



Original Article

Effects of breathing exercises on resting metabolic rate and maximal oxygen uptake

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Abstract. [Purpose] The aim of the present study is to examine effects of diaphragm breathing exercise and feedback breathing exercise on maximal oxygen uptake and resting metabolic rate. [Participants and Methods] Thirty-eight healthy participants were randomly assigned to two groups; the diaphragm breathing exercise group and the feedback breathing exercise group. The diaphragm breathing exercise group was asked to perform diaphragm respiration, and the feedback breathing exercise group was asked to breathe with feedback breathing device. Maximal oxygen uptake and resting metabolic rate were measured before and after two breathing exercises. [Results] Significant difference was found in maximal oxygen uptake before and after two breathing exercises. There was also significant difference in resting metabolic rate before and after diaphragm breathing exercise. However, significant difference was not found in resting metabolic rate before and after feedback breathing exercise. There were not significant between-group differences in both maximal oxygen uptake and resting metabolic rate. [Conclusion] Diaphragm breathing exercise and feedback breathing exercise could influence maximal oxygen uptake. Diaphragm breathing exercise could influence resting metabolic rate, but feedback breathing exercise could not.

Key words: Diaphragm breathing exercise, Feedback breathing exercise, Resting metabolic rate

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INTRODUCTION

Respiration muscles can influence respiratory functions through increasing muscular strength and endurance¹⁾. Among many respiratory muscles, it is known that the diaphragm is considered an important factor influencing respiratory functions^{2, 3)}. Several studies reported that diaphragmatic respiration performed by contraction of the diaphragm muscle contributes to promote trunk stability by enhancing intraabdominal pressure to reinforce the lumbar vertebrae^{4, 5)}. Many breathing methods have been studied for improving function of respiratory muscles. It was reported that the breathing exercise using a feedback respiratory device has been commonly used to improve respiratory functions in patients with respiratory diseases⁶⁾. It was also found that feedback breathing exercise could increase inspiratory capacity in healthy adults⁷⁾. The training for inspiratory muscles put loads on the diaphragm and the breathing accessory muscles to help enhancing strength and endurance of the respiratory muscles. It is performed under the overload principle as the basis of strengthening exercise of the skeletal muscles⁸⁾. Since types of exercise that therapists apply may induce different effects on respiratory functions, it is needed to investigate effects of various types of breathing exercise. The aim of the present study is to examine effects of diaphragm breathing exercise and feedback breathing exercise on maximal oxygen uptake (VO_2 max) and resting metabolic rate (RMR).

PARTICIPANTS AND METHODS

Thirty-eight individuals with no history of neuromuscular, orthopedic, and cardiopulmonary disorder participated in this

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Table 1. Effects of diaphragm breathing exercise and feedback breathing exercise on VO₂max and RMR

	DBE (n=21)		FBE (n=17)	
	Pre	Post	Pre	Post
VO ₂ max (ml/kg/min)	64.60 ± 16.67	77.17 ± 17.99*	83.70 ± 20.00	92.19 ± 20.65*
RMR (kcal/kg)	24.34 ± 6.69	29.46 ± 5.01*	27.73 ± 8.72	29.91 ± 7.61

Values are reported as the Mean ± SD.

*p<0.05 vs. Pre.

study. They were randomly assigned to two groups; the diaphragm breathing exercise (DBE) group (n=21; age, 19.71 ± 0.78 years; height, 163.90 ± 8.72 cm; weight, 57.87 ± 9.21 kg) and the feedback breathing exercise (FBE) group (n=17; age, 20.06 ± 1.78 years; height, 169.59 ± 7.24 cm; weight, 66.18 ± 10.86 kg). The purpose and procedures of this study were explained to all participants, and they provided written informed consent prior to participation. The study was approved by the Institutional Review Board of Daegu University (Approval No: 1040621-201501-HR-013-02). All participants in the DBE group were asked to put his/her hands on the rectus abdominis muscle immediately below the anterior costal cartilage, and to inhale slowly and deeply only by swelling his/her abdomen without moving his/her upper chest while relaxing his/her shoulders. Then, the participant exhaled all the air slowly. During inhalation, the air was breathed in through his/her nose, and his/her abdomen was swollen. After the breathe was suspended at the last moment, the participant exhaled the air according to the pursed lip breathing, with which the participant breathed out the air through his/her mouth with his/her lips half-opened and his/her abdomen made hollow. For breathing exercise, the TIGER[®], a device that consists of a mouthpiece and a tube connected with a rebreathing bag for training of respiratory muscle endurance, was used. Under the tube, a cable is connected to the mainframe of the TIGER[®], which displays marks that provide visual and auditory feedback of inhalation and exhalation and signal sounds expressing proper breathing. All participants in the FBE group were asked to sit with a mouthpiece in his/her mouth, watching the TIGER[®] mainframe. The investigator pressed the start button, and the participant breathed in when the orange needle directed toward the “IN” mark and breathed out when the needle toward the “OUT”. Before the exercise, the investigator taught the participants how to accurately perform the exercise two or three times for them to adjust to the method. VO₂max was measured using a Fitmate MED (COSMED, Italy) and a treadmill, and the Bruce protocol was applied as a test of maximum exercise before and after breathing exercises. All participants sat on a chair comfortably for fifteen minutes to measure RMR. After the initial five minutes of warming-up, we measured the oxygen intake during respiration, which was used as RMR before and after breathing exercises. Paired t-test and independent t-test were used to examine effects of feedback breathing and diaphragm breathing on VO₂max and RMR. Statistical analyses were performed using SPSS ver. 21.0, and statistical significance was set at p<0.05.

RESULTS

Significant differences were found in VO₂max between before and after two breathing exercises (p<0.05). There was also significant difference in RMR between before and after diaphragm breathing exercise (p<0.05). However, significant difference was not found in RMR between before and after feedback breathing exercise (p>0.05). There were not significant between-group differences in both VO₂max and RMR (p>0.05) (Table 1).

DISCUSSION

The present study investigated effects of diaphragm breathing exercise and feedback breathing exercise on VO₂max and RMR. In general, respiratory function can be estimated by physical examinations and the measurement of vital capacity⁹⁾. VO₂max is an index with a high degree of objectivity in assessing cardiopulmonary functions. Since functional efficiency of the heart and lungs affects the volume of oxygen consumed during maximal intensity exercise, VO₂max can be used to predict cardiopulmonary function¹⁰⁾.

The results of the present study showed that significant differences in VO₂max and RMR were found before and after diaphragm breathing exercise. Significant difference in VO₂max was found although no significant difference in RMR was found. No significant between-group differences were found in VO₂max and RMR. Judging from the results, it is suggested that both diaphragm breathing exercise and feedback breathing exercise could enhance cardiopulmonary function.

RMR, one of main factors in determining energy consumption in daily life, indicates a minimal energy value needed in personal physiological process during twenty-four hours^{11, 12)}. RMR is calculated by measuring normal breathing. In the FBE group, the participants used the breathing accessory muscles more than the diaphragm, showing costal respiration by raising their shoulders or moving their chests for excessive inhalation and exhalation. The exercise group using diaphragm respiration might show more increase than the group using feedback respiration device because the diaphragm occupies considerable part of normal inhalation. A possible limitation of the present study was nonattendance of elderly group and

respiratory patients with decreased VO₂max or RMR.

In conclusion, diaphragm breathing exercise and feedback breathing exercise could influence VO₂max. Diaphragm breathing exercise could influence RMR, but feedback breathing exercise could not. It is suggested that the results can be useful in clinical applications.

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Conflict of interest

None.

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