

## Impact of External Oblique Muscle Training on Ultrasonography and Spirometry Parameters among Elderly Population

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A progressive, generalized loss of skeletal muscle mass and accompanying decline in muscle strength and performance with increasing in age. Aging affect the respiratory muscle performance on respiratory system due to anatomical and physiological changes in muscle strength as well as thickness of the respiratory muscles. During resting breathing the limitation of movement is more evident in expiration than inspiration were the FEV<sub>1</sub>/FVC% falls in older people. There are lot of study on peripheral muscle thickness and muscle torque among elderly population, but not much study on respiratory muscle training. This made us to conduct a study on pulmonary function and muscle thickness in elderly population by training the expiratory muscles. To determine the effects of external oblique muscle training on pulmonary function and muscle thickness in elderly population. 60 geriatric voluntary subjects were assigned to experimental and control group as (n=30) each. Experimental group subjected to 16 weeks of external oblique strengthening along with incentive spirometer training. Control group subjected to incentive spirometer alone. Pre and post training muscle thickness and pulmonary parameters were assessed. The paired t test found there is significant difference (P<0.05) between pre and post training muscle thickness and pulmonary parameters in experimental group. We recommend that resistance training, not only maintain the muscle thickness also improve the muscle thickness and pulmonary parameters among elderly population.

**Keywords:** External oblique strengthening, Muscle thickness, Pulmonary parameters.

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Aging is a progressive process and is associated with constriction of homeostatic reserve of organs. The most important impact of aging on respiratory system were decrease in elastic recoil of the lungs and respiratory muscle performance due decrease in anatomical and physiological parameters especially respiratory muscle strength i.e. sarcopenia.

The proportion of the world's population over 60 years increased from 9.2% in 1990 to 11.7% in 2013 and is projected to be 21.1%, or 2 billion people, by 2050.<sup>1</sup> Aging is associated with reduction in chest wall compliance and increased air trapping. The decline in forced expiratory volume in first second (FEV1) with age likely has a nonlinear phase with acceleration in rate of decline

after age 70 years. There is an increase in airspace size with aging resulting from loss of supporting tissue. Respiratory muscle strength decreases with age and much more so in men than in women.<sup>2</sup>

The external oblique muscle is the largest and the outermost of the three flat muscles of the lateral anterior abdomen. It originates from eight fleshy digitations, each from the external surfaces and inferior borders of the fifth to twelfth ribs. The external oblique muscle pulls the chest downwards and compress the abdominal cavity that increases the intra-abdominal pressure as in a valsalva maneuver.

Lung functions decrease throughout adult life, even in healthy people. Cross sectional analyses have suggested that the decline may go faster after aging. Normal aging results in changes in pulmonary mechanics, respiratory muscle strength, gas exchange and ventilatory control. Increased rigidity of chest wall and a decrease in respiratory muscle strength with aging result in an increased closing capacity and a decreased forced expiratory volume in first second (FEV1), Forced vital capacity (FVC). During resting breathing the limitation of movement is more evident in expiration than inspiration, perhaps because there are no efficient accessory muscles of expiration. Due to these changes the cough efficiency, FEV1 and FVC will be reduced in elderly people.

Elderly persons are vulnerable to risk factors such as chronic diseases, impaired physical condition, and functional limitations, as well as cardiopulmonary dysfunction and muscle weakness. Thus, it is important that the elderly should perform aerobic and strengthening exercises, and to manage the risk of falls in order to ensure their health.<sup>3</sup>

Both cross section and longitudinal studies have demonstrated that there is decline in maximum oxygen uptake, VO<sub>2</sub> with advanced aging. Another factor which implicated in reduction of maximum uptake with age is customary level of physical activity, the rate of decline in (ml/kg.min) may be reduced as much as half by a high level of customary physical activity.<sup>4</sup> Electrical stimulation was applied to the rectus abdominis and muscles around the abdomen, and it improved and tidal volume and pulmonary ventilation in spinal cord injury patients.<sup>5</sup> The IMT group showed significant

improvement in balance, TA and IO thickness, FVC, FEV1, and PEF.<sup>6</sup>

### **Background and purpose**

A progressive, generalized loss of skeletal muscle mass and accompanying decline in muscle strength and performance occurs with increase in age. Disability, frailty, comorbidities, hospital admissions and death are the negative outcomes of elderly. Aging affect the respiratory muscle performance on respiratory system due to anatomical and physiological changes in muscle strength as well as thickness of the respiratory muscles. Progressive loss of protective reflexes in the airway with the advancement of age is one of the commonest changes in the respiratory system.<sup>7</sup> During resting breathing the limitation of movement is more evident in expiration than inspiration, perhaps because there are no efficient accessory muscles of expiration. Due to these changes the cough efficiency will be reduced and the FVC falls in older people. There are lot of study on peripheral muscle thickness and abdominal muscle thickness among elderly population, but not much study on external oblique muscle training. Hence we conducted a study on pulmonary function and muscle thickness in elderly population by training the external oblique muscles.

## **METHODOLOGY**

### **Study design**

### **Experimental design**

**Study setting:** Universiti Kuala Lumpur- Royal College of Medicine Perak.

**Participants:** 60 geriatric voluntary persons were randomly selected

### **Inclusion criteria**

- Age between 55-65
- Males only.
- Independent ADL.

### **Exclusion criteria**

- Haemodynamically unstable
- Asthmatics
- Dementia
- Depression

**Tools required:** Spyrolyser SPL-10, Diagnostic ultrasound machine

The procedure and benefits were discussed with the voluntary subjects and informed consent



**Fig. 1.** External oblique muscle thickness during normal and end of the expiration.

**Table 1.** Mean and standard deviation of control group

		Paired Samples Statistics <sup>a</sup>			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRSN	6.933 <sup>b</sup>	30	2.2959	0.4192
	POSN	6.933 <sup>b</sup>	30	2.2959	0.4192
Pair 2	PRSDE	8.727	30	3.0977	0.5656
	POSDE	8.73	30	3.0917	0.5645
Pair 3	PRFVC	72.357	30	15.8593	2.8955
	POFVC	72.807	30	16.4604	3.0052
Pair 4	PRFEV1	81.01	30	17.5475	3.2037
	POFEV1	82.337	30	17.4143	3.1794
Pair 5	PRPEF	83.797	30	24.9727	4.5594
	POPEF	85.103	30	24.5222	4.4771

a. group = cont

b. The correlation and t cannot be computed because the standard error of the difference is 0

**Table 2.** Comparison of Pre and Post-test values in control group using paired t test

		Paired Samples Test <sup>a</sup>							
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 2	PRSDE – POSDE	-0.0033	0.0556	0.0102	-0.0241	0.0174	-0.328	29	0.745
Pair 3	PRFVC – POFVC	-0.45	1.7033	0.311	-1.086	0.186	-1.447	29	0.159
Pair 4	PRFEV1 – POFEV1	-1.3267	1.8351	0.335	-2.0119	-0.6414	-3.96	29	0
Pair 5	PRPEF – POPEF	-1.3067	2.7787	0.5073	-2.3443	-0.2691	-2.576	29	0.015

a. group = cont

were obtained before the procedure. Sixty voluntary subjects were randomly assigned to experimental group (n=30) and subjected to strengthening of external oblique muscle along with expiratory training using incentive spirometer, control group (n=30) with incentive training alone were subjected to pulmonary function test (FEV1, FVC, PEF values) and muscle thickness measurement prior to the study. Then the experimental group were subjected to expiratory muscle strengthening especially external oblique using various exercise and incentive spirometer as a visual feedback for a period of 16 weeks. Post-training measurements were taken and they were correlated with pre-training values. The referred point of external oblique muscle was approximately 15 cm lateral to the umbilicus (right side) in standing position.

#### Muscle thickness

Muscle thickness was measured by TOSHIBA XARIO ultrasound equipment.

Participants were tested before and after 16 weeks period for muscle thickness of external oblique. All tested were conducted at the same day and participants were instructed to hydrate normally a day before the test. Measurement were taken 5 days after the last training session. During these time participants were instructed not to involve in any other resistance training in abdominal area. Muscle thickness were measured by a trained radiologist at 13 cm lateral to umbilicus using M-mode ultrasound by a water based gel with 7.5 MHz ultrasound probe was placed perpendicular to the tissue while not depressing the skin.

#### Lung parameters

Lung parameters such as FVC, FEV1 and PEF were assessed using Spyrölyser SPL-10. The pre and post intervention lung parameters were recorded in upright sitting posture.

#### Exercise protocol

Participants were randomly assigned in

**Table 3.** Mean and standard deviation of experimental group

		Paired Samples Statistics <sup>a</sup>			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRSN	6.927	30	2.396	0.4374
	POSN	7.063	30	2.4212	0.4421
Pair 2	PRSDE	8.763	30	3.1545	0.5759
	POSDE	9.293	30	2.9686	0.542
Pair 3	PRFVC	73.903	30	16.9274	3.0905
	POFVC	82.16	30	12.6083	2.3019
Pair 4	PRFEV1	84.407	30	19.1309	3.4928
	POFEV1	90.54	30	18.4747	3.373
Pair 5	PRPEF	85.663	30	26.3785	4.816
	POPEF	93.557	30	22.3215	4.0753

a. group = exp

**Table 4.** Comparison of Pre and Post-test values in experimental group using paired t test

		Paired Samples Test <sup>a</sup>							
		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference				
				Mean	Lower	Upper			
Pair 1	PRSN – POSN	-0.1367	0.2723	0.0497	-0.2383	-0.035	-2.749	29	0.01
Pair 2	PRSDE – POSDE	-0.53	0.3725	0.068	-0.6691	-0.3909	-7.794	29	0
Pair 3	PRFVC – POFVC	-8.2567	6.5148	1.1894	-10.6893	-5.824	-6.942	29	0
Pair 4	PRFEV1 - POFEV1	-6.1333	4.734	0.8643	-7.901	-4.3656	-7.096	29	0
Pair 5	PRPEF – POPEF	-7.8933	7.8666	1.4362	-10.8308	-4.9559	-5.496	29	0

a. group = exp

to two groups. The experimental group performed resistance exercise and incentive spirometer training, while the control group were trained using incentive spirometer only. The exercise protocol was designed in accordance to the guideline of American college of sports and Medicine, with three sets of 8 to 12 maximum repetition. Subjects were instructed to perform concentric and eccentric phase without pause between them. Training were conducted 2 days per week with a minimum of 48 hours rest and 2 to 3 sets, per exercise session is appropriate with 2.5 minutes of rest between each set. Cool down phase for 10 - 15 minutes. The warm up phase include mild stretching and allow individuals to walk in the treadmill for 10 to 15 minutes. Cool down phase that includes mild stretching and 3-4 repetition of deep breathing exercise of inspiration through nose, hold the breath for 3 seconds and expire through mouth slowly. Exercise regimen that initiated with incentive spirometer for 2 days and followed by strengthening of external oblique muscle.

In a study they suggested that 8 to 12 repetitions should be performed per set. When the individual is able to perform 12 repetitions, the resistance should be increased to a point where only 8 repetitions are possible.<sup>9</sup> A minimum of one set, but preferably 2 to 3 sets, per exercise session is appropriate with 2.5 minutes of rest between each set. The author also recommends exercising 1 to 3 days per week, for no more than one hour per session and with at least 48 hours between sessions. We followed the same principle of strengthening external oblique in elderly adults.

#### **Statistical analysis**

All the values were reported as mean (standard deviation) and significance were analyzed using SPSS 23 version. Paired t test was used to analyse the significance of the intervention.

### **RESULTS**

Repeated-measures paired t test showed that, in the experimental group, FVC, FEV1, PEF, and muscle thickness in the external oblique muscle had increased significantly after sixteen weeks ( $p < 0.05$ ),

In the control group, FEV1 and PEF had increased significantly after sixteen weeks ( $p < 0.05$ ), but reduced significantly in FVC and

muscle thickness of external oblique following sixteen weeks ( $p < 0.05$ ).

### **DISCUSSION**

The major finding of the present study was there is significant difference on pre and post training outcome in experimental group. Exercise selection is crucial step in designing resistance training. However, there are many controversies in prescribing resistance training for older individuals. In a previous study they reported that both single joint and multi joint training both improves the muscle thickness in elbow group of muscles.<sup>8</sup> But in our present study it will be difficult to strengthen the external oblique muscle alone, so multiple joint resistance exercise was given. However, the post FEV1 and PEF of control group showed significant improvement in control group, the possible reason could be incentive spirometer expiratory training may move FEV1 and PEF but there is no significant difference in FVC and muscle thickness among control group.

In another study the author recommended that a progressive resistance training program for sarcopenia should be dynamic and target the major muscle groups using both concentric and eccentric movements.<sup>9</sup> In our present study also we followed the same technique of both eccentric and concentric contraction of external oblique muscle. Taaffe also suggests that 8 to 12 repetitions should be performed per set. When the individual is able to perform 12 repetitions, the resistance should be increased to a point where only 8 repetitions are possible. A minimum of one set, but preferably 2 to 3 sets, per exercise session is appropriate with 1 to 2 minutes of rest between each set. The author also recommends exercising 1 to 3 days per week, for no more than one hour per session and with at least 48 hours between sessions. But in our present study we limited to 2 sessions per week because of the availability of the subjects with the rest period of 2.5 minutes between each set of exercise.

In a study a ten weeks of progressive resistance training with 3 session of training per week increased muscle cross sectional area by 3 to 9% and improved muscle strength and performance in gait speed and stair climbing abilities.<sup>10</sup> In our present study there is significantly increase in external oblique muscle thickness

among experimental group, but we gave 16 week of resistance training with 2 sessions of training per week. In another study the author stated that there is increase in FVC, FEV1 and rectus abdominal muscle thickness improved due to 4 weeks of Feedback Breathing Exercise (FBE) for 15 minutes, and three sets of Balloon-Blowing Exercises (BBE).<sup>11</sup> This is contrary to our study, for control group due to expiratory training using incentive spirometer improved the FEV1 and PEF in 16 weeks of training but there is no significant improvement in FVC and external oblique muscle thickness.

In another study the placement of active electrode for external oblique was placed 13 cm lateral to the umbilicus, for internal oblique 3 cm medial and inferior to the right Anterior Superior Iliac Spine (ASIS) while assessing the electromyography find the maximal contraction force.<sup>13</sup> We also used the same point as a reference for taking external oblique muscle thickness.

A limitation of this study was that only male subjects were participated, because of the social characteristics. It also did not set a criterion for all elderly individual. Future research should address these limitations.

### CONCLUSION

Aging is a major cause of disability and increased health care costs. Although very common, muscle wasting is underdiagnosed and undertreated. Muscle wasting should be investigated from 50 years of age and above all in older patients with a decline in physical functioning, and strength. We recommend that resistance training, not only maintain the muscle thickness also improve the muscle thickness and pulmonary parameters among elderly population.

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