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Original Article

Changes in cardiopulmonary function in normal adults after the Rockport 1 mile walking test: a preliminary study

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Abstract. [Purpose] The purpose of this study was to investigate the changes of cardiopulmonary function in normal adults after the Rockport 1 mile walking test. [Subjects and Methods] University students (13 males and 27 females) participated in this study. Before and after the Rockport 1 mile walking test, pulmonary function, respiratory pressure, and maximal oxygen uptake were measured. [Results] Significant improvements in forced vital capacity and maximal inspiratory pressure were observed after the Rockport 1 mile walking test in males, and significant improvements in forced vital capacity, forced expiratory volume at 1 s, maximal inspiratory pressure, and maximal expiratory pressure were observed after the Rockport 1 mile walking test in females. However, the maximal oxygen uptake was not significantly different. [Conclusion] Our findings indicate that the Rockport 1 mile walking test changes cardiopulmonary function in males and females, and that it may improve cardiopulmonary function in middle-aged and older adults and provide basic data on cardiopulmonary endurance.
Key words: Rockport 1 mile walking test, Aerobic fitness, Respiratory function

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INTRODUCTION

Walking is generally perceived as a means of improving health and fitness, and is one of the most natural human motions[1)]. Regular walking exercise can improve the mental state, muscle strength, and the ability to metabolize sugar by improving the insulin concentration in fat and the insulin response to blood sugar[2)]. In addition, it has a positive effect on cardiovascular patients and reduces the risk of cardiovascular disease. Furthermore, it has been reported that walking-based exercises improve the activities of daily living and the quality of life of elderly people[3)].

Walking exercise increases respiration, which is a means of generating energy. Two muscle groups control respiration, namely inspiratory and expiratory muscles. The diaphragm and intercostal externi are agonists of inspiration for tidal breathing, and the synergistic muscles are the sternocleidomastoid, scalene, pectoralis major, pectoralis minor, and serratus anterior, which are activated during deep, forced, and labored breathing. Muscles related to expiration not activated during normal breathing but are activated during deep and forced breathing include the rectus abdominis, transverse abdominis, internal and external obliques, and intercostalis interni[4)].

"Aerobic" indicates energy generation by using oxygen, and aerobic exercise is active, durational, and rhythmic and has a substantial effect on cardiopulmonary endurance. Walking, jogging, skipping, aerobics, dancing, swimming, and cycling are all aerobic exercises that facilitate cardiopulmonary function because they require large amounts of oxygen to be supplied to the body[5)].

Walking exercise is efficient because it is an energy-consuming, convenient, and low-impact aerobic exercise, and is widely performed by people regardless of gender or age to improve health. Furthermore, it is safe; for example, it is prescribed as a low-impact exercise for the knee joints[6)].

The Rockport 1 mile walking test (RWT) is the most commonly used field test to assess cardiopulmonary fitness and provides a representative means of predicting aerobic fitness based on gender, age, body mass index, and heart rate information[7)]. However, no study has yet investigated cardiopulmonary function after the RWT. Therefore, in this study, we measured pulmonary functions, respiratory pressures, and maximal oxygen uptake (VO_2max) after the RWT, and investigated changes in cardiopulmonary competence in males and females.

SUBJECTS AND METHODS

Forty university students were recruited for this study. All subjects understood the purpose of this study and provided written informed consent before participation. This study was approved by the institutional review board of Daegu University. Recruited subjects with a diagnosis of cardiac

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disease and those who perform aerobic exercise regularly were excluded.

Pulmonary function, respiratory pressure, and VO_2max were measured after the RWT. Before the RWT, height and weight were measured by using a stadiometer (Biospace, Korea). To measure the VO_2max, heart rate was measured for 60 s immediately after the RWT. The formula used to calculate VO_2max was as follows[7]:

VO_2max = 132.853−(0.0769 × body weight in pounds) −0.3877 × age in years+(6.315 × sex score)−(3.2649 × time in minutes to walk 1 mile)−(0.1565 × heart rate at the end of the walk)

For the sex score, males were given a score of 1 and females a score of 0. Walking time was calculated in minutes. Pulmonary function measures, such as forced vital capacity (FVC), forced expiratory volume at 1 s (FEV_1), FEV_1/FVC ratio, and peak expiratory flow (PEF), were measured after the RWT by using a portable spirometer (Spiropalm; Cosmed, Italy). The subjects were instructed to sit on a chair in an upright posture and to exhale into a mouthpiece. The maximal air speed and volume at maximum inspiration were recorded. The maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) were measured to determine the PImax values by using a respiratory pressure meter (MicroRPM; CareFusion, Ireland). Maximum inhalations and exhalations were performed in a comfortable sitting position. The RWT was performed on a treadmill after stretching and slow-walking practice. The participants were instructed to walk as fast as possible but not to run. The speed of the treadmill began at 0.5 mph and then was increased to 3.0 mph and to 3.5 mph. Perceived exertion (PE) was rated during the walk test.

Descriptive statistics were used to analyze the demographic data, and the paired t-test was used to compare differences between pre- and post-RWT. Statistical analysis was performed with the PASW ver. 18.0 statistical package (SPSS, Chicago, IL, USA), and statistical significance was accepted for p values <0.05.

RESULTS

The general characteristics of the 40 subjects are provided in Table 1. In males, the FVC and MIP significantly changed after the RWT; however, the FEV_1/FVC, MEP, and VO_2max did not. In females, the FVC, FEV_1/FVC, MIP, and MEP changed significantly after the RWT. In males and females, the VO_2max changed after the RWT; however, the difference was not significant (Table 2).

DISCUSSION

This study was undertaken to investigate the changes in cardiopulmonary functions, such as pulmonary function, respiratory pressure, and VO_2max, after the RWT. This test is not only useful for measuring cardiopulmonary efficiency but is also easily applied and requires little equipment. Furthermore, it can be used to predict cardiopulmonary endurance and physical fitness in all ages[8].

Pulmonary function is commonly measured by evaluating the FVC, FEV_1, FEV_1/FVC, and PEF. The MIP and MEP are the most commonly used variables in assessing respiratory muscle pressure because they are easy to evaluate and the measurements have fewer adverse effects[9]. Respiratory competence has been widely used to diagnose and monitor pulmonary function and respiratory pressure in many studies[10, 11].

In females, significant differences were observed for FEV_1/FVC and MEP after the RWT, which suggests that the RWT has positive effects on pulmonary function and respiratory pressure in both males and females. However, the VO_2max increased marginally and FVC significantly increased. This result is in line with the results of a previous randomized control study, in which treadmill gait exercise was performed for 30–45 min at 70–80% heart rate, by using the Naughton protocol in patients with pulmonary hypertension[12]. In addition, significant differences in FVC were reported after testing in another study that investigated the cardiopulmonary function of 13 children with cystic fibrosis after the 6-min walk test[13].

We considered that the respiratory pressure was changed by the coactivations of respiratory muscles during the RWT, which is in line with the conclusion of a previous study that inspiratory muscle training and expiratory muscle training

Table 1. General characteristics of the subjects

	Males (n = 13)	Females (n = 27)
Age (years)	25.9±5.0	22.1±0.6
Height (cm)	174.7±5.5	161.6±5.0
Weight (kg)	67.6±7.0	54.9±8.2

Values are expressed as mean ± SD

Table 2. Comparison of changes in respiratory function and maximum oxygen uptake in men and women

		Males (n = 13)		Females (n = 27)	
		Pre-RWT	Post-RWT	Pre-RWT	Post-RWT
Respiratory function	FVC (l)	3.5±0.8	4.1±0.6*	2.4±0.4	2.7±0.4*
	FEV_1/ FVC (%)	3.3±0.8	3.8±0.5	2.2±0.4	2.5±0.4*
	MIP (cmH_2O)	82.1±16.1	94.5±18.6*	53.0±15.7	67.0±21.4*
	MEP (cmH_2O)	75.6±24.4	84.4±26.9	52.2±13.9	65.4±22.4*
VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)		45.2±12.1	53.8±7.2	42.8±11.3	43.7±11.4

Asterisk (*) indicates a significant change pre-to-post RWT at the p < 0.05 level.

help improve muscle strength and endurance by applying load to the diaphragm and accessory muscles[14].

The VO_2max is a more representative index of physical endurance than parameters such as pulmonary ventilatory capacity and cardiac output, and thus, it is widely used to investigate maximum exercise performance and cardiopulmonary endurance. The VO_2max is defined as the maximum volume of oxygen that the human body can absorb per unit time during exercise. In addition, the relation between muscle activity and oxygen consumption is important and is widely used to analyze endurance because it provides a measure of oxygen transport[15]. In the present study, VO_2max values were found to be nonsignificantly higher post-RWT, and we attribute this lack of significance to individual differences in muscle mass, gait pattern, and walking speed. It has been reported that mild aerobic exercise uses fat as a fuel, and thus, aids in weight maintenance. In a study that compared heavy- and mild-intensity exercises, no postexercise difference in body composition was observed in the heavy-exercise group, but a significant difference was noted in the mild-exercise group, which suggests that mild-intensity exercise is more effective at reducing body fat levels. Furthermore, it was found that the cardiovascular systems of females who performed mild-exercise programs improved as much as those who performed jogging and cycling exercises[16, 17].

Physical activities and exercise consume energy and have a positive effect on health and physical fitness. Walking is an everyday activity, and can be performed safely in parks and living spaces. Regular walking can improve cardiopulmonary function and endurance[18] and retard the progression of degenerative and metabolic diseases, in addition to its many social and psychological benefits[19].

In this pilot study, the respiratory function after the RWT showed various changes, and it is believed that walking training may influence respiratory function and cardiopulmonary endurance in normal adults and in the elderly.

Some limitations of this study should be considered. First, this study was performed with a single measurement design; thus, we cannot comment on long-term effects. Second, the number of subjects recruited was too small to allow drawing generalizations. Third, only young healthy male and female subjects were selected. Thus, further studies with middle-aged and elderly participants are needed to confirm the clinical associations identified in this study.

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