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COMPARISON OF THE EFFECTS OF CORE STABILIZATION AND CHEST MOBILIZATION EXERCISES ON LUNG FUNCTION AND CHEST WALL EXPANSION IN YOUNG OLD PEOPLE: AN EXPERIMENTAL STUDY

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Abstract:

Background: According to WHO aging is defined as a persistent decline in the age-specific fitness components of an individual due to internal physiological degeneration. Aging involves changes in the complex regulatory interplay among cells, organs and systems. Considering the anatomical structure of the diaphragm and the transverses abdominis, it is considered that increased contractility of the transverses abdominis, would lead to an increase in diaphragm activity. The diaphragm, a component of core stability, plays a role in respiration by controlling intra-abdominal pressure.
Aim: To compare the effects core stabilization and chest mobilization exercise on lung function and chest wall expansion in young old people.
Methods: Total 30 young old subjects were screened for this study as per the inclusion and exclusion criteria. They were divided in two groups randomly and equally. Group A was received core stabilization exercise and Group B was received chest mobilization exercises. Both groups received 30 minutes of training per day, 3 times/week for four weeks. Pre and Post data was collected in terms of Pulmonary Function Test and Chest Expansion before and after the 4 weeks of intervention. Results were tested for normal distribution using Shapiro-Wilk test. Paired Sample t-test was used for pre and post test difference within group comparison and independent sample t-test was used post test comparison between 2 groups.
Conclusion: This present study concludes Core Stabilization Exercise results a significant increase in peak expiratory flow rate (PEFR) and some aspect on FEV1/FVC ratio. Chest Mobilization Exercise results a significant increase in upper and lower chest expansion.
Keywords - Chest Mobilization, Core Stabilization, Lung Function, Chest Expansion.

INTRODUCTION

According to WHO Aging is defined as a persistent reduces in the age-specific fitness elements of an individual due to internal physiological degeneration.[1] According to the WHO, chronological old age is classified as follows: 65-75 years define young old ages and a transition period from working life to retirement; 75-85 years define advanced old ages and a period where functional losses begin to be observed; 85 years and older define very advanced old ages.[2]

Aging involves changes in the complex regulatory interplay among cells, organs and systems.[3] Cardiac and smooth muscle cells participate in involuntary control of heart and vascular functions. The integrity, excitability, conductivity, contractility and elasticity of these cells are important to cardiovascular control. Progressive losses of physiological function of cardiomyocytes and vascular smooth muscle cells have been associated with cellular aging.[4]

The diaphragm is man's main respiratory muscle. It is composed of the muscles and tendons that separate the chest from the abdominal cavity, and forms the floor of the thoracic cavity.[5] The transverses abdominis is the diaphragm's partner. Considering the anatomical structure of the diaphragm and the transverses abdominis, it is considered that increased contractility of the transverses abdominis, would lead to an increase in diaphragm activity[6].

The lungs cannot contract by themselves during respiration. Instead, they passively contract and relax as a result of the contraction and relaxation of the thoracic cage respiratory muscles, leading to gas exchange between the air and lungs[7]. While relaxed expiration is performed by the passive recoil of the diaphragm, during forced expiration, the air is driven out as the diaphragm is forced upwards by a rise in intra-abdominal pressure induced by contraction of the abdominal muscles[8]. Moreover, the diaphragm, a component of core stability, plays a role in respiration by controlling intra-abdominal pressure.[9, 10]

The abdominal muscles are the principle muscles of expiration among the others. The role of the abdominal muscles is in both quiet and forceful breathing. It is believed that the abdominal muscles could be strengthened in order to assist the ventilatory process. The strength of the abdominal muscles can assist prolonged and forced expiration[11].

A chest expansion exercise is a full-body exercise technique that combines deep breathing with active movements of the trunk and limbs. This exercise is an intervention method more specific to the musculoskeletal system as it moderates inspiration and expiration rates, improves mobility of the intercostals space, relaxes the stiff connective tissue, and relaxes soft tissues such as the pectoralis major, intercostals, and quadratus lumborum muscles.[12]

MATERIALS AND METHODS

After getting approval from institutional ethical committee of Uka Tarsadia University, candidate was screened according to inclusion and exclusion criteria. Group A had total 15 participants (Male: 6, Female: 9) and Group B have also 15 participants (Male: 7, Female: 8) age between 60 to 75 years. The total numbers of participants were 30 including male and female both. Young healthy old people between the ages of 60-75 years were recruited surrounding residential society in and around Surat. Exclusion criteria were: visual impairment & hearing damage, nervous system & vestibular organ problem, unable to understand of experiement, heart or lung diseases, musculoskeletal disorder related to thoracic cage, undergone abdominal or thoracic surgery within past 6 months, regular exercise habits. The study was conducted from February 2021 - February 2022. Group A was received core stabilization exercise and Group B was received chest mobilization exercises. Both groups received 30 minutes of training per day, 3 times per week, for four weeks. Data was collected before and after 4 weeks of intervention.

Core Stabilization Exercise for Group A (CSEG): Each Exercise was performed for 6 minutes.

1. Contractions of Transverse Abdominals
2. Bridging
3. Bridging with one leg lift
4. Lifting both leg in supine
5. Lifting both arm and leg in supine

Figure illustrate Contraction of TA (CSE)

Figure illustrate Bridging exercise (CSE)

Figure illustrate Bridging with one leg lift (CSE)

Figure illustrate Lifting both legs in supine (CSE)

Figure illustrate Lifting both arms and legs in supine (CSE)

Chest Mobilization Exercise for Group B (CMEG): 5 kinds of movements were included.

1. **Fascia global mobilization:** The patient was in supine, with the therapist at the bedside with 2 hands on the patient's sternum. The hand of the practitioner was caudally directed and supported by the manubrium. The middle of the hand was at the direction of the head at the xiphoid process. At the end of the inspiration, the therapist gave downward with patient expiration. At the end of Expiration, the therapist was amplified the chest elevation through a little traction on the xiphoid process. The 2 subsequent manoeuvres were performed without interrupting the patient's breathing rhythm.
2. **Scalene muscle mobilization:** The patient was in supine, with the therapist at the bedside with the opposite hand on the scalene. The therapist was performed an occipital grip and gave little pull as well as the thumb of the hand was rest on the posterior surface of the first rib. The thumb was applying pressure to the neck at the region of the angle of the upper trapezius under the sternocleidomastoid for 30 seconds and 30 seconds gave patient rest. This procedure was done for next 6 minute. Tension was obtained by occipital hand pull.

3. **Sternocleido-occipital-mastoid muscle mobilization:** The patient was in supine, head opposite rotates to the treated muscle. The muscle was remaining on the same axis of the sternum. The therapist at the bedside with the hand on the muscle will be treated held the skull base. The other hand will be rested on the SCM and gave gentle mobilize and going downward with mind stretch to this muscle.
4. **To mobilize bilateral side of the chest:** while sitting, asking patient to deep inhale and after that the patient was bending away from one side and expand that side of the chest during inspiration. Then, same repetition done on opposite side.
5. **To mobilize the upper chest and stretch the pectoralis muscles:** While the patient was sitting in a chair with hands clasped behind the head, has him or her horizontally abduct the arms during a deep inspiration. Then instruct the patient to bring the elbows together and bend forward during expiration. Each exercise was done for 6 minutes, for a total of 30 minutes. [17]

Figure illustrate Fascia global mobilization

Figure illustrate Scalene muscle mobilization

Figure illustrate Sternocleido-occipital-mastoid muscle mobilization

Figure illustrate To mobilize bilateral side of the chest

Figure illustrate To mobilize the upper chest & stretch pectoralis muscles

Outcome measures:

- **Pulmonary Function Test (PFT):**

  Respiratory measurements were taken with the subjects comfortably seated and the trunk at a 90° angle. Pulmonary function was measured with a portable Spirometer (RMS Helios 401) while the subjects were wearing a nose clip. The test was repeated three to five times to obtain at least two acceptable trials (variability <100 mL), with a 2-minute rest interval between the trials to ensure adequate recovery. The best trial result for each subject was used for analysis. Respiratory measurements were taken according to general guidelines. A single investigator interpreted the data according to established guidelines to obtain a target value for each subject and to ensure that the manoeuvre had been performed correctly. Forced vital capacity (FVC), Forced expiratory volume in one second (FEV1), and Peak expiratory flow rate (PEF) were evaluated.

  - **FVC (FORCED VITAL CAPACITY):** FVC is the volume of air that can be exhaled forcefully and rapidly after a maximal or deep inspiration deep inspiration. It is a dynamic lung capacity. Normally FVC is equal to vital capacity.[13]
  - **FEV1 (FORCED EXPIRATORY VOLUME):** FEV is the volume of air, which can be expired forcefully in a given unit of time (after a deep inspiration). It is also called timed vital capacity or forced expiratory vital capacity. It is a dynamic lung capacity. FEV1 = volume of air expired forcefully in 1 second.[13]
  - **FEV1/ FVC (%):** It is ratio of the two volumes FEV1 and FVC. The calculation of FEV1/ FVC allows the identification of obstructive or restrictive Ventilatory defects. The FEV1/ FVC <70% where FEV1 is reduced more than FVC signifies an obstructive defect. An FEV1/ FVC >70% where FVC is reduced more than FEV1 it is seen in restrictive defects. [13]
  - **PEFR (PEAK EXPIRATORY FLOW RATE):** PEFR is the maximum flow achieved during a forced expiration starting from the level of maximal lung inflation. [13]

- **Chest Wall Expansion:**

  The chest-wall expansion measurement was performed using a tape measure to determine the range of motion of the thoracic cage. The upper chest expansion was measured by placing the tape measure parallel to the space between the 3rd rib and then measuring the area where it made contact with the 5th spinous process. The lower chest expansion was measured the area that horizontal to the inferior aspect of the xiphoid process and 10th spinous process and the measurement value was the difference between the measured value at maximum inspiration and maximum expiration. [14]

STATISTICAL ANALYSIS

This study was conducted to find out the comparison of core stabilization and chest mobilization exercise on lung function and chest wall expansion in young old people for this purpose data was collected by principle investigator in terms of Pulmonary function test (PFT variables: FVC, FEV1, PEFR) and chest wall expansion. Statistical analysis was carried out using SPSS version 22.0 software. Results were tested for normal distribution using a Shapiro-Wilk Test. Paired Sample t-test was used to determine pre- and post-test difference within the groups. Independent Sample t-test was used to determine differences in Pulmonary Function Test Variables and Chest Wall Expansion scores, between groups. Significance was set at $p<0.05$.

RESULTS

Demographic Data:

A total of thirty young old people were screened for the study as per inclusion and exclusion criteria. The subjects were conveniently divided into 2 groups. Each group comprised of 15 subjects each. [Core Stabilization Exercise Group (CSEG) n = 15, mean age 66.33 ± 3.59 years, mean BMI 24.46 ± 0.74 kg/m^2 and Chest Mobilization Exercise Group (CMEG) n = 15, mean age 68.27 ± 3.45 years, mean BMI 23.36 ± 1.65).

Pulmonary Function Test and Chest Expansion variable difference between and within groups: There was significant improvement found between Pre and Post PFT variable as well as chest expansion.

Table 1: Illustrate Mean±SD of pre and post parameters of both the groups

Parameters	Groups	Pre Value	Post Value
FEV1	A (CSEG)	1.30±0.27	1.85±0.14
	B (CMEG)	1.30±0.19	1.78±0.19
FVC	A (CSEG)	1.48±0.23	2.00±0.17
	B (CMEG)	1.48±0.17	1.89±0.12
FEV1/FVC	A (CSEG)	87.71±10.53	92.48±4.91
	B (CMEG)	88.12±12.83	94.40±7.76
PEFR	A (CSEG)	127±28.40	164.33±38.17
	B (CMEG)	140.67±38.21	155±35.51
Upper Chest Expansion	A (CSEG)	1.57±0.66	1.69±0.63
	B (CMEG)	1.44±0.37	2.51±0.36
Lower Chest Expansion	A (CSEG)	2.73±0.48	2.81±0.53
	B (CMEG)	2.63±0.43	3.61±0.32

Paired Sample t-test mean difference within CSEG showed significant improvement in PEFR compare to FEV1, FVC and FEV1/FVC ratio after 4 weeks of training ($p<0.05$). Paired Sample t-test mean difference within CMEG also showed improvement in all PFT variables after 4 weeks of training ($p<0.05$).

Table 2: Illustrates the mean comparison of pre and post PFT and Chest expansion variables within both the groups

Parameters	Groups	Pre Value	Post Value	t-value	p-value
FEV1	A (CSEG)	1.30±0.27	1.85±0.14	-9.325	0.00
	B (CMEG)	1.30±0.19	1.78±0.19	-7.407	0.00
FVC	A (CSEG)	1.48±0.23	2.00±0.17	-12.138	0.00
	B (CMEG)	1.48±0.17	1.89±0.12	-8.372	0.00
FEV1/FVC	A (CSEG)	87.71±10.53	92.48±4.91	-1.809	0.092
	B (CMEG)	88.12±12.83	94.40±7.76	-2.044	0.06
PEFR	A (CSEG)	127±28.40	164.33±38.17	-8.671	0.00
	B (CMEG)	140.67±38.21	155±35.51	-7.152	0.00
Upper Chest Expansion	A (CSEG)	1.57±0.66	1.69±0.63	-3.199	0.006
	B (CMEG)	1.44±0.37	2.51±0.36	-11.809	0.00
Lower Chest Expansion	A (CSEG)	2.73±0.48	2.81±0.53	-1.852	0.085
	B (CMEG)	2.63±0.43	3.61±0.32	-13.395	0.00

Table 3: Illustrates the post-training mean difference between the CSEG and CMEG.

Parameters	Mean difference	Std. error Difference	t-value	p-value
POSTFEV1	0.066	0.06264	1.054	0.301
POSTFVC	0.112	0.05506	2.034	0.052
POSTFEV1/FVC	-1.92733	2.37215	-0.812	0.423
POSTPEFR	9.33333	13.45952	0.693	0.494
POSTUCE	-0.81333	0.18668	-4.357	0.00
POSTLCE	-0.80667	0.15896	-5.074	0.00

There is no significant difference found in post-training for all variable of pulmonary function test between two groups with $p>0.05$. There is significant difference found in post-training for variable of Chest Expansion between two groups with $p<0.05$.

DISCUSSION

The objective of this study was to compare the effects of core stabilization and chest mobilization exercise on lung function and chest wall expansion in young old people.

Result of the present study showed those 4 weeks of exercise training significantly improved pulmonary function and chest expansion in young old people of both the groups. However, the improvement in FEV1 and FVC were not that much significant in both groups but PEFR was significantly improved in Group A compare to Group B. At the same time chest expansion was significantly improved in Group B compare to Group A.

In this study core strength training has been shown to change the physiologic parameters. Most of the previous research conformed the finding of present study. It is apparent that training adaptations are very specific to movement pattern, velocity of movement, contraction type and contraction speed.

The diaphragm is a main muscle of inspiration. It involves in trunk stability and posture control along with abdominal muscles like Transverses abdominis, internal oblique, External oblique, and Rectus abdominis. By increasing intra-abdominal pressure, the abdominal muscles can push the diaphragm upward into the thoracic cage provides optimal length-tension relationship, hence increasing both the volume and speed of exhalation.[17]
Cavaggioni et al. studied effect of six week core strengthening exercise on respiratory parameters combined with diaphragmatic breathing showed statically significant improvements in FVC, FEV1 and PEFR in exercise group compared to control group.
Song and Park reported that the FVC and FEV1 of stroke patients increased after performing chest-expansion exercises 5 times a week for 30 minutes each, for 8 weeks total. Park reported that there was an increase in the upper and lower chest expansion through rib cage joint mobilization among stroke patients. In addition, Minoguchi et al., showed that chest expansion significantly increased after carrying out respiratory muscle stretch exercises in patients with chronic obstructive pulmonary disease, but there were no significant differences in PEF, which is consistent with our study's results. [16]

Unlike Kim's, study, the current study showed a significant increase in PEF in the core stabilization exercise group, and there was a significant increase in chest expansion in the chest mobilization exercise group. It is assumed that the chest mobilization exercise improves chest-wall expansion as it is an intervention aimed at reducing stiffness of the chest wall, not at improving respiratory muscle strength. In addition, an increase in the chest-wall motion can increase one's lung volume during inspiration, so the FEV1 is also increased when the FVC increases. [18]

In terms of the action of the respiratory muscles and the core stabilization mechanism, the volume of the thoracic cavity increases and the negative pressure of the intrathoracic pressure are maintained due to the piston movement, via which the diaphragm descends and the ribs expand upward and outward. Due to this action, inhalation, which is the process of air inflow into the lungs, occurs, and when the muscles relax, exhalation is performed by passively venting air out. At this time, the main muscle of the inhaler is composed of the diaphragm, the quadrangular muscle, and the intercostals muscle. When the diaphragm contracts, the length becomes shorter and the abdominal pressure is lowered and compressed, thereby increasing the intra-abdominal pressure. The tension in the abdominal muscles increases the intraabdominal pressure during diaphragm contraction, thereby promoting the action of the diaphragm to complete inspiration. In addition, the aerobic muscles, the abdominal muscles, the internal and external abdominal muscles, the transverse abdominal muscles, etc. assist exhalation and promote diaphragm contraction, such that active respiratory muscle training contributes to the strengthening of the deep muscle core, which is otherwise inactive. [18]

Kolar et al. and Frank et al.; discussed the positive results of increased core muscle activity in double breathing, improved endurance, and reduced muscle compensatory action, such as femoral fasciitis. The results of these studies show that most elderly suffer from the hardening of muscles and soft tissues of the joints; therefore, respiratory stimulation, which increases the utilization of trunk muscles, relieves muscle tension during core exercise and reduces the burden on the lower extremity joints. The results of the review supported the effectiveness of the respiratory action in the core exercise. Concluding, active exercise in respiratory muscle training must be included in elderly exercise, and the research results presented in this study will serve as a basis for positive improvement in core function recovery through respiratory muscle activation. Therefore, the respiratory muscle training exercise intervention of the elderly can expect to strengthen and stabilize the core muscles necessary for the stability of the body by straightening the lower abdominal contractions and the spine, and further improving the physical, physiological, and psychological health of the elderly. [18]

The present study has several limitations. Firstly, the sample size was small. Second, the sampling method was convenient so the affected population was not able to be excess properly.

Large number of samples should be incorporated into the study for better result recommendation with strong statistical significance among different groups. The study can be conducted in gender specific because male core strength and power is greater than female.

CONCLUSION

This present study concludes that both exercises were effective in some aspect of pulmonary function. Core Stabilization Exercise results a significant increase in peak expiratory flow rate (PEFR) and some aspect on FEV1/FVC ratio. Chest Mobilization Exercise results a significant increase in upper and lower chest expansion.

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ETHICAL CLEARANCE: The study was approved by the ethical committee of Shrimad Rajchandra College of Physiotherapy, Maliba Campus, Bardoli, Surat.
CONFLICT OF INTEREST: None

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