pulmonary function, overweight or obese individuals (BMI ≥ 25, according to WHO classification, 2004) or history of smoking in last 3

months or chronic smoker. After being understood the purpose of study, the subjects gave consent for the participation. Parameters of PFT (FVC, $FEV_1$, $FEV_1$/FVC ratio) were measured using Helios 401.

### 2.2 Methods

PFT measurements were taken in sitting position. Subject filled the lungs fully by inhalation and then put the mouth-piece in the mouth and nose was closed to discard air entry or exit from nasal route. Beginning from expiration, subject was instructed to breathe out completely and then breathe in slowly in mouth piece as the tester gives signal. PFT measurements were conducted 3 times and the average values were used in analysis. Resting time of 5 minutes was given between each measurement. After measuring the PFT parameters, the respiratory PNF exercise was started. The intervention was given for 20 minutes/session for 5 sessions/week for 4 weeks.

Subjects were in supine lying. Therapist placed her open hands on lateral surfaces of 8, 9, 10, 11 ribs on both sides. Therapist instructed the patient by saying "take a deep breath". As subject's ribs moved upward and laterally, therapist assisted the movement to promote the subject's respiratory pattern. At the maximum inspiration, therapist said "hold your breath for 5 seconds" and dorso-medially applied soft manual resistance to lower the ribs on both sides. When subject breathed out with the ribs moving downward and medially, therapist said "breathe out maximally".

At end of expiration, therapist pushed the lower ribs on both sides upward like gathering the ribs dorso-medially and then shook the region to assist the discharge of air remaining in the lungs. This way the procedure continued. If the patient felt fatigue or dizziness in between, rest was given and then exercise was performed again. At the end of 4 weeks, the PFT parameters were recorded again.

SPSS 20 was used to obtain mean and standard deviation of all three parameters (table 1) and paired t-test was used to assess the effectiveness of the intervention. Statistical significance was set at 0.05.

**Table 1:** Comparison of respiratory function before and after the intervention

| | Mean ± SD | |
|---|---|---|
| | **Pre-test** | **Post-test** |
| Age | 65.6 ± 4.09 | |
| FEV1 | 1.19 ± 0.58 | 1.93 ± 0.57 |
| FVC | 1.98 ± 0.57 | 2.46 ± 0.48 |
| FEV1/FVC ratio | 62.93 ± 11.31 | 66.32 ± 9.98 |

## 3. Results

The p value for all three parameters ($p < 0.05$) is showing that there is significant difference in the results before and after the intervention, which proves that the intervention is effective (Table 2).

**Table 2:** Statistical analysis by paired sample t test

| | | Paired Differences | | | | | t | Df | p value |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% confidence interval | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FEV1 pre & FEV1 post | 0.74 | 0.41 | 0.07 | 0.89 | 0.60 | 10.47 | 34.00 | 0.001 |
| Pair 2 | FVC pre & FVC post | 0.48 | 0.38 | 0.06 | 0.62 | 0.36 | 7.61 | 34.00 | 0.000 |
| Pair 3 | FEV1 / FVC ratio pre & FEV1/ FVC ratio post | 3.38 | 3.75 | 0.63 | 4.68 | 2.10 | 5.34 | 34.00 | < 0.001 |

Figure 1, 2 and 3 shows the graphical representation of the improvement in PFT parameters following the intervention.

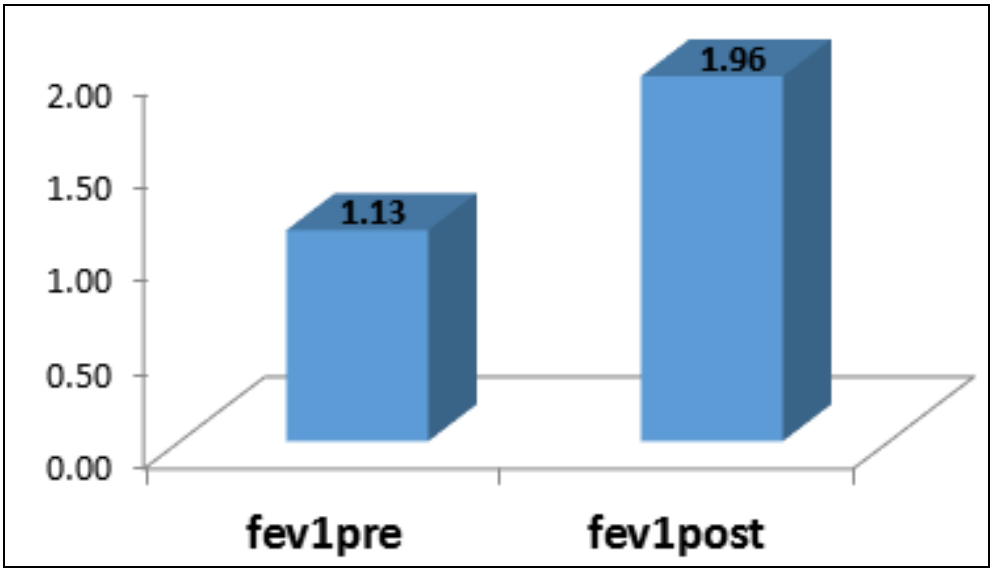


**Fig 1:** Graphical representation of comparison of mean FEV1 pre-test and post test

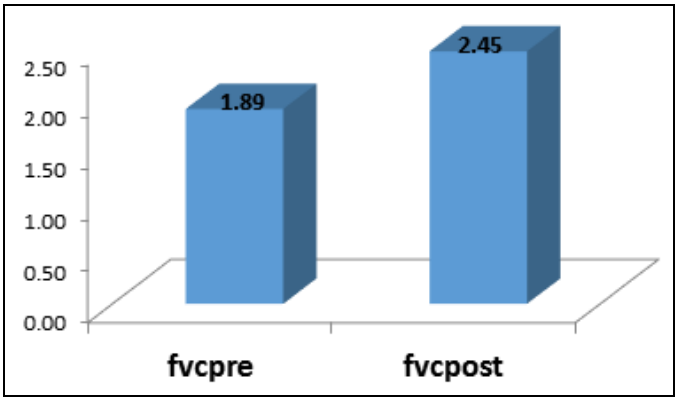


**Fig 2:** Graphical representation of comparison of mean FVC pre-test and post test

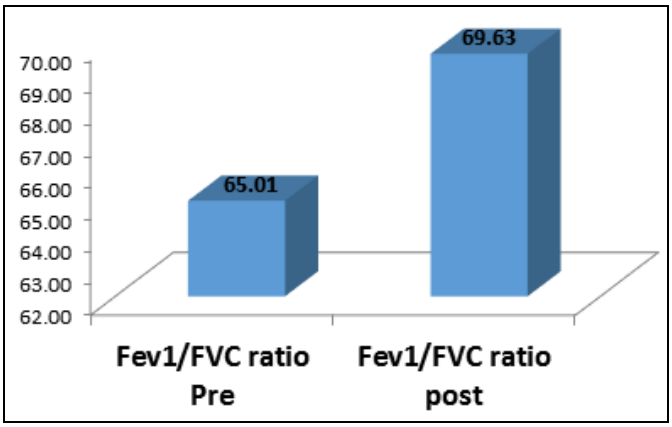


**Fig 3:** Graphical representation of comparison of mean FEV1/ FVC ratio pre-test and post test

## 4. Discussion

As aging progresses, physical exercise ability as well as pulmonary function of the person decreases. Dehn *et al.* studied that by the time of 60 years of age, person's exercise ability decreases by 41% and maximum oxygen uptake by about 5.5% per decade. [11] Further research on the interventions to improve pulmonary function in geriatric population was necessary. This study accordingly examined the effect of respiratory PNF exercise on the pulmonary function in geriatric population. The results showed significant improvement in the PFT parameters (FVC, FEV1, FEV1/FVC ratio).

Some authors have done similar studies previously. Spengler *et al.* noted that respiratory endurance increases by resistive respiratory exercises using special equipment. [12] Muller studied that FEV1 and FEV1/FVC ratio improves significantly by resistive respiratory exercises in spinal cord injury patients [13], while Britto *et al.* reported significant improvement in maximal inspiratory pressure and inspiratory muscle endurance after applying resistive respiratory exercises using an instrument in stroke patients. [14] A study done by Liaw *et al.* on spinal cord injury patients reported that FVC improved by 67% after applying resistive inspiratory muscle strengthening exercise [15], while Van Houtte *et al.* examined 37% increase in FVC through exercises that gradually increased the load on respiratory muscles in spinal cord injury patients. [16]

All the mentioned previous studies showed that pulmonary functions can be improved by various respiratory muscles strengthening exercises in different populations. Present study also proved that repetitive PNF respiratory exercises improve chest wall mobility, oxygen intake, lung elasticity and chest expansion.

The reason of the improvement may be direct resistance applied by the therapist during inspiration increased the intra-abdominal as well as intra-thoracic pressure. So the activity of diaphragm and other assisting inspiratory muscles was improved, while by assisting thrust given at the end of expiration enhanced the ventilation of under-ventilated lungs and improved the chest wall movement. [17] During inspiration and expiration, interaction between the lungs and chest cavity is a crucial parameter for gas exchange ability of the lungs. Furthermore, mobility of skeletal muscles, elasticity of surrounding soft tissues and strength of respiratory muscles determines the capacity of thorax, which affects the expansion and contraction of the lungs. [18]

An another study done by Jeong *et al.* proved that after doing resistive inspiratory muscle training for six weeks, subjects' FEV1 and maximal expiratory pressure significantly improved but FVC and FEV1/FVC ratio did not increase significantly. [19] This shows contradiction in the result in comparison with the previously mentioned studies and the present study also.

The reason for the improvement in this study can be that the repetitions and duration of the technique as well as the length of rest times were considered to minimize subjects' muscle fatigue and to achieve efficient increase in muscle strength.[2] It is proven that the interventions are effective only when applied for at least 20-30 minutes, two to five times per week for 4-12 weeks. [20] In this study, the intervention was implemented for 20 minutes, 5 times a week for 4 weeks.

So the result of this study is same as those studies which showed that by strengthening the respiratory muscles using proprioceptive stimulation technique, the pulmonary function can be improved in geriatric persons. But small sample size, shorter duration of treatment and lack of long term follow-up are some of the limitations of this study. Subjects from different races and different age groups of geriatric population (i.e. young old, old old and oldest old) can be included for future studies. In conclusion, it can be said that respiratory PNF has the positive effects on examined PFT parameters, which shows that this technique improves the pulmonary function in geriatric population.

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