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Original Article

The effects of place running exercises on the pulmonary function of normal adults

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Abstract. [Purpose] The purpose of this study was to determine whether place running exercises increase the pulmonary function of normal adults. [Subjects and Methods] Thirty normal adults in their 20s were randomly assigned to an experimental group (n=15) or a control group (n=15). Over the course of four weeks, the experimental group participated in place running exercise for 30 minutes five times per week. The control group only participated in moto-med exercise for 30 minutes five times per week. Subjects were assessed pre- and post-test by measuring the tidal volume, inspiratory reserve volume, expiratory reserve volume, and vital capacity. [Results] Our findings show significant improvements to vital capacity in the experimental group. The experimental group had higher pulmonary function than the control group. In the investigation of the differences between the intervention group and the control group before and after the experiment, significant differences were found for expiratory reserve volume and vital capacity. [Conclusion] Finally, the experimental group showed a greater improvement in pulmonary function than the control group, which indicates that place running exercises are effective at increasing the pulmonary function of normal adults.

Key words: Pulmonary function, Cycle exercise, Place running exercise

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INTRODUCTION

Recently, air pollution, change of life style, and smoking have increased airway resistance, which chronically progresses and increases breathing capacity[1)]. Moreover, emphysema and chronic obstructive pulmonary disease (COPD), which hinders gas exchange in the lung, cause difficulties in daily life due to perfusion effects arising from the excessive expansion of the thorax[2)]. It has been reported that pulmonary function diminishes when muscles that contribute to respiratory function are weakened[3)]. When these muscles are weakened due to a variety of causes, dyspnea can occur, and the ability to perform exercise can also be affected. Therapeutic interventions, such as ventilator muscle training, are required to reduce severe, hectic breathing patterns and strengthen respiratory muscle function to ultimately enhance exercise tolerance[4)]. While responding to patients' weakened breathing efficiency and changed breathing mechanisms, it is necessary to properly maintain expansion of the chest wall, ventilation, lung capacity, and lung volume[5)].

A number of studies have investigated the use of breathing exercises in diverse subject groups, including one that applied feedback respiratory equipment to normal, healthy individuals[6)], one that implemented a combination of diaphragm breathing exercises and pursed-lip breathing exercises among patients with CNS[7)], and one that only implemented pursed-lip breathing exercises among order[8)]. A variety of breathing training methods was proven to increase muscle strength and endurance, resulting in an increase of breathing function[9)]. Muscle strength training that involves resistance loads, such as running, cycling, and swimming, has been implemented as well as respiratory muscle training that involves moving the upper and lower limbs for endurance[10)].

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So far, most previous research has implemented exercises for cardiopulmonary rehabilitation while subjects are in a supine or sitting position. Yet, for patients who recover mobility to a certain degree, cardiopulmonary exercises are commonly replaced by aerobic exercises. Hence, it is necessary to develop a new combined exercise routine that mixes cardiopulmonary and aerobic exercises for patients with cardiopulmonary disease that have a certain degree of mobility. This study attempts to produce objective data that can be used as clinical grounds for changes in breathing capability by implementing a place running exercise among normal individuals.

SUBJECTS AND METHODS

For the subjects of this study, 30 normal individuals were selected from the college students attending N university in Cheonan, Chungcheongnam-do in Korea between December 1 and 31, 2016. The study subjects were randomly assigned to an experimental group of 15 subjects and a control group of 15 subjects. The subjects were selected from those who had no history of lung disease; who had no respiratory damage, such as congenital deformation of the chest; and who had not received any treatments to improve pulmonary functions. The subjects understood the purpose of this study and consented to participate in it. This study was approved by the Clinical BioethicsCommittee at Korea Nazarene University (KNU IRB 16-1021-04), and it was conducted in accordance with the ethical principles of the Declaration of Helsinki. The general characteristics of both groups are shown in Table 1.

The training of the experimental group was conducted three times per week for four weeks, and each session consisted of 30 minutes of the place running exercise. The place running exercise was implemented, which the subjects performed in the center of a square mark with a size of 30 cm by 30 cm. Before the exercise, the subjects straightened their backs and looked forward. They maintained the neutral position of the cervical vertebra and waist pelvis by drawing their jaw close to the body. Then, they placed their feet approximately 10 cm apart and lifted one knee to the height of the hip joint by bending it 90°. They bent the elbow opposite to the lifted leg by 90° and lifted the tip of that hand to eye height. The subjects then jumped while lifting each arm and leg on opposite sides along the sagittal plane and kept jumping for a predetermined number of times. During the exercise, the subjects carefully maintained their constant posture inside the restricted space. Each session consisting of 20 jumps in one place with a 30-second resting time between each session was implemented for 30 minutes.

In the control group, each participant performed a cycling exercise using MOTOmed (RECK-Technik GmbH & Co., Betzenweiler, Germany), which allowed for regular and repetitive training without affecting respiration. The strength of the training was controlled so that the heart rate of the participants did not exceed 20% of the heart rate reserve[11]. Measurements were conducted in the sitting position using a Fit Mate (COSMED Srl., Italy), which is a measuring instrument for pulmonary function tests. To ensure accuracy, explanations and demonstrations of the procedures were given prior to the measurements. The experimental and control groups were instructed to use a mouthpiece, and the subjects' noses were closed during the measurement so that air could not be inhaled or exhaled through the nose. Beginning from expiration, the subject was instructed to breathe out slowly and completely and then to breathe in slowly when the tester gave the signal. The values of tidal volume (TV), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), and vital capacity (VC) were measured. The measurements were conducted three times both before and after the experiment, and the average values of the three measured values were used in the analysis. A resting time of five minutes was given after each measurement[12, 13].

In this study, SPSS ver. 12.0 was used to examine the general characteristics of the subjects and to obtain the means and standard deviations of individual groups. A paired sample t-test was used to compare pulmonary functions before and after the intervention, and the exercise and independent sample t-test was used to examine the differences between the measurements taken before and after the experiment between the groups. The statistical significance level was set at 0.05.

RESULTS

Here, we review the comparison of vital capacities before and after the intervention between the experimental group and the control group. The experimental group showed significant differences in VC ($p<0.05$) but did not show any significant differences in TV, IRV, or ERV ($p>0.05$). The control group did not show significant differences in any of the measured items ($p>0.05$). In the comparison between the intervention group and the control group before and after the experiment, significant differences were found for ERV and VC ($p<0.05$) but not for TV or IRV ($p>0.05$) (Table 2).

DISCUSSION

This study divided normal subjects in their 20s into two groups. We implemented a place running exercise in the experimental group and a moto-med exercise only in the control group. To investigate the effects of these exercises on the pulmonary function of normal individuals in their 20s, we compared the results of both groups. In breathing rehabilitation programs, muscle strength training often uses equipment or has restrictions on space restrictions[14]. Hence, to design training that improves pulmonary function without such restrictions, we implemented breathing exercises while the subjects were in place running exercises. The number of repetitions, the duration of the exercise, and the length of rest time should be considered to minimize the subjects' muscle fatigue and increase their muscle strength efficiently[15]. Given that interven-

Table 1. General participant characteristics

	EG (n=15)	CG (n=15)
Gender (M/F)	7/8	8/7
Age (years)	21.1 ± 0.3	21.8 ± 0.3
Height (cm)	169.7 ± 4.0	162.6 ± 6.0
Weight (kg)	64.5 ± 4.5	62.6 ± 7.1

Values are presented as the mean ± SD.
EG: experimental group; CG: control group

Table 2. A comparison of pulmonary function values for the EG and CG pre- and post-test

	EG		CG	
	Pre-test	Post-test	Pre-test	Post-test
TV (L)	0.8 ± 0.1	0.9 ± 0.1	0.7 ± 0.1	0.8 ± 0.1
IRV (L)	2.3 ± 0.1	2.7 ± 0.1	2.4 ± 0.1	2.4 ± 0.2
ERV (L)[a]	0.6 ± 0.1	0.8 ± 0.1	0.5 ± 0.1	0.6 ± 0.1
VC (L)[a]	3.1 ± 0.1	3.4 ± 0.1*	3.1 ± 0.1	3.4 ± 0.1

Values are presented as the mean ± SE.
[a]Significant difference in changes between the two groups, $p<0.05$.
*Significant difference from the pre-test value, $p<0.05$.
TV: tidal volume; IRV: inspiratory reserve volume; ERV: expiratory reserve volume; VC: vital capacity

tions are effective only when implemented for at least 20–30 minutes, 2–5 times per week for 4–12weeks, in this study, the interventions were conducted for 30 minutes, 5 times per week for 4 weeks[16)].

Pulmonary function tests were conducted after four weeks of intervention. The experimental group showed a significant increase in VC after the intervention compared to the measurements taken prior to the intervention, but they did not show significant increases in TV, ERV, or IRV. The control group showed no significant increase in any of the measured items. In the examination of pre- and post-test changes in the experimental and control groups, although the experimental group showed greater increases than the control group in all measurements, the differences were significant only for ERV and VC. In the experimental group, ERV and IRV was a slight improvement. We believe the active and powerful place running exercise not only directly increased the activity of respiratory muscles and strengthened the overall cardiopulmonary function, but it also improved breathing capability through the deep breathing activity.

In a study conducted by Enright et al.[17)], normal people who had undergone high frequency inspiratory muscle training registered significant increases in breathing capacity, total breathing capacity, inspiratory muscle strength, and inspiratory endurance. Normal people group which performed diaphragm respiration exercises showed a greater improvement in pulmonary function compared with the control group[18)]. In a study conducted by Townsend[19)], normal people who had undergone respiration training exhibited large differences between the resultant inspiratory volumes and expiratory volumes. In previous studies, pulmonary functions have been improved by diverse exercises aimed at improving the respiratory activities of patients with a variety of diseases. The use of PNF breathing and place running exercises showed similar effects to those of direct breathing exercises for normal individuals.

This study has limitations in that the sample consists of healthy subjects who have normal functional activity instead of those with cardiopulmonary disease. Nevertheless, we believe that this study provided objective data that can be that can be applied to patients with cardiopulmonary disease in the future.

Finally, despite the limitation that basic professional therapy methods have not been popularized or standardized in heart and cardiac pulmonary rehabilitation centers in Korea, physiotherapy that specializes in breathing is already wide spread in Western developed countries. We believe that there will be more opportunities to implement effective breathing interventions among patients with cardiopulmonary disease if the physiotherapy interventions for breathing gradually advance and gain popularity in Korea in the future.

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