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Comparative Effect Of Abdominal Muscle Exercises And Thoracic Mobility In Post-Menopausal Females

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Abstract

Menopause involves hormonal changes that cause physical symptoms which vary from woman to woman. The vasomotor symptoms include hot flushes and night sweats. The vaginal symptoms include uterine prolapsed and vaginal atrophy. During high intensity exercise, when the minute ventilation increase, the work of abdominal muscles is required to increase expiratory flow rate. The enhanced abdominal muscles activity during exercise helps expiration of air out of the lungs which result in decrease in the end-expiratory lung volume. **Aim**: The purpose of the study is to understand the effect of abdominal muscle strengthening exercises and thoracic mobility exercises and to determine general activity improvement in post-menopausal females. **Methodology**: Quasi experimental design, Simple random sampling**,** 30 post-menopausal women were divided into 3 groups, Group 1 performed thoracic mobility exercises and Group 2 performed abdominal muscle strengthening exercises and Group 3 performed both thoracic and abdominal muscle strengthening exercises. **Result**: Within the group pre and post intervention comparison was done by chi-square test. Normality test was done by Shapiro-Wilk test. The intervention was given twice a day for 2 weeks. Post exercise outcome measures were measured. The mean difference of PEFR for group A was 21 and for group B was 19 and for group C was 27. Our study concluded that group C who did both thoracic mobility and abdominal muscle exercises was more significant as comparison to group A who did only thoracic mobility exercise and group B who did only abdominal muscle strengthening exercises. Although group A and group B also showed significant result. **Conclusion**: Combined thoracic mobility and abdominal muscle strengthening exercises were more effective as comparison to single thoracic mobility and single abdominal muscle strengthening exercises.

Key words: post-menopausal females, thoracic mobility, chest expansion, abdominal exercises, strengthening exercises, chest mobility exercises

INTRODUCTION

When woman's ovaries stop producing eggs, and the production of hormones such as estrogen and progesterone decline menopause occurs, which is a natural process. Menopause is a sign of aging in the woman and does not occur suddenly [Margaret *et al*.,1985]. Natural menopause is recognised after 12 months of amenorrhea which is not associated with a pathologic cause. Premenopause is the time up to beginning of the perimenopause, but is also used to define the time up to the last menstrual period. Perimenopause is the time around menopause during which menstrual cycle and endocrine changes are occurring but 12 months of amenorrhea has not yet occured. Postmenopause begins at the time of last menstrual period, although not recognized until after 12 months of amenorrhea [Nelson *et al*.,2005]. Due to loss of ovarian function reduction in resting metabolic rate, physical energy expenditure, fat-free mass and abdominal adipose tissue accumulation [Margaret *et al.*,1985]. Most women experience menopause between 40 and 58 years of age, the median age being 51 years [Dratva *et al*.,2009]. In Indian women average age of menopause is 47 years with an average life expectancy of 71 years [Sreerenjini *et al.*,2018].

Menopause involves hormonal changes that cause physical symptoms which vary from woman to woman. The vasomotor symptoms include hot flushes and night sweats. The vaginal symptoms include uterine prolapsed and vaginal atrophy. The psychosomatic symptoms include dizziness, rapid heartbeat, numbness of extremities, irritability, tiredness, headache, sleep disturbance, pressure and tightness in head and body, muscle and joint pain, fainting and breast pain. The psychological symptoms include dysuria, increased urine frequency and urine leak during coughing and laughing [Sreerenjini *et al*.,2018].

Typical symptoms at the time of menopause lasting 4-5 years are hot flushes, night sweats, vaginal dryness and sleep disturbance [Nelson *et al.*,2005; Woods *et al*.,2005: Col *et al.*,2009]. In the coming decades with the aging of the population it is estimated that 1.2 billon women worldwide will be menopausal or postmenopausal by the year 2030 [Matthew *et al*.,2015]. In Asian women from different ethnic backgrounds have reported symptoms prevalence rates ranging between 10-40% [Laxminarayana *et al*.,2009]. With advancing reproductive stage, which ranges from late reproductive, early menopause transition, late menopause transition, to post menopause, symptoms prevalence and severity generally increases [Matthew *et al*.,2015]. In menopausal women, abdominal weight gain and lung capacity are correlated to each other [Frederiksberg *et al*.,2006]. Pulmonary function changes are associated primarily with aging but ovarian hormones also have a certain impact on them [Carey *et al.*,2007]. Along with other organ system dysfunctions, lung functions are also adversely affected, in post menopausal women. Loss of lung function occurs quickly in postmenopausal women, respiratory muscle strength decreases with age. Decreased pulmonary function can be attributed to low level of sex hormones in post menopausal women [Goodwin *et al*.,2006; Massaro *et al*.,2006]. In females, sex hormones strongly influence adipocyte metabolism [Teresa *et al*., 2011]. Estrogen levels are significantly lower in postmenopausal women as compared with premenopausal women. Progesterone levels were lower in post menopausal women in proliferative phase of premenopausal women as compared with luteal phase of menstrual cycle. The peak expiratory flow rate are lower in postmenopausal women compared with premenopausal women [Amar *et al.*, 2010]. The peak expiratory flow rate is a person's maximum speed of expiration. It is measured with peak flow meter, a small, hand-held device used to monitor a person's ability to breathe out air [Poonam *et al*.,2017]. Peak expiratory flow rate is lower in post-menopausal women compared to pre-menopausal women [Troyer *et al.*, 1990]. As abdominal muscles are the

principle muscles of expiration, it improves the efficiency of expiration [Kshtrashal 2013]. Abdominal muscles helps in forced expiration, so weakness of abdominal muscles affect forced expiration [Zinnat *et al.*,2011].

Abdominal muscles are external oblique, internal oblique, transverse abdominis and rectus abdominis. Relaxed normal expiration is a passive process, happens because of the elastic recoil of the lungs and surface tension. However there are a few muscles that help in forceful expiration and include the internal intercostals, intercostalis intimi, subcostals and the abdominal muscles. The accessory expiratory muscles are the abdominal muscle: rectus abdominis, external oblique and transversus abdominis. In the thoracolumbar region the lowest fibres of ilicostalis and longissimus, serratus posterior inferior and quadrates lumborum [Hiroshi *et al.*,2014]. As respiratory muscles, they have two principle actions. First, as they contract, they pull the abdominal wall inward and produce an increase in intra-abdominal pressure. The other function of the abdominal muscles in relation to breathing is to displace the rib cage [Troyer ,1988] . In so doing, the abdominals are powerful muscles of expiration that play important roles in activities such as forced expiration [Ishida *et al*.,2012]

During high intensity exercise, when the minute ventilation increase, the work of abdominal muscles is required to increase expiratory flow rate [Yii-jiun *et al*.,2018]. The enhanced abdominal muscles activity during exercise helps expiration of air out of the lungs which result in decrease in the end-expiratory lung volume [Taylor *et al*.,2006].

Though quite expiration is passive, it occurs with relaxation of respiratory muscles. Expiration becomes active during fast hard breathing and the abdominal muscle contract causing the diaphragm to push upwards. Weakness of abdominal muscles affect the forced expiration, as abdominal muscles helps in forced expiration [Kshtrashal 2013]. As abdominals are powerful muscles of expiration plays a important roles in activities such as forced expiration. Maximum expiration is useful in coactivation of the deep and superficial abdominal muscles [Ishida *et al.*,2012].

Strengthening of abdominal muscle through abdominal strengthening exercise will helps to improve the abdominal muscle strength and also the muscles assist in act of the forced expiration [Patricia *et al*.,1993; Gardiner1985; Kothari,1985]. Partial or complete weakness of abdominal muscles is unable to cough and produce forced expiration effectively which affects in clearing secretions from the lungs and sputum retention. So, abdominal strengthening exercises helps in removing secretions and sputum and improves lung compliance and daily activities of the individuals. Abdominal muscle strengthening exercise is safe and beneficial for any normal individual as to improve peak expiratory flow rate which improves quality of life [Mishra *et al.*,2013].

Abdominal exercises, such as core conditioning exercises, are often promoted as an effective means to reduce abdominal fat and trim the waistline. They potentially improve the strength and endurance of abdominal muscles [Vispute *et al*.,2011]. Expiratory muscles involved in similar proportion as inspiratory muscles during exercise or pathological conditions as expiratory muscles have higher proportional of fast-twitch fibers and less oxidative stress than inspiratory muscles [Yii-jiun *et al*,2018]. Expiratory muscle training, especially the abdominal muscles may improve pulmonary function exercise performance [Childs *et al*.,2010]. Deep breathing helps in reducing menopausal symptoms among menopausal females [Sreerenjini *et al*.,2018].

Hence, the purpose of the study is to understand the effect of abdominal muscle strengthening exercises and thoracic mobility exercises and to determine general activity improvement in post-menopausal females.

METHODOLOGY

STUDY DESIGN- Quasi experimental design

SAMPLING METHOD- Simple random sampling

SAMPLE SIZE- 30 post-menopausal women that will be divided into three groups

INCLUSION CITERIA

- Post-menopausal women between age group 45-55 years
- Abdominal muscle power 3^+ (according to oxford muscle grading classification)
- Females who can understand commands and willing to participate in the study
- Females with BMI 20-29.9

EXCLUSION CRITERIA

- Cardio-respiratory disorders
- Musculoskeletal disorders
- Neurological disorders
- Mentally retarded persons
- Chronic illness
- Endocrinal disorders
- Smokers or ex-smokers
- Trauma patients
- Individuals taking any medications or participating in any other exercise programmes

VARIABLES

DEPENDENT VARIABLE

- Peak expiratory flow rate (PEFR)
- Waist hip ratio (WHR)
- Manual muscle testing (MMT) for abdominal muscles
- Chest expansion

INDEPENDENT VARIABLE

- Abdominal muscle exercise
- Thoracic mobility exercise

PROCEDURE

The study was a quasi experimental study which included the post-menopausal females divided into three groups. Group 1 performed thoracic mobility exercises and group 2 performed abdominal muscle strengthening exercises and group 3 performed both thoracic and abdominal muscle strengthening exercises. The complete exercise protocol was explained to the subjects. From each and every individual an informed consent was taken. Prior to exercise protocol therapist took baseline measurements for abdominal girth, MMT of abdominal muscle and peak expiatory flow rate and chest expansion. Abdominal girth was measured by inch tape method, MMT

of abdominal muscles was checked, peak expiratory flow rate was measured by peak expiratory flow meter and chest expansion was measured by inch tape method at three different levels that is axillary level, xiphoid level and diaphragmatic level. Abdominal muscle strengthening exercises and thoracic mobility exercises was performed under supervision and all the measurements were taken again after 2 weeks.

Peak expiratory flow rate- is a person's maximum speed of expiration, as measured with a peak flow meter, a small, hand-held device will be used to monitor a person's ability to breathe out air.

Waist Hip ratio- is the ratio of the circumference of the waist to that of the hips. This will be calculated as waist measurement divided by hip measurement (W ÷ H, where W is for waist and H is for hips). This will be measured by inch tape.

MMT for abdominal muscle

Upper abdominal exercises-

Starting position-The subjects were instructed to lie in supine with the hips at 45 degree and knees at 90 degree and hand at sides. In all these activities subjects were instructed to keep the low back flat.

Grade1-subjects were asked to perform the curl ups by contracting abdominal muscles and then lifting the head off table with flexed knees.

Grade 2-the progression was made by lifting the shoulders until the top of scapulae lift from table, keeping the arms extended towards knees.

Grade 3- The next progression was done by lifting the shoulders until the scapulae clear table, keeping the arms horizontal.

Grade 4- The subjects were asked to progresses further by keeping the arms crossed over chest, until scapulae clear table.

Grade 5- The subjects were asked to progress the difficulty of the curl ups by having the subject change the arm position from horizontal and then to behind the neck, until scapulae clear table.

Chest expansion

The subject was comfortably positioned supine and the tape measure placed around the chest at the axillary level, xiphoid level and diaphragmatic level. The subject was asked to take his maximum inspiration and to exhale fully. Subject was encouraged to exert his maximum by the examiner. Therapist red the inches of inspiration and expiration directly from the tape measure. This was repeated twice more without the tape measure being moved. The subject was allowed to rest for a few breaths between each trial. The largest expansion of the three trials was used as the maximum chest expansion.

PROTOCOL

Abdominal Strengthening Exercises

Upper Abdominals

Curl-ups:

Starting position: crook lying

- Have the subject lift the head off the mat. This will cause a stabilizing contraction of the abdominal muscle.
- Lifting the shoulders until the scapulae and thorax clear the mat. Keeping the arm horizontal.
- The subject does not come to a full sit-up because once the thorax clears the mat the rest of the motion is performed by the hip flexor muscles.

Oblique-Muscles

Hip-roll

Starting position: Supine lying

Procedure

- Bend our legs. Keeping feet firmly flat on the floor.
- Lower the knees to one side turning at the waist.
- Aim to allow the thigh to touch the floor then slowly repeat again on other side.
- Avoid lifting the shoulders come up of the floor.

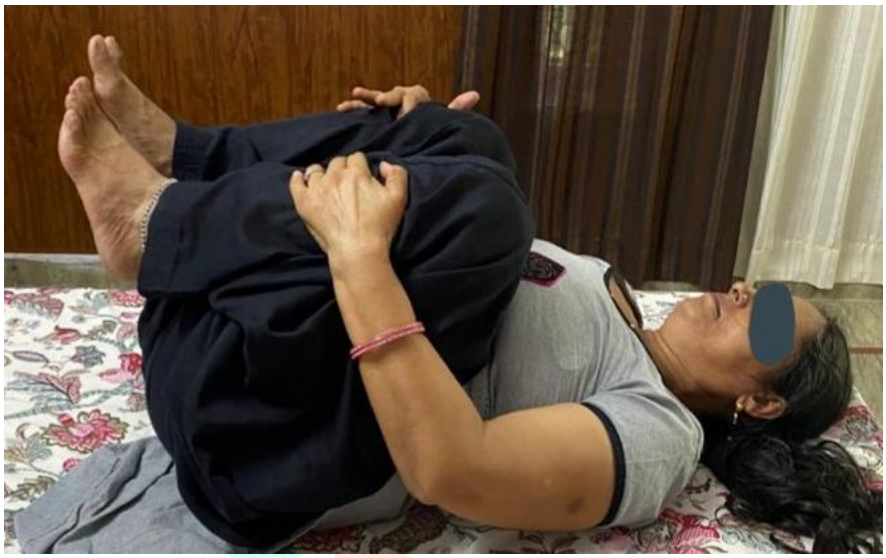
Lower Abdominals

Double knee to chest

Starting: crook lying

Procedure

- Having the subject set a posterior pelvic tilt bring both knees to chest and return.

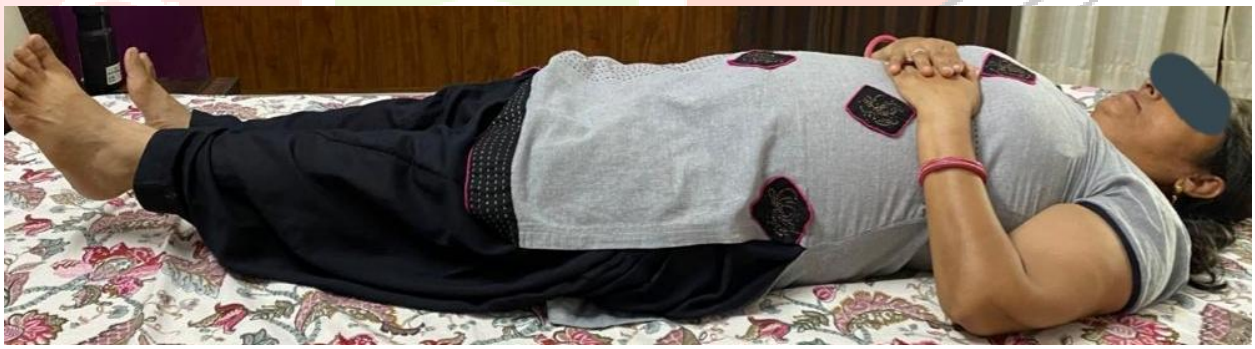


Leg Lowering Movement

Starting position: supine lying and forearms are folded across the chest to ensure that the elbows are not resting on the mat for support.

Procedure

- The subject enable to keep low back flat to the table while lowering the legs to table level, the legs are elevated a few degree.



Thoracic Mobility Exercises

Starting position: side-lying

Procedure

- Lie on your side with a towel roll placed under your rib cage.
- Bring your arm over your head (or as far as you can) and take a large, slow breath. Hold for 3 seconds.
- Blow your air out and bring your arm back to your side.
- Do this 10 times.
- Repeat on the other side.

Starting position: supine

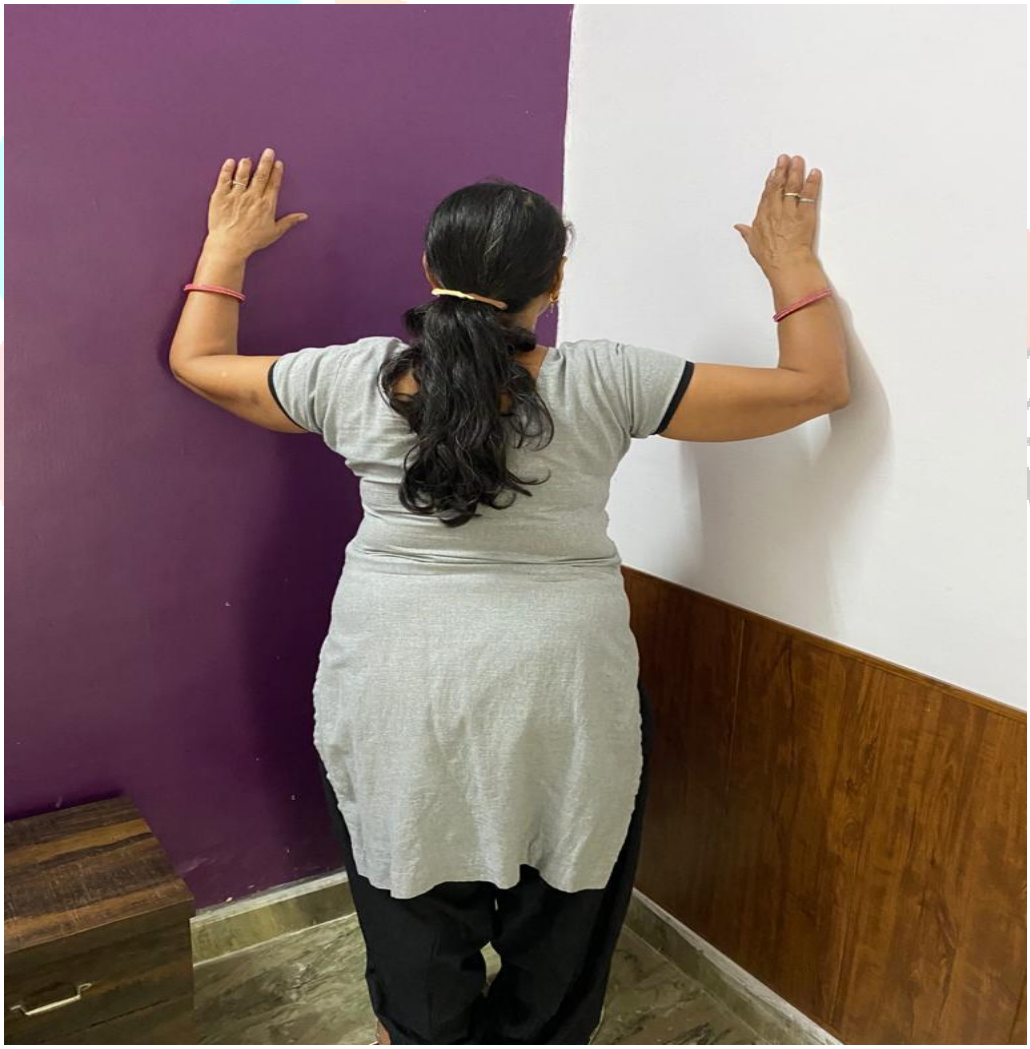
Procedure

- ❖ Lie on your back with a small towel roll along your spine.
- ❖ Raise your arms up over your head as far as you can.
- ❖ Stay in this position for 2 minutes practicing your deep breaths.

Doorway/corner stretch

Procedure

- ❖ Stand facing a doorway or corner with arms up at a 90 degree angle.
- ❖ Lean forward until the muscle feel a stretch.
- ❖ Hold this stretch for 30 seconds.



Diaphragmatic Breathing

Procedure

- Subject was in a relaxed and comfortable position in which gravity assists the diaphragm, such as a semi-Fowler's position.
- Therapist placed hand(s) on the rectus abdominis just below the anterior costal margin. Therapist asked the subject to breathe in slowly and deeply through the nose.
- The subject kept the shoulders relaxed and upper chest quiet, allowing the abdomen to rise slightly.
- Therapist asked the subject to relax and exhale slowly through the mouth.
- The subject practiced for three to four times and then rest.

DURATION OF EXERCISES- 20 min

FREQUENCY OF EXERCISES- 2 times per day for 2 weeks

INSTRUMENTATION

- Peak expiratory flow meter
- Inch tape

Variable	Group A	Group B	Group C
Age	50.80±1.751	50.30±2.214	51.80±1.814
Weight	59.90±2.132	61.80±2.251	60.70±2.541
Height	1.61±0.040	1.58±0.031	1.60±0.066
BMI	23.21±0.799	24.77±1.666	23.74±1.389
PEFR	180±.13.333	184±12.649	178±19.003
Waist	36.40±1.075	35.90±2.885	34.30±1.418
Hip	45±1.633	44.40±2.413	42±1.969
WHR	0.81±0.028	0.79±0.019	0.80±0.031
Chest Expansion 2nd ICS	2.99±0.145	2.96±0.406	3.29±0.393
4th ICS	2.60±0.236	2.43±0.403	2.62±0.483
Xyphoid Process	3.32±0.187	3.29±0.446	3.53±0.406

Table 1. Shows baseline data

Outcome	Group	Pre-Intervention Mean±SD	Post-Intervention Mean±SD	t value	P value
PEFR	Group A	180±13.333	201±14.491	11.69	<0.001
Group B	184±12.649	203±15.239	7.96		<0.001
Group C	178±19.003	205±17.288	5.238		0.001
WHR	Group A	0.81±0.028	0.81±0.042	0.188	0.856
Group B	0.79±0.019	0.78±0.026	2.281		0.049
Group C	0.80±0.031	0.77±0.044	0.615		0.044
CHEST EXPANSION	Group A 2nd ICS 4th ICS Xiphoid process	2.99±0.145 2.60±0.236 3.32±0.187	3.77±0.380 3.77±0.430 4.01±0.099	9.586 7.516 13.119	0.000 0.000 0.000
Group B 2nd ICS 4th ICS Xiphoid process	2.96±0.406 2.43±0.403 3.29±0.446	4.11±0.375 3.68±0.274 0.40±0.383	19.138 23.958 17.336		0.000 0.000 0.000
Group C 2nd ICS 4th ICS Xiphoid process	3.29±0.393 2.62±0.483 3.53±0.406	4.38±0.371 4.04±0.350 4.59±0.373	23.786 8.930 24.832		0.000 0.000 0.000

Table 2. It shows pre- and post- PEFR, WHR and chest expansion scores

Discussion

Menopause is a natural process and it does not show any pathology. It shows aging of females. The aim of the study is to understand the effect of abdominal muscle strengthening exercises and thoracic mobility exercises in post-menopausal females to determine expiratory flow rate and general activity improvement of the post-menopausal females. The selected subjects were females of age group 45-55 years. The pre outcome measure was peak expiratory flow rate, waist hip ratio and abdominal strength. Peak expiratory flow rate measured by peak expiratory flow meter, waist hip ratio measured by inch tape and abdominal strength measured by grades of abdominal muscle. The subjects were grouped under three groups which received thoracic mobility exercises, abdominal muscle strengthening exercises and both thoracic mobility and abdominal muscle strengthening exercises. The intervention was given twice a day for 2 weeks. Post exercise outcome measures were measured. The mean difference of PEFR for group A was 21 and for group B was 19 and for group C was 27. Our study concluded that group C who did both thoracic mobility and abdominal muscle exercises was more significant as comparison to group A who did only thoracic mobility exercise and group B who did only abdominal muscle strengthening exercises. Although group A and group B also showed significant result. The mean difference of WHR for group A was 0 and for group B was -1 and for group C was -0.03. The mean difference of chest expansion at 2nd ICS for group A was 0.78, for group B was 1.17 and for group C was 0.69. The mean Difference of chest expansion at 4th ICS for group A was 1.17, for group B was 1.25 and for group C was 1.42. The mean difference of chest expansion at xiphoid process for group A was 0.69, for group B was 0.75 and for group C was 1.06. In group A and B after intervention there is non-significant changes in MMT as p value is <0.005. In group C there is a significant change in MMT from 2+ to 4.5+ post intervention.

After menopause women start gaining excessive weight around the abdominal area and this creates difficulty for them in performing strenuous activities like stair climbing, brisk walking. Abdominal weight gain and lung capacity are correlated in post menopausal females [Frederiksberg *et al*., 2017]. As ovarian function reduces there is reduction in resting metabolic rate, physical energy expenditure, fat-free mass and abdominal adipose tissue.

In post menopausal women low level of estrogen and progesterone are related with changes in peak expiratory flow rate. PEFR values are low in post menopausal women [Amar *et al*., 2017]. In post menopausal women lung function changes are observed because after menopause ovaries become less functional and there is

reduction in amounts of estrogen and progesterone produced by ovary. Hyperventilation is induced by progesterone through both central medullary and peripheral chemoreceptors [Pai *et al*., 2004]. Estrogen and progesterone have been associated with relaxation of airway smooth muscles mediated by relaxation of bronchial muscles and widening of bronchi [Foster et al., 1985]. Progesterone plays a beneficial role on the upper airway function and breathing is supported by pharyngeal dilator muscle activity [Popovic *et al.*, 1998]. Estrogen also contribute to increase lung function by increasing number of progesterone receptors [Leavitt *et al*., 1972]. Post menopause is associated with loss of bone mineral density [Villareal *et al.*, 1995]. Lack of estrogen is the primary cause of bone loss after menopause [Lindasy et al., 1976]. Bone mass density in the bones of thoracic cage is also reduced [Ganong et al., 2005]. Intrathoracic space is decreased due to deformities of bones of thoracic cage which is related to decreased lung function [Rossi et al., 1989]. Respiratory muscle strength is also decreased due to decrease in levels of estrogen and progesterone. They also induced skeletal myoblast growth [Cevrioglu et al., 2004]. When estrogen and progesterone levels are reduced this cause decrease strength of muscles, relaxation of bronchial smooth muscle also decreased, and compression of thoracic spine is increased and total lung capacity is declined [Amar et al., 2017].

As abdominal muscles are expiratory muscles, are usually silent during quiet breathing. During high-levels of ventilation, the forceful contraction of expiratory muscles not only helps to expire air out of lungs, but also act as an accessory muscle of inspiration by maintaining an optimum position at end of expiration [Hopkinson et al., 2010]. In healthy individuals the PEFR is also affected by strength of expiratory muscles which generate the force of contraction and elastic recoil pressure of the lungs and airways size. In obese individuals the PEFR value is low because the normal respiratory biomechanics is altered. The respiratory muscle action is limited by the excess body fat lines the chest and occupies the abdomen.

Diaphragm and inspiratory muscles strength also improved by abdominal exercises despite of abdominal muscle strength [Childs *et al*., 2010]. Transdiaphragmatic pressure significantly increases by abdominal exercises that result in increase in maximum inspiratory pressure and maximum expiratory pressure [DePalo *et al*., 2004]. Mechanical muscular activity is altered due to accumulation of adipose, altered airway quality and increase in respiratory resistance reduced lung functioning and lower PEFR in obese women. Lung functions are altered with increase in BMI [Puri *et al*., 2019]. Physical activities in which trunk and abdominal muscles are involved raise the intra-abdominal pressure which enhance the respiratory muscle strength. Pulmonary functions are improved by respiratory muscle training [Ray *et al*., 2010]. Chest wall expansion is reliable at three different anatomical levels of chest which is used to examine the effectiveness of an intervention in both clinical and research practice [Mohan *et al*., 2012]. One of the inexpensive method to measure chest expansion is cloth tape measurement which is used to measure consistency [Keating et al., 1998]. Chest expansion is measured at axillary, fourth intercostal space and xiphoid with the arms are placed at the side [Senjyu *et al*., 2003].

Limitations of the study:

- ❖ Sample size was small.
- ❖ Duration of intervention was too short.
- ❖ Samples were taken from a particular location.
- ❖ Only one pulmonary parameter PEFR was measured.

Scope of further study:

- ❖ Further study can be done with large sample size.
- ❖ Duration of intervention can be increased.
- ❖ Samples can be taken from all over Haryana.
- ❖ Other pulmonary parameters can be measured.

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