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Effects of Combined Training with Respiratory Equipment on Lung Function, Balance, and Life Satisfaction of Elderly People in Community

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Abstract

In this study, we selected and trained 9 people in the diaphragm training group and 9 people in the power-breath training group among elderly people aged 65 or older living in the community, and investigated the effect of combined training using respiratory equipment on lung function, balance, and life satisfaction. We conducted the elderly to do combined exercises, twice a week for a total of 6 weeks, that include the breathing training by diaphragm, the breathing training using Power-breath equipment, and the training using a theraband. We evaluated the changes in the lung function, the balance, and the life satisfaction before and after the intervention for our study subjects.As a result of our measurement, lung function, balance, and life satisfaction showed significant changes in the experimental group that performed the combined training using Power-breath equipment. As a result of the study, we confirmed that the elderly in the community had a positive effect on the life satisfaction by improving lung function and balance ability after conducting a combined training using respiratory equipment.

Keywords: *Elderly in the Community, Respiratory Training, Lung Function, Balance, Life Satisfaction*

1. Introduction

According to data from the Statistics Korea, the aging rate of Korean population was 16.5 % in 2021, and it is expected to be 33.9% in 2024 and 43.9% by 2060 [1]. Such a rapid pace of aging rate for population aging is unprecedented in the world. According to the report by the UN, comparing the global population aging rate from 2019 to 2050, it is predicted that Korea will not only be aging the fastest, but also become the country with the highest population aging by the year 2050 [2].

As changes in lung functions due to aging, the elastic tissues of alveoli and alveolar ducts decrease, and sclerotic collagen increases. As a result, the ventilation and the perfusion are inconsistent, and the amount of expiratory flow is reduced.

In addition, from the people's age of 55, the respiratory muscles weaken, the diaphragm becomes stiff, the intercostal cartilage becomes calcified, and changes in the rib cage appear [3, 4].

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Because of these changes, the total lung capacity does not decrease, but the decrease in the elasticity of the lungs increases the residual capacity of lungs. At the age of 70, the residual capacity of a person increases by 30-50%, and the lung capacity of a person decreases by 40-50% [5]. As such, with aging, the respiratory muscles weaken and the lung function deteriorates, and as a result, the risk of various respiratory diseases such as the motivation of atelectasis or ineffective coughing increases. As a result of decreased lung function, the morbidity of infectious diseases among respiratory diseases increases. Compared to young people the elderly people, aged 65 or older, had a relatively higher morbidity rate with the mortality rate caused from COVD-19 [6].

The movements of inhalation and exhalation for breathing depend on the action by the auxiliary muscles of respiratory, including muscles of trunk and muscles of diaphragm. The respiratory muscles are anatomically equivalent to skeletal muscles [7], and the respiratory muscles act on the stability and movement of the spine in order to maintain balance [8]. In the case of the elderly people over 70 years of age in Korea, the physical alignment of body posture is deformed due to changes in the musculoskeletal system due to aging [9], and in particular, in the case of the elderly over 70 years of age in Korea, the deformity of kyphosis decreases the function of the respiratory muscles, including the diaphragm, and deteriorates lung functions [10]. In order to strengthen the respiratory muscles and spinal stabilization muscles at the same time, the training for those is very helpful in improving the balance ability as well as the function of inhalation and exhalation [11].

Elderly people in the community have lower levels of overall physical activity when their respiratory muscles weaken. They need to train to prevent the weakening of respiratory muscles and strengthen respiratory muscles in order to maintain independent activities in their daily lives [12]. In the case of respiratory muscle training, combined training for respiratory muscle, including physical strength training, is more effective than training respiratory muscles independently [13].

As a result of the training of combined respiratory muscles by the elderly in the community, the functions of the lungs and respiratory muscles were strengthened, and the stability of the trunk was also increased due to the strengthening of the respiratory muscles. And the training should be conducted according to a systematic program, and should be continued under their own initiatives. Such training improves their life satisfaction through various activities in their community [14].

In this study, we tried to investigate the effect of combined training for the elderly using respiratory equipment on lung function, balance, and life satisfaction for the purpose of maintaining a healthy life in old age by the elderly in the community. And we present a basis for a respiratory training program for the elderly people living in the community in order to help them maintain their health and prevent respiratory-related diseases.

2. Research Methods

2.1 Research Subjects

We selected as our research objects those people who were 18 male elderly people and female elderly people, over 65 years old living in Jumunjin-eup, Gangneung-city. We selected as our research objects those people who did not receive drug treatment due to diseases of the deep respiratory system and those who had a score of 24 or higher on the Korean Simplified Mental State Test (MMSE-K). We excluded those people with thoracic deformity and disease and those people with endocrine system and rheumatic diseases. And we excluded those people who had difficulty walking due to diseases of the central nervous system and orthopedics.

The subjects of our study were those people using the senior citizens' community center in Jumunjin-eup. We selected 25 people who understood the purpose of our study and wanted to participate voluntarily as our research subjects. We selected a total of 18 people for the subjects of our study, after excluding 5 people who dropped out due to their health reasons during the training processes. We randomly assigned the subjects of the study for the control group, consisted of 9 people in the diaphragm breathing training, and the experimental group, consisted of 9 people in the training group using power breathe. Table 1 shows the general characteristics of the study subjects. As a result of analyzing the homogeneity of the two groups before the interventional study, there were no significant differences in age, height, and weight (p>.05).

Table 1. General characteristics of subjects

Variables	Study Group(n=9)	Control Group(n=9)	p
Gender(Female)	9	9	
Age(year)	68.77±9.40	74.44±4.63	0.38
Height(cm)	156.55±6.12	158.00±8.58	0.36
Weight(kg)	61.77±8.89	61.88±11.50	0.20

2.2 Method of Intervention

The combined training we presented in this study was performed by a physical therapist. For the exercise using theraband and for the exercise of breath
ing training, we performed the breathing training by diaphragm and we performed the breathing training by using the equipment of Power-breathe (HAB® international limited, England). We trained the subjects in a group twice a week for a total of 6 weeks for combined training. We asked the subjects to perform the exercise for 20 minutes using the theraband, the exercise of breathing training for 20 minutes, and the exercise of cool-down for 20 minutes. And on days when there was no group training, we asked the people of our research subjects to perform the exercise by themselves.

2.2.1 Theraband Exercise

We used a red theraband for our exercises. They carried out the exercises in order such as over-head lift, sliding door, reverse fly, and relative rise for upper extremity exercise. And they carried out exercise in order such as abduction, adduction, flexion, and extension for lower extremity exercise. As the finishing exercises, they performed twice the total of 6 items: bending the neck, turning the neck, extending the hand behind the back, holding the elbow and pulling the arm back, bending the body, bending one knee forward, and turning the ankle [15].

2.2.2 Breathing Training by Diaphragm

They performed a breathing training by diaphragm in a sitting position on a chair.

With the theraband [16] in contact with both shoulder blades, the elderly people open their shoulder joints horizontally to inhale, and they close their shoulder joints horizontally to exhale <Figure 1>. We verbally instructed the subjects to inflate their ventral side during inhalation and retract their ventral side during exhalation, and we encouraged them to actively perform the motions of inhalation and exhalation. They repeated 10 training sessions per set, for a total of 10 sets. The breaktime between sets was a duration of 30 seconds. The training was conducted for 20 minutes once, twice a week, for a total of 6 weeks.

Figure 1. Breathing Training by Diaphragm

2.2.3 Breathing Training Using Power-Breathe

In order to perform breathing training, they conducted Power-breathe trainingin the same posture as the breathing training of the diaphragm. As a breathing training device for Power-breathe, we used a light green device with the lowest pressure

At the time of the initial training, the strength of 30 RM was set for the subject to perform one drill to strengthen the breathing muscles, and the resistance was gradually increased according to the conditions of the study subjects <Figure 2>. They repeated 10 training sessions per set, for a total of 10 sets. The breaktime between sets was 30 seconds. The training was conducted for 15 minutes once, twice a week, for a total of 6 weeks. If a subject complained of dizziness or fatigue during our breathing training, the subject was asked to take a break or to stop the training [17, 18].

Figure 2 shows the breathing training by using the Power-breathe.

Figure 1. Breathing training by diaphragm

Figure 2. Breathing training by Power-breathe

2.3 Measurement Method

2.3.1 Lung Function

Lung function is measured by the spirometer (Pony Fx, Cosmed Sri, Italy). And the function is measured by using three variables such as FVC (forced vital capacity), FEV_1 (forced expiratory volume at one second), and the ratio of the FEV_1 (forced expiratory volume at one second) to FVC (forced vital capacity) or FVC/FEV_1, We judge the presence or absence of obstructive ventilatory impairment by using the ratio of FEV_1 (forced expiratory volume at one second) to FVC(forced vital capacity) for 1 second, and judge the degree of obstructive ventilatory impairment by using FEV_1 (forced expiratory volume at one second) for 1 second, and judge FVC (forced vital capacity) in order to determine the presence or absence of restrictive lung impairment [19].

2.3.2 Romberg Test

The Romberg test uses the equipment of Win−Track platform (Win−Track, company – Medicapteurs, n^0−12k0022, made in France) and measures the degree to which the center of pressure of the foot shakes in the forward, backward and left or right directions, while the subject maintains a posture standing upright on the foot plate.

The test subject maintains a standing posture with both feet shoulder-width apart, and watches 4 meters forward for 30 seconds, in the position with eyes opened or closed. Data is collected through a monitor with a frequency of 1200 Hz for 30 seconds [20].

2.3.3 Life Satisfaction

The measure of life satisfaction was consisted of four sub-factors such as positive emotions, negative emotions, positive daily experiences, and negative daily experiences. It consists of a total of 20 questions, and is a 5-point Likert scale consisting of 5 levels, ranging from 'not at all (1 point)' to 'strongly agree (5 points)'. Life satisfaction is measured on a 5-point Likert scale for a total of 20 items, and a higher score means higher anxiety about death. The reliability of the item on the 5-point Likert scale is Cronbach'α =0.89 [21].

2.4 Data Processing

We used SPSS version 18.0, as a tool for all statistical analysis methods in our study. In this study, we described the general characteristics of the study subjects through technical statistics, and before the experiment we performed an independent sample t-test in order to test the homogeneity of the experimental group and control group. In the study, according to the interventional method, we conducted a paired-sample t-test in order to verify significance before and after the intervention, and we conducted an independent-sample t-test in order to test the significance between each group. We set p=0.05 as the statistical significance level.

3. Result

3.1 Changes in Lung Function, Balance, and Life Satisfaction Before and After Combined Training Using Breathing Equipment

As a result of performing combined training using a breathing apparatus, the the values of FVC and FEV1 represented by the experimental group showed significant (p<.05) changes in comparison before and after training. The values of LEO and LEC for balance was shown to have a significant (p<.05) difference when comparing before and after training. There was no significant change in FVC and FEV1 for the control group compared to before and after training (p>.05). In the case of balance, there was no significant difference between LEO and LEC before and after training (p>.05). In the case of life satisfaction, there was no significant difference between before and after the training.

Table 2 shows the changes in lung function, balance, and life satisfaction before and after combined training using breathing equipment.

Table 2. Changes in lung function, balance, and life satisfaction before and after combined training using breathing equipment

		Pre	Post	z	P
Study Group(n=9)	FVC(L)	2.52±.46	2.70±.42	-2.66	.00
	FEV_1(L)	1.41±.38	1.62±.48	-2.01	.04
	LEO(cm^2)	271.66±28.69	248.88±27.01	-2.67	.00
	LEC(cm^2)	282.00±31.50	248.88±27.01	-2.67	.00

	Life sat(score)	58.44±5.17	51.55±6.55	-2.67	.00
Control Group(n=9)	FVC(L)	2.50±.58	2.47±.57	-1.47	.13
	FEV_1(L)	1.57±.44	1.51±.48	-.59	.55
	LEO(cm^2)	264.77±37.41	263.33±40.08	-1.03	.29
	LEC(cm^2)	276.11±34.08	271.77±34.08	-1.68	.09
	Life sat(score)	57.66±4.94	56.66±4.84	-.12	.95

p < .05, M±SD: Mean ± standard deviation, Romberg test eye-open:LEO, Romberg test eye-close:LEC, Life sat: Life satisfaction

3.2 Comparison of lung Function, Balance, and Life Satisfaction According to Combined Training Using respiratory Equipment Between Groups

There were significant differences in lung function, FVC, FEV1, balance LEO, LEC, and life satisfaction according to the combined training using respiratory equipment (p<.05)(Table 3).
Table 3 shows the comparison of the difference in the mean the two groups.

Table 3. Comparison of the difference in the mean the two groups

	Study Group(n=9)	Control Group(n=9)	z	P
FVC(L)	.17±.28	-.02±.10	-2.96	.00
FEV_1(L)	.21±.31	-.06±.19	-2.65	.00
LEO(cm^2)	22.77±20.50	1.44±3.53	-3.33	.00
LEC(cm^2)	33.11±9.77	4.33±7.21	-3.58	.00
Life sat(score)	6.88±3.72	1.00±6.68	-2.26	.02

p < .05, M±SD: Mean ± standard deviation, Romberg test eye-open:LEO, Romberg test eye-close:LEC, Life sat: Life satisfaction

4. Considerations

In old age, lean body mass and total body water, which decrease with increasing age, affect the rate of aging. A decrease in lean mass is a significant decrease, in muscle strength and muscular endurance, that changes with age. In the elderly, the weakening of skeletal muscles limits physical activity and causes weakness of the respiratory muscles, and as a result, the quality of life decreases [22].

Physiological aging of the respiratory system causes the changes in the chest and lung parenchyma, decreases expiratory flow rates, and increases functional residual capacity. In addition, in the elderly, a general weakning of muscle in the body results in respiratory muscle weakness, and as a result, the maximum inspiratory pressure is lowered. Such changes in the respiratory system that occur with aging cause the heart respiratory diseases [23]. In the elderly, the decrease of skeletal muscle strength and sarcopenia affect FVC and FEV1 [24]. When performing the training to strength the skeletal muscle, the elderly people should include the training of respiratory muscle; and the recovery of lung function also improves physical endurance of body [25]. In this study, we selected the elderly people, aged 65 years or older, as the subject of our study, and asked them to conduct the training for respiratory muscle strengthening. In order to conduct breathing training for the elderly, we conducted diaphragm breathing training using a theraband, and we conducted breathing training using a device, Power-breathe. As a result. lung function was improved more in the case of the group trained using Power-Breathe device than in the group trained trained with diaphragmatic breathing. The subjects who had a history of lung surgery among the elderly over 65 years of age showed improvement in lung function and walking ability, after performing combined training using Power-breathe equipment along with the training of muscle strengthening and training of walking.

It is beneficial to strengthen the inspiratory muscles and improve cardio lung function, if active exercise to strengthen physical strength and combined training using breathing equipment are performed for the elderly people who can perform their physical activities. In order to prevent sarcopenia and weakening of muscle strength caused by aging, combined respiratory training should be continuously performed [26]. It has been shown that the functions of lung has been improved after performing the the exercise of Pilates or exercise of Power-breathe device, and it was found that the combined breathing training performed had an posoitive effect on the general improvement of physical body functions and the respiratory function. In general, compared to the breathing training by diaphragm, because breathing training using Power-breathe equipment provides resistance above the threshold value, and the overload of the respiratory muscles increases muscle strength and endurance, it is cosidered to be a more effective exercise method [16].

Among the methods used by the study subjects to perform respiratory training in this study, the lung function of the training group which uses the Power-breathe equipment was improved, which showed the same training effect as the previous studies. Compared to the diaphragm breathing training, the training using a breathing device is considered to be more effective because it gives direct resistance to the respiratory muscles. In addition, compared to training the respiratory muscle, which is corresponding to the skeletal muscle alone, it is thought that the segmental muscle strengthening exercise in the body and combined training using a breathing apparatus are more effective in improving the pulmonary function of the elderly people.

We conducted the training using muscle strength in arms and legs, trunk stabilization training, and training using Power-breathe equipment to the people of 65-year-old elderly subjects, without chronic obstructive pulmonary disease (COPD) or pulmonary disease. As a result, BBS and static postural stability were improved in both groups, and FVC and FEV1 were significantly changed [18].

We performed respiratory training using an inspiratory muscle training (IMT) device for stroke patients. As a result, BBS and TUG were significantly increased, and FVC, FEV1, MIP, and MEP were improved [28]. For the research objects, we performed the combined one of trunk stabilization training and breathing training at the same time [11], and as a result, the train of respiratory muscles improved the function of lung. When we train the respiratory muscles, the lungs expand as the volume of the chest cage increases, the function of the lungs improves, and as a result, the function of stabilizing the posture by the diaphragm, the muscles between the ribs, and the respiratory muscles of the chest appears [29]

In this study, we conducted a combined training of respiratory training to strengthen muscle strength by using the theraband, and as a result, in the training group using a breathing apparatus, significant differences were found in FVC, FEV1, and Romberg test. Compared to individual training for strengthening muscles and training for strengthening respiratory muscles of the elderly people, combined training is more effective to improve the function of the lungs, and it is more helpful to maintain and increase balance in order to prevent falls. We asked the elderly people over 65 years old living in the community, to perform a combined exercise of coughing, lips curling and breathing, low-intensity exercise and active joint exercise using an expiratory pressure device, and as a result, it was shown that the function of lungs was improved and life satisfaction was improved. Elderly people in the community with chronic diseases need to improve their quality of life by implementing a rehabilitation program in order to improve their physical strength and respiratory functions. In addition, if the respiratory muscles are weakened, the muscles of the body are weakened, so it is necessary for the elderly people to maintain and increase the functions of the body, by implementing a rehabilitation program such as exercise to train the respiratory muscles [31].

In this study, we found that when the test subjects performed the combined training using respiratory equipment, the function of lungs was improved and the life satisfaction was increased. According to these results, it is judged that not only training the respiratory muscles but also training the body segments using the theraband has a positive effect on life satisfaction by improving the function of lungs. Therefore, the elderly people living in the community need an exercise program for respiratory muscle exercise and muscle strengthening in order to maintain a satisfactory life, and it is considered necessary to provide professional guidance and continuous and systematic management for program operation. The limitations of this study were that the number of subjects was small, MIP and MEP tests were required for pulmonary function tests, and the variety of interventional methods for balance during combined training was limited. In addition, since we selected the elderly people confined to the community as subjects for our study, it is judged that a study that sets the duration of intervention for a long time is necessary.

5. Conclusion

In this research, we conducted the combined training using respiratory equipment for the elderly in the community, and as a result, it was confirmed that pulmonary function and balance ability were improved and the trainingh had a positive effect on life satisfaction of the elderly people. In the case of respiratory training, it was found that the training using equipment gave a direct resistance to the respiratory muscle and was more effective in improving the function of lungs, cpmpared to the breathing training by diaphragm. Respiratory muscles are included in skeletal muscles and have an impact on maintaining and increasing the balance of health. In this way, our combined training using respiratory equipment for the elderly people in the community improved the function of lungs and the balance ability of them, and the elderly in the community were able to diversify their social activities, resulting in a positive change in their life satisfaction. In addition, if the combined exercise program, using respiratory equipment conducted for the elderly people in the community, is systematically and continuously implemented, the satisfactory life in old age will be maintained.

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