# Effect of Diaphragmatic Breathing Exercise and Respiratory Muscle Stretch Gymnastics Combined with Posture Correction Exercises on Pulmonary Function in Individuals with Forward Head Posture

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**Abstract**

**The aim of this study was to compare the effects of the diaphragmatic breathing exercises combined with postural correction exercises and respiratory muscle stretch gymnastics combined with postural correction exercises on pulmonary function in individuals with forward head posture.**

**This study included a total of 46 participants of age group 20 years to 35 years, both male and female with individuals having Craniovertebral angle <50 degree. Participants were randomly divided into 2 groups- Group A and Group B using the chit system. Group A received postural correction exercises with diaphragmatic breathing exercises and Group B received postural correction exercises with respiratory muscle stretch gymnastics. Both protocols were given for the duration of 3 weeks. Both the groups were assessed for craniovertebral angle and respiratory capacities (FEV1, FVC, FEV1/FVC, PEFR) prior commencement of the study and at the end of 3 weeks. Craniovertebral angle was measured using photogrammetry method and respiratory capacities (FEV1, FVC, FEV1/FVC, PEFR) was measured using pulmonary function test.**

**The results of the study concluded that, diaphragmatic breathing exercise combined with posture correction exercises and Respiratory muscle stretch gymnastics combined with posture correction exercises both showed improvement in the Craniovertebral angle and Pulmonary function in forward head posture but Respiratory muscle stretch gymnastics was significantly proved to be more effective technique in improving Craniovertebral angle and Pulmonary function when combined posture correction exercises.**

**Index Terms: Diaphragmatic Breathing, Respiratory muscle stretch gymnastics, postural exercises forward head posture, pulmonary function, respiratory capacities**

Abbreviations: (RMSG) Respiratory muscle stretch gymnastics, (DBE) - Diaphragmatic Breathing Exercise, (PFT) Pulmonary Function Test, (CVA) Craniovertebral angle, (FVC) Forced Vital Capacity, (FEV1/FVC) Forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC, (PEFR) Peak Expiratory Flow Rate

## INTRODUCTION (HEADING 1)

The anterior positioning of head relative to the line of gravity in the sagittal plane is called forward head posture. [1] Characteristics of forward head posture are hyperextension of upper cervical spine (C1-C3) and flexion of lower cervical spine (C4-C7) with reduced craniovertebral angle (CVA<50 degree).[13] Pain in the neck, shoulder region, fatigue, restricted movement of neck, reduced proprioception and respiratory capacities are some of the symptoms observed in individuals with forward head posture. [5-12] It has been observed that

people with forward head posture have weakness of neck flexors and erector spinae muscles in upper thoracic region due to prolonged lengthening, elevation of scapula due to tension in levator scapulae muscle, sternocleidomastoid, splenius muscle and the sub occipitalis which causes increased tension in upper trapezius. [14] Because of the imbalance of muscles, such as shortening or lengthening, straining or loosening of the muscle around the neck, a rounded shoulder is exhibited, in which the upper thoracic region is slightly bent in sitting posture. [4] Along with all this, the respiratory function is largely influenced by the forward head posture due to the weaking of respiratory muscles. [15] The important accessory respiratory muscles involved in inspiration are sternocleidomastoid, scalene muscle, upper trapezius, pectoralis major and thoracolumbar erector spinae muscle which becomes weak due to prolonged forward head posture and therefore decrease the respiratory function of an individual. [16,17] This also limits the expansion of ribcage, this restriction of rib mobility reduces the amount of air that enters the lungs [26] Posture correction exercises consisting of stretching and strengthening can be used. Stretching of the cervical and pectoral muscles and strengthening of the deep cervical flexor and shoulder retractor muscles addresses the imbalance of underlying tissues. Postural alignment has improved by using this management approach. Many other studies also have supported this protocol. [21] Diaphragmatic breathing exercise consists of smooth and deep nasal inspiration with anterior displacement of abdominal region, this emphasizes the action of diaphragm. [27] Diaphragmatic breathing exercise also decreases the activity of accessory muscles, ensures the breathing pattern close to normal, and also reduced the work of breathing. [28,30] Respiratory muscle stretch gymnastics (RMSG) is a group of stretching exercises which are performed sequentially to stretch the muscles specifically which are involved in the respiration. [34]
Respiratory muscle stretch gymnastics has shown significant effect in improving the respiratory capacities and posture. [22] Respiratory muscle stretch gymnastics includes 4 stretching techniques – Elevating and pulling back the shoulders, stretching the upper chest, stretching the back muscles, stretching the lower chest. [22] Craniovertebral angle (CVA) is the most common way used to measure the forward head posture objectively. Craniovertebral Angle was measured using photogrammetry method and the angle was calculated using mb ruler. [21] Pulmonary function tests (PFTs) are non-invasive tests that show how well the lungs are working. The tests measure lung volume, capacity, rates of flow, and gas exchange. Measurements that are made include- Forced expiratory volume in one second (FEV1), Forced vital capacity (FVC), The ratio of the two volumes (FEV1/FVC) [19,24]

## NEED OF THE STUDY

There are literatures which state that the forward head posture leads to reduction in the pulmonary function because of weakness and disharmony of accessory respiratory muscles. [19] The important accessory respiratory muscles involved in inspiration are sternocleidomastoid, scalene muscle, upper trapezius, pectoralis major and thoracolumbar erector spinae muscle which become weak due to prolonged forward head posture and therefore decrease the respiratory function of an individual.[16,17] There are studies done regarding the correlation of forward head posture and reduced pulmonary function but there are scarce data to our knowledge regarding the intervention used to correct the forward head posture and improve pulmonary function. [23] There is a study stating respiratory muscle stretch gymnastics for 4 weeks has shown to improve pulmonary function in normal elderly individual. [22] Hence, we would like to compare the effects of diaphragmatic breathing exercise and Respiratory muscle stretch gymnastics combined with postural correction exercises on pulmonary function in individuals with forward head posture.

## AIM AND OBJECTIVE

**Aim:** To study the effects of diaphragmatic breathing exercise and Respiratory muscle stretch gymnastics combined with postural correction exercises on pulmonary function in individuals with forward head posture.

**Objectives:**

1. To compare the effect of diaphragmatic breathing exercise combined with postural correction exercises and respiratory muscle stretch gymnastics combined with postural correction exercises for 3 weeks on pulmonary function in individuals with forward head posture using Digital spirometer for the Pulmonary function test.
2. The secondary objective of this study is to compare the effect of diaphragmatic breathing exercise and Respiratory muscle stretch gymnastics combined with postural correction exercises for 3 weeks on craniovertebral angle in individuals with forward head posture using the MB ruler.

## HYPOTHESIS

**EXPERIMENTAL HYPOTHESIS (H1):** THERE WILL BE SIGNIFICANT DIFFERENCE BETWEEN THE EFFECT OF DIAPHRAGMATIC BREATHING EXERCISE COMBINED WITH POSTURAL CORRECTION EXERCISES AND RESPIRATORY MUSCLE STRETCH GYMNASTICS COMBINED WITH POSTURAL CORRECTION EXERCISES ON PULMONARY FUNCTION IN FORWARD HEAD POSTURE.

**NULL HYPOTHESIS (H0):** There will be no significant difference between the effect of diaphragmatic breathing exercise combined with postural correction exercises and respiratory muscle stretch gymnastics combined with postural correction exercises on pulmonary function in forward head posture.

## METHODOLOGY

Type of study: randomized control study
Study Duration: 18 months
Study setting: Metropolitan city.
Method of Randomization: Simple Randomization
Sampling Population: participants with forward head posture between age group 20-35 years
Sample Size: 46 (GROUP A – 23, GROUP B – 23)
Material: Camera, digital spirometer

## METHODS OF SELECTION OF STUDY SUBJECTS

**Inclusion Criteria:**

Both male and female subjects willing to participate in the study.
Age group -20 to 35years.
Individuals with Craniovertebral angle <50.
No history of smoking.

**Exclusion Criteria:**

Diagnosed cardio pulmonary conditions
BMI >30 kg/m2
Spinal pathologies.
Recent Cervical fractures (6 months)
Cervical tumors
Shoulder pain / Radiculopathy
Neurological conditions
Hypertension / diabetes / Thyroid
Recent surgical procedures.
Pregnant females

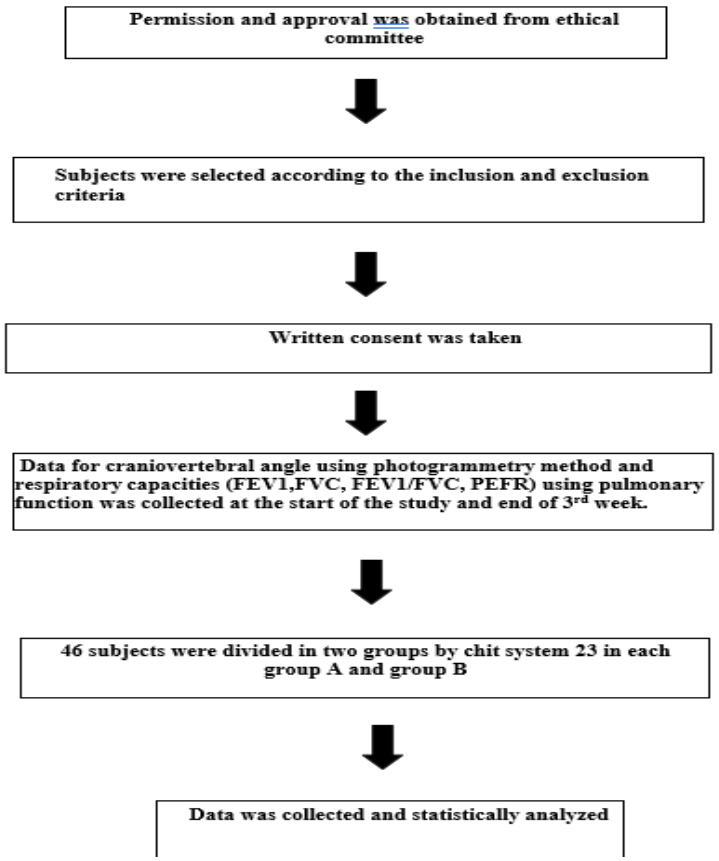
## OUTCOME MEASURE

1. 1.craniovertebral angle
2. 2.Respiratory capacities - FVC- Forced Vital Capacity
    a. FEV1/FVC- Forced expiratory volume in 1second (FEV1)/forced vital capacity (FVC)
    b. PEFR- Peak Expiratory Flow Rate

## STUDY PROCEDURE

1. Ethical approval will be taken from the institutional ethical committee
2. A written informed Consent form was taken from all the participants prior to screening.
3. Subjects were screened as per the inclusion and the exclusion criteria.
4. Subjects were informed about the aim of the study prior to the study.
5. Demographic data (age, sex, BMI, surgical and medical history) was taken.

6. Baseline data for craniovertebral angle using photogrammetry method and respiratory capacities (FEV1, FVC, FEV1/FVC, PEFR) using pulmonary function test was taken on first day prior to the study.
7. Subjects were randomly divided into GROUP A (Control group) and GROUP B (experimental group) using chit system.
8. Group A received postural correction exercises with diaphragmatic breathing exercises.
9. Group B received postural correction exercises with respiratory muscle stretch gymnastics.
10. The exercise session was for 20-30 mins on an average.
11. Exercises were performed twice a day, 3 times a week (alternate days) for a total of 3 weeks. both the sessions in a day were supervised by the therapist, one session was personally supervised and the other session was supervised using video call/ telephonic methods.
12. Craniovertebral angle and respiratory capacities (FEV1, FVC, FEV1/FVC, PEFR) were measured at the end of the 3rd week which was the end of the study intervention to understand the effect of exercises in respective groups.




**Appropriate methods of measurements:**

- **CRANIOVERTEBRAL ANGLE** was measured using photogrammetry method. For measuring the angle, the reflective markers were placed on the tragus of the ear and spinous process of the C7. The participant was asked to stand and maintain her usual upright posture with her arms resting at the sides, and looking straight ahead. The photos were captured by a digital camera (iPhone 13) from the dominant side of the upper extremities. CVA was calculated using the image in the digital application (MB ruler) [21]
- **PULMONARY FUNCTION TEST** Each patient FEV1, FVC, FEV1/FVC, PEFR were measured using digital spirometer before the start of the study and at the end of the 3 weeks of the study. The patient was seated on chair in comfortable position. The subject was asked to perform rapid full inspiration through the mouth piece, then perform full expiration with maximum force. [19,24]

| Group A | Group B |
|---|---|
| 1. POSTURAL CORRECTION EXERCISES-<br>a) Deep cervical flexor muscle strengthening<br>b) Scapular retractor muscle strengthening<br>c) Pectoralis musclestretching<br>d) Sternocleidomastoi dmuscle stretching<br>e) Trapezius stretching | 1. POSTURAL CORRECTIO N EXERCISES-<br>a) Deep cervical flexor muscle strengthening<br>b) Scapular retractor muscle strengthening<br>c) Pectoralis musclestretching<br>d) Sternocleidomastoi dmuscle stretching<br>e) Trapezius stretching |
| 2) DIAPHRAGMATIC BREATHING EXERCISE | 2) RESPIRATORY MUSCLE STRETCH GYMNASTICS |

GROUP A and GROUP B both the groups performed the postural exercises.

**POSTURAL CORRECTION EXERCISES.**

1. **Deep cervical flexor muscle strengthening:** The patients were instructed to sit with their arms at the side. The patient was asked to tuck his head down and in Correct movement of tucking the chin in and straightening the spine was verbally reinforced. The patient was then asked to tuck his chin so that his ears were in line with the tip of shoulders from sitting position. The patient was advised to perform two sets of 12 repetitions with 6 second hold, two times a day, three days a week for three weeks.
2. **Scapular retractor muscle strengthening:** The patient was made to stand with hands grasped behind the lower back. The patient was instructed to adduct scapula and hold the adducted position while keeping both arms lowered down for 6 seconds. Two sets of 12 repetitions with 6 second hold, two times a day, three days a week for three weeks.
3. **Pectoralis major muscle stretching:** In this exercise the patient was instructed to sit with hands behind the head, shoulder abducted and externally rotated 90 degrees. The therapist then applied passive stretch at the end of range. This stretch was done 3 times with 30 seconds of hold, two times a day, three days a week for three weeks.
4. **Sternocleidomastoid muscle stretching:** The participant was positioned in optimal posture and asked to place left arm behind the body and depress the shoulder, tuck chin and slowly draw her right ear to the right shoulder, also was asked to rotate her neck upward toward the ceiling until a slight stretch is felt on the left side; This stretch was done 3 times with 30 seconds of hold, two times a day , three days a week for three weeks. [9]
5. **Trapezius stretch:** the participant was asked to sit on a a table with foot supported on the ground, then the patient was instructed to grip the table on side with elbow straight on the right side. The left hand was made to place on the head as if pulling the head and neck towards the left shoulder and then gently

side flex towards the left shoulder and feel the stretch in the right trapezius. Patient repeated the same on other side as well.

GROUP A performed Diaphragmatic breathing exercises along with postural correction exercises.
**DIAPHRAGMATIC BREATHING-** The patient performed diaphragmatic breathing for 10 minutes. The patient was in the semi fowler position with head supported, one hand is over the upper chest and the other hand was on the diaphragm. The patient was instructed to breathe in deep and exhale slow such that the hand on the diaphragm was raised during inhalation and lowered during exhalation. Patient performed this breathing exercises for 10 minutes with 30 second interval after every 2 minutes.

GROUP B performed Respiratory muscle stretch gymnastics along with postural correction exercises.
**RESPIRATORY MUSCLE STRETCH GYMNASTICS-**
**Respiratory muscle stretch gymnastics No. 1- Elevating and pulling back the shoulders:** Patient was in a relaxed position with straight back. Then the patient was instructed to elevate the shoulders and simultaneously move them backward. At the same time, they were instructed to lean backward while inhaling. Then the patient was asked to exhale slowly and resume original position
**Respiratory muscle stretch gymnastics No. 2- stretching the upper chest:** The patient was instructed to stand with back straight and both hands held behind the buttocks. While slowly exhaling hands were pushed away from the body after full and slow inspiration. After full expiration, they were instructed to breathe quietly and resume original position slowly
**Respiratory muscle stretch gymnastics No. 3- stretching the back muscles:** The patient was instructed to keep back straight, hold the hands in front of the chest with fingers entwined and the palms in. he was instructed to inspire fully in that position. He was then instructed to extend the arms and bend the upper body as far as possible while exhaling slowly. Full breath was taken after arm extension and body bending. Original position was resumed after breathing quietly
**Respiratory muscle stretch gymnastics No. 4-stretching the lower chest:** While keeping the back straight, he held hands above the head with arms stretched and palms facing down. After the full inspiration in this position, he pulled the arms back while exhaling slowly. Once full expiration was completed, he was instructed to breathe quietly and resume original position. [22]

## STATISTICAL ANALYSIS

1. Data Analysis: The data was entered using Microsoft Office Excel 2013 and was analysed using GraphPad Prism 9 S.
2. Descriptive data analysis was done for Age, Gender, BMI.
3. Normality of the data was confirmed using Shapiro Wilk Test for both the groups.
4. Paired T Test was used to analyse parametric data within the Group A and Group B for the readings of CVA (Craniovertebral angle), FVC (Forced Vital Capacity), PEFR (Peak Expiratory Flow Rate.)
5. Wilcoxon rank test was used to analyse non parametric data within Group A and Group B for the readings of FEV1/FVC (Forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC))
6. Unpaired T test was Used for the intra group analysis for the difference between the mean values of both Group A and Group B for CVA (Craniovertebral angle), FVC (Forced Vital Capacity), PEFR (Peak Expiratory Flow Rate.)
7. Mann Whitney U test was used for the intra group analysis for the difference between the median values of both Group A and Group B for FEV1/FVC (Forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC))
8. P value less than 0.05 was considered statistically significant.

## RESULTS

- The total sample size was 46, with age 20-35 years, was divided into two groups Group A and Group B each having 23 subjects.
- The mean age of Group a was 28.08 years with a standard deviation of 1.41 years. The mean age of Group B was 27 years with standard deviation of 2.82 years.

- The mean BMI of Group A was 24.85 kg/m2 with a standard deviation of 0.63 kg/m2. The mean BMI of Group B was 22.3 kg/m2 with a standard deviation of 1.69 kg/m2.
- Total number of females were 23 which constitutes 50% and the total number of males was 23 which constituted of another 50%.

**Table 1 – Demographic Data**

| | **GROUP A** | **GROUP B** |
|---|---|---|
| **Sample size** | n=23 | n=23 |
| **Age** | 28.08±1.41 | 27±2.82 |
| **Gender Male** | 10 | 13 |
| **Female** | 13 | 10 |
| **BMI** | 24.85±0.63 | 22.3±1.69 |

**Table 2.1 – FVC Comparison Within Group A**

| **GROUP** | **FVC** | **MEAN ±SD** | **P VALUE** |
|---|---|---|---|
| **GROUP A** | **PRE** | 67.26 ± 0 | <0.0001 |
| | **POST** | 70.47 ± 0.7 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of FVC. For the above data there was a statistically significant difference seen between the pre and post values of FVC within GROUP A (p value- <0.0001).

**Table 2.2 – FEV1/FVC Ratio Comparison Within Group A**

| **GROUP** | **FEV1/FVC** | **MEDIAN±SD** | **P VALUE** |
|---|---|---|---|
| **GROUP A** | **PRE** | 98 ± 7 | <0.0001 |
| | **POST** | 100 ± 3 | |

**Inference:** As the above data did not pass the normality test, Wilcoxon test was used to compare the median of pre and post values for FEV1/FVC. For the above data there was a statistically significant difference seen between the pre and post values of FEV1/FVC within GROUP A (p value- <0.0001)

**Table 2.3 – PEFR Comparison Within Group A**

| **GROU P** | **PEFR** | **MEAN±SD** | **P VALUE** |
|---|---|---|---|
| **GROU P A** | **PRE** | 33 ± 2 | <0.0001 |
| | **POST** | 36 ± 2 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of PEFR. For the above data there was a statistically significant difference seen between the pre and post values of PEFR within GROUP A (p value- <0.0001).

**Table 2.4- CVA Pre and Post Comparison Within Group A**

| GROUP | CVA | MEAN±SD | P VALUE |
|---|---|---|---|
| GROUP A | PRE | 47.44 ± 2.12 | <0.0001 |
| | POST | 48.27 ± 2.26 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of CVA. For the above data there was a statistically significant difference seen between the pre and post values of CVA within GROUP A (p value- <0.0001)

**Table 3.1 – FVC Comparison Within Group B**

| GROUP | FVC | MEAN±SD | P VALUE |
|---|---|---|---|
| GROUP B | PRE | 68 ± 0 | <0.0001 |
| | POST | 77 ± 9 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of FVC. For the above data there was a statistically significant difference seen between the pre and post values of FVC within GROUP B (p value- <0.0001).

**Table 3.2 – FEV1/FVC Ratio Comparison Within Group B**

| GROUP | FEV1/FVC | MEDIAN±SD | P VALUE |
|---|---|---|---|
| GROUP B | PRE | 103 ± 2 | <0.0001 *** |
| | POST | 106 ± 0.7 | |

**Inference:** As the above data did not pass the normality test, Wilcoxon test was used to compare the median of pre and post values for FEV1/FVC ratio. For the above data there was a statistically significant difference seen between the pre and post values of FEV1/FVC ratio within GROUP B (p value <0.0001)

**Table 3.3– PEFR Comparison Within Group B**

| GROUP | PEFR | MEAN±SD | P VALUE |
|---|---|---|---|
| GROUP B | PRE | 34 ± 2 | <0.0001 |
| | POST | 47 ± 4 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of PEFR. For the above data there was a statistically significant difference seen between the pre and post values of PEFR within GROUP B (p value <0.0001).

**Table 3.4 – CVA Comparison Within Group B**

| GROU P | CVA | MEAN±SD | P VALUE |
|---|---|---|---|
| GROU P B | PRE | 48.93 ± 1.3 | <0.0001 |
| | POST | 50.78 ± 1.5 | |

**Inference:** As the above data passed the normality test, Paired T test was used to compare the pre and post values of CVA. For the above data there was a statistically significant difference seen between the pre and post values of CVA within GROUP B (p value- <0.0001).

**Table 4.1- Comparison of FVC Between Group A and Group B.**

| FVC | GROUP | MEAN | P VALUE |
|---|---|---|---|
| | GROUP A | 3.21 | <0.0001 |
| | GROUP B | 8.52 | |

**Inference:** As the above data passed the normality test, Unpaired T test was used to compare the mean difference values of GROUP A with GROUP B for FVC. For the above data there was a statistically significant difference seen between GROUP A and GROUP B (p value- <0.0001).

**Table 4.2- Comparison of FEV1/FVC ratio Between Group A and Group B**

| FEV1/FVC RATIO | GROUP | MEDIAN | P VALUE |
|---|---|---|---|
| | GROUP A | 3 | 0.0019 |
| | GROUP B | 4 | |

**Inference:** As the above data did not pass the normality test, Mann-Whitney U test was used to compare the median difference values of GROUP A with GROUP B for FEV1/FVC ratio. For the above data there was a statistically significant difference seen between GROUP A and GROUP B (p value- 0.0019).

**Table 4.3- Comparison of PEFR Between Group A and Group B**

| PEFR | GROUP | MEAN±SD | P VALUE |
|---|---|---|---|
| | GROUP A | 2.82 | <0.0001 |
| | GROUP B | 13.26 | |

**Inference:** As the above data passed the normality test, Unpaired T test was used to compare the mean difference values of GROUP A with GROUP B for PEFR. For the above data there was a statistically significant difference seen between GROUP A and GROUP B (p value- <0.0001).

**Table 4.4- Comparison of CVA Between Group A and Group B**

| | GROUP | MEAN | P VALUE |
|---|---|---|---|
| **CVA** | **GROUP A** | 0.83 | <0.0001 |
| | **GROUP B** | 2.172 | |

**Inference:** As the above data passed the normality test, Unpaired T test was used to compare the mean difference values of GROUP A with GROUP B for CVA. For the above data there was a statistically significant difference seen between GROUP A and GROUP B (p value- <0.0001).

## DISCUSSION

In the current study we compared the effect between diaphragmatic breathing exercise combined with posture correction exercises and respiratory muscle stretch gymnastics combined with posture correction exercises on pulmonary function in individuals with forward head posture. Males and females between the age group of 20-35 years participated in the study, there were total 23 males and 23 females. All the participants were divided into group A and group B. Group A was the control group who were given diaphragmatic breathing exercise combined with posture correction exercises and Group B was the experimental group who was given respiratory muscle stretch gymnastics combined with posture correction exercises.

The statistical analysis that was done for Group A it showed that there is a statistically significant difference between the pre and post intervention values for CVA (p value <0.0001), FVC (p value <0.0001), FEV1/FVC (p value <0.0001) and PEFR (p value <0.0001) within the group. Diaphragmatic breathing showed immediate benefits in increasing the tidal volume and oxygen saturation, reduction in breathing frequency and improvements in ventilation.[27] Our results are in accordance with the findings of Tahir et al who showed that diaphragmatic breathing exercise group was able to improve pulmonary mechanics which eventually led to beneficial effect on pulmonary function and diaphragm excursion. Diaphragmatic breathing exercise also showed to improve basal ventilation. Diaphragmatic ascent and diaphragmatic descent improves during inspiration and expiration respectively with diaphragmatic breathing exercises. [3] Breathing through the full vital capacity and holding for 3-5 seconds ensures full inflation of the lungs which helps opening up alveoli which have low volume and stimulating production of surfactant , these are the physiological benefits of diaphragmatic breathing exercise. [28,30] Surfactant produced reduces the surface tension and improves the lung compliance , allowing the lung to inflate more easily and reduces the airway resistance as well.[34] Manzano et al. also had founded that diaphragmatic breathing exercises was able to improve pulmonary mechanics and showed beneficial effect on forced vital capacity (FVC). [36] Posture correction exercises had also contributed to increase lung capacity and increase in depth of breath, it also positively affects the nervous system by stimulating the process of maturing motor areas of brain which contribute to the locomotor skill. [37] Using a combination of stretching and strengthening exercises has a very important role and is a very significant component of physical intervention to correct the forward head posture. [37] One of the previous studies has shown significant effects of adding breathing exercises along with therapeutic exercise program to improve forward head posture and pulmonary capacities in individuals with forward head posture.[20]

Our study showed that adding diaphragmatic breathing exercises along with posture correction exercises had shown significant improvement in the pulmonary function and also the craniovertebral angle in individuals with forward head posture as posture correction exercises work on correcting the muscle imbalances such as lengthening and shortening , straining or loosening of muscles around the neck and minimize the use of accessory muscles while breathing and diaphragmatic breathing works on decreasing the work of breathing , improving oxygenation, ventilation, inflation of alveoli, reversal of hypoxemia and increase diaphragm excursion which eventually promotes better breathing pattern and pulmonary mechanics.

The statistical analysis that was done for Group B showed that there is a statistically significant difference between the pre and post intervention values for CVA (p value <0.0001), FVC (p value <0.0001), FEV1/FVC (p value <0.0001) and PEFR (p value <0.0001) within the group. Respiratory muscle stretch gymnastics (RMSG) is a group of stretching exercises which are performed sequentially to stretch the specific muscles

involved in respiration. This particular exercise is based on the lapascle's law, which states that ventilation of the lung depends upon the length of respiratory muscles. When the muscles are in the optimal length maximal force is generated. When there is an alteration in the optimal length of respiratory muscle and RMSG is given the muscle spindles stimulate and sends signal to the Alpha motor neuron, which results in contraction of extrafusal fiber of muscle spindle. More relaxation can be achieved when the muscle contracts more according to the starling law. Hence, optimal length of respiratory muscle can be achieved by giving RMSG which overall improves the pulmonary function as well. [34] Thus stretching the contracting muscle is a powerful stimulus for muscle spindles. Kananmaru et al. recorded electromyographic activity from respiratory muscles and reported that activity during RMSG is greater than that during deep breathing alone, which indicates RMSG stimulates muscle spindles. Minihiko Yamada et al , who studied the benefits of RMSG in COPD patients and found that there was an immediate reduction of dysnea at rest , improved spirometric variables including the FVC and peak expiratory flow (PEFR) in patient with severe COPD. In our study we have studied the effect of RMSG on pulmonary function in forward head posture individuals and we found that it aligns with the results of the study done by hetal et al, which stated that long term practice of RMSG could have led to repeated stimulus from the muscle fibers to the higher centers which helped in regulating the correct postural mechanics. RMSG has helped in lengthening specific muscles of the upper chest, back and lower chest muscles which has helped reducing the rounded shoulder and improving the pulmonary function as a whole. [22] Sahin et al stated that stretch receptor reflex decreased the tracheal smooth muscle tone which in turn leads to decreased airway resistance and increase airway caliber thus increasing the PEFR post RMSG training. [22]

Our study showed that adding RMSG along with posture correction exercises had shown to be effective in improving the pulmonary function and craniovertebral angle in individuals with forward head posture as posture correction exercises work on correcting the muscle imbalances such as lengthening and shortening , straining or loosening of muscles around the neck and minimize the use of accessory muscles while breathing and RMSG stretches the specific respiratory muscles leading to increased activity of the muscle , improvement in the pulmonary function and reduction of rounded shoulder as well which directly shows reduction in the craniovertebral angle.[34]

The statistical analysis that was done to compare GROUP A and GROUP B showed that there was a significant difference between GROUP A and GROUP B for CVA (p value <0.0001), FVC (p value <0.0001), FEV1/FVC (p value 0.0019) and PEFR (p value <0.0001). GROUP B has shown significant improvement than GROUP A in all the four components – CVA, FVC, FEV1/FVC, PEFR. GROUP A and GROUP B both had posture correction exercises which worked to correct the imbalance of the muscle and simultaneously reducing the use of accessory muscles while breathing but GROUP B was more effective than GROUP A in showing improvements in craniovertebral angle and pulmonary function because GROUP B performed RMSG along with posture correction exercises and RMSG stretched the specific respiratory muscles with synchronized breathing which helped improve the pulmonary function and also regulated the postural mechanisms which helped to improve the craniovertebral angle while GROUP A performed diaphragmatic breathing along with posture correction exercises and diaphragmatic breathing consisted of smooth and deep nasal inspiration with anterior displacement of the abdominal region , which emphasizes the action of diaphragm and reduced the work of breathing , improves ventilation and increases the tidal volume.

Hence, we conclude from our study that both the interventions showed improvement for CVA and pulmonary function but 2 sets of respiratory muscle stretch gymnastics (RMSG) (3times per week for 3 weeks, 2 times a day) combined with posture correction exercises had shown more better improvement, so we can incorporate RMSG along with posture correction exercise intervention for forward head posture.

## CONCLUSION

We conclude this from our study that both the techniques – diaphragmatic breathing exercise combined with posture correction exercises and RMSG combined with posture correction exercises showed improvement in the CVA and Pulmonary function in forward head posture, but RMSG was proved to be more effective technique in improving CVA and Pulmonary function when combined posture correction exercises.

## SUGGESTIONS

- Future studies can include large sample size.
- Long term follow-up studies should be incorporated.
- Respiratory muscle stretch gymnastics can be compared with any other technique to see effect on pulmonary function in a different population.

## LIMITATIONS

- This study consisted of a short course of treatment of three-week therapy sessions, result only showed about short-term effects of the interventions.
- The sample size was small (Group A, n = 23; Group B, n = 23)

## CLINICAL IMPLICATION

- Results of this study proved Respiratory muscle stretch gymnastics to be more effective than diaphragmatic breathing exercise when combined with posture correction exercises in improving the Craniovertebral angle (CVA) and Pulmonary function in forward head posture.
- So, we can consider to add RMSG as a part of the intervention along with posture correction exercises in forward head posture individuals.

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