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The Effect of Motivational Abdominal Breathing Device on Breathing Patterns and Shortness of Breath in Patients with Chronic Obstructive Pulmonary Disease

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Abstract

Background: In the absence of a definitive therapy for the chronic obstructive pulmonary disease (COPD), the pulmonary rehabilitation is proposed as one of the treatments for this disease. The motivational abdominal breathing is a new rehabilitation technique with limited evidence of effect on the respiratory status in the COPD patients.

Aim: To determine the effects of the motivational abdominal breathing device on breathing patterns and shortness of breath in the COPD patients.

Method: This randomized controlled clinical trial was carried out on 70 patients with COPD at Samen Al-Aemmeh Hospital in Chenaran, Iran in 2015. The participants were assigned into the intervention and control groups who performed abdominal breathing with the newly developed device and the normal abdominal breathing, respectively, twice a day for two weeks. The shortness of breath as well as respiratory rate and depth were measured by numerical rating scale and spirometry. The data were analyzed using the independent t-test and Mann-Whitney test through SPSS software version 11.5.

Results: According to the results, the mean ages of the participants were 50.9±9.4 and 49.5±9.8 years in the intervention and control groups, respectively. The independent t-test showed no significant difference between the two groups regarding the changes in the respiratory rate before and after the intervention (P=0.78). However, the results of the independent t-test and Mann-Whitney test revealed significant difference between the two groups in terms of the changes in the respiratory depth (P<0.001) and shortness of breath (P<0.001) before and after the intervention.

Implications for Practice: As the findings of the present study indicated, the motivational abdominal breathing device can improve the shortness of breath and respiratory depth in the COPD patients because of creating appropriate visual feedback. As a result, this device can be used in the pulmonary rehabilitation. However, further studies are needed to assess the impact of this device on the respiratory status in the COPD patients.

Keywords: Chronic obstructive pulmonary disease, Diaphragmatic breathing, Motivational abdominal breathing, Pulmonary rehabilitation

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Introduction

Chronic obstructive pulmonary disease (COPD) is a growing serious health problem, which is highly prevalent (1). This disease is the fourth leading cause of decease in most parts of the world and will have become the third and the fifth common cause of mortality and morbidity by 2020, respectively (2-6). Based on the statistics, in 2001, the number of COPD patients per 100,000 people was reported to be 1162 cases (i.e., 105 patients with an age range of 15-49 years and 1057 individuals with age of over 50 years) in Iran.

This disease is characterized by progressive airflow limitation that is not fully reversible (7), which maliciously decreases the lung function and leads to respiratory failure (8). The COPD is associated with abnormalities in physical, psychological, and social conditions and makes serious limitations in life due to decreased self-care ability, depression, anxiety, and weakness (9). Inspiratory muscle weakness, reduced exercise tolerance capacity, and shortness of breath are highly prevalent in these patients (10). Accordingly, a high rate of COPD mortality has been attributed to respiratory muscle dysfunction since it causes significant changes in the pulmonary function (11).

The COPD has harmful effects on the respiratory muscle pump, including increased airway resistance and decreased lung compliance, which results in the chronic enhancement of respiratory muscle workload. Accordingly, the minute ventilation increases slightly higher in these patients, compared to the normal population due to the defect in gas exchange. In addition, due to the increase in the functional residual capacity, the ability of inspiratory muscles to reduce the intrathoracic pressure is decreased, leading to the hyperinflation of the lungs, reduction of lung elasticity, and increase of expiratory flow limitation. As a result, the inspiratory capacity is reduced and the end-expiratory lung volume rises, which imposes a huge burden on the inspiratory muscles.

There is considerable evidence to show that the main breathing muscle (i.e., diaphragm) is affected by this mechanism more than the chest muscles (10). The diaphragm muscle becomes shorter in the COPD patients due to the increase of airway resistance, air-filled lungs, and air trapping. Therefore, the diaphragm apex will get lower than normal, which in turn weakens the diaphragm motion. Consequently, the gas exchange becomes ineffective and could be the reason for the escalation of shortness of breath (12).

During the inhalation, the diaphragm naturally begins to move downwards and causes a decrease in intrathoracic pressure. However, the diaphragm in these patients is also lower in the chest wall, compared to that in the healthy subjects, and its ability to descend during inspiration is impaired. Therefore, the ability of the diaphragm to increase the lung volume is reduced in these patients, and the act of breathing is more dependent on the chest muscles (13). In other words, the motions of the thoracic respiratory muscles increase for compensation (14).

The elevated chest muscle motion and decreased diaphragm motion are associated with increased shortness of breath and exercise intolerance (15). Recent studies have shown that the impaired diaphragm motion leads to some changes in the main pulmonary parameters, including the reduction of forced expiratory volume in one second (FEV1) and air trapping in the lungs (16). Davachi et al. (2012) demonstrated that the severity of COPD is directly related to the level of diaphragm motion dysfunction (17). Paolin et al. (2007) also indicated that the diaphragm motion could affect the exercise tolerance and the shortness of breath among the COPD patients (18).

Furthermore, Yamagoti et al. (2009) found that the COPD patients with diaphragm dysfunction have a high risk of mortality (16). Since there is no definitive treatment for the COPD, the therapeutic measures should be undertaken in order to control the symptoms (19), including oxygen therapy that has its own limitations in spite of its practicality. For example, the nurse should provide great support, keep close monitoring, and deliver strong training for the COPD patients undergoing oxygen therapy (20).

Steroid therapy is another treatment used for this disease. Although inhaled corticosteroids may prevent exacerbations, their positive effects have not been demonstrated on lung function or survival rate of these patients (21). In addition to the enormous financial costs, there are concerns about the side effects of the excessive corticosteroids administration, especially the risk of pneumonia that has always been observed in the related studies (22).

Nowadays, the focus on COPD treatment has shifted from the prevention and avoidance of the deterioration of the individual status by medication towards the pulmonary rehabilitation as an

effective non-pharmacological method (23). This approach is a comprehensive achievement to control and relieve the symptoms and optimize the functional capacity of the COPD patients (24). Breathing exercises are considered as a major component of the pulmonary rehabilitation (25), which includes a range of techniques such as abdominal breathing (14). The main objective of abdominal breathing is to improve the abdominal motion, which reduces the activity of the thoracic respiratory muscles (26).

The diaphragm dysfunction can occur in the COPD patients; as a result, the activity of the accessory chest muscles increases for compensation. Subsequently, the function of the diaphragm muscle in breathing falls to less than 30%; therefore, more energy will be spent in breathing, and fatigue and shortness of breath happen more frequently (27). Therefore, abdominal breathing training can reduce the respiratory rate and prolong the exhalation; furthermore, it can cause lower the energy consumption by resting the accessory respiratory muscles (7).

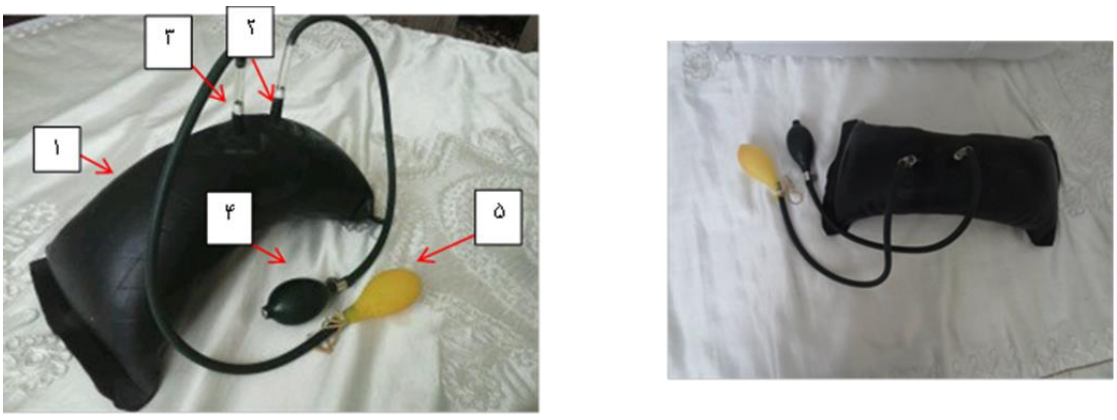
There are several ways to use abdominal breathing in the COPD patients. In normal abdominal breathing training, the patient puts one hand on the abdomen and the other hand on the chest. The emphasis is on outward abdominal movement during the inspiration and inward abdominal movement during the expiration. The hand on the chest should be as still as possible and breathing out should be done slowly through pursed-lips (28). However, the adequacy of this technique in improving the breathing status of the patients has been questioned by some studies since it does not allow for the transmission of the suitable auditory or visual feedbacks to the patients regarding its proper utilization; as a result, the incoordination between the chest and abdomen motion is not noticed and corrected.

There are also other methods such as the use of 2.5 kg weights and electrical stimulation of the diaphragm, which have their own limitations such as fatigue and unwanted stimulation of the accessory chest muscles (29). The controlled diaphragmatic breathing has been widely included within the pulmonary rehabilitation program in the COPD patients. This technique is used to increase the use of the diaphragm muscle and decrease the accessory muscle use during respiration (30). Although this exercise have been shown to have such benefits as improving ventilation and breathing patterns as well as relieving the symptoms, it has been challenged by some researchers (31). Some recent studies have demonstrated that the abdominal breathing did not lead to any changes in the total respiratory muscle performance (32).

The respiratory muscle training requires a respiratory rate regulator (33), and the auditory and visual stimuli must be prepared to correct the uncoordinated breathing (14). Regarding this, there is a need for such tools that can be used for training the abdominal breathing in order to achieve the objectives of enhancing self-care and skills as well as modifying the uncoordinated breathing.

To this aim, the researcher invented and patented a motivational abdominal breathing device (Figure 1). This device consists of a plastic tube that is fastened around the abdomen (at the navel) and has two holes, one of which is connected to a hand air pump and the other one to a balloon. The balloon fills and empties after abdominal breathing and with each inhalation and exhalation. Therefore, the visual feedback of filling and emptying the balloon encourages the patient to do deeper abdominal breathing.

Figure 1. (1- plastic tube, 2-air entry hole, 3-air outlet hole, 4-hand air pump, 5-balloon)



Furthermore, this device is cost-effective and its application is easy for the patients. However, further clinical trials are needed to examine this device and determine its effects on the status of the respiratory function in the COPD patients. Regarding this, the aim of the present study was to evaluate the effects of the motivational abdominal breathing device on the respiratory function in the COPD patients and compare it with the usual abdominal breathing exercises.

Methods

This randomized controlled clinical trial was conducted on all patients with moderate COPD, who referred to the Specialist Clinic of Samen Al-Aemmeh Hospital in Chenaran, Iran, during October 2015-April 2016. The sample size of this study was calculated using the mean and standard deviation of a study conducted by Cancelliero et al. in 2014 (28) and the formula of comparing the means of the two communities. Accordingly, the sample size was estimated five times, and then the highest number was obtained (i.e, 32 patients). In order to ensure the validity of the results, the sample size was determined to be 70 patients (i.e., 35 patients in each group).

The inclusion criteria consisted of: 1) COPD approved by a pulmonary specialist and clinical assessments, 2) moderate disease (i.e., FEV1≥80%, FEV1/FVC ratio<70%), 3) no signs of a pulmonary infection diagnosed by a pulmonary specialist, 4) age range of 18-65 years, 5) medium frame size (to fit with the motivational abdominal breathing device), 6) no history of chest and abdominal surgery, and 7) no history of neuromuscular disorders and heart disease.

On the other hand, the exclusion criteria included 1) unwillingness to continue to participate in the study, 2) failure to properly complete the treatment protocol, 3) respiratory infection and fever during the study, 4) deterioration of the patient's condition, 5) the need for hospital stay for any reason, and 6) the risk of heart problems and cardiac involvement during the study.

For data collection, the present study used the personal and medical information questionnaire, containing two sections and 12 questions. The first part included information on the relevant demographic characteristics (e.g., age, height, weight, gender, and occupation) completed through patient interviews. The second part was related to the medical information (e.g., history of cough, sputum, smoking, hospitalizations, and medications) obtained through interviews and patient records.

Additionally, a form was developed to record the two indices of the breathing pattern (i.e., respiratory rate and depth of breathing) within three stages, namely before the intervention and after 7 and 14 days of the intervention. Given that the two weeks of the intervention was carried out at home by the patients, the researchers invited the participants to the clinic in the given three stages of the study to collect data and ensure the accurate implementation of the technique. Additionally, the respiratory rate was determined through observation, and the depth of breathing was measured using the tidal volume measured through the spirometer (Chest HI801).

These indicators were selected based on the reference books, and then validated through content validity. The reliability of the Registration Form of Indices, representing the breathing pattern and spirometric indices, has been approved in a study conducted by Ahmadi et al. (34). The reliability of these tools was also evaluated in the present study using the test-retest method, which rendered a correlation coefficient of 0.98. Additionally, the depth of breathing and other spirometric indices measured by the spirometer showed a correlation coefficient of 0.97. The reliability of the Chest HI801 spirometer was confirmed by performing spirometry on five individuals during two sessions with an interval of 30 min and determining the correlation coefficient of 0.94. The accuracy of the device was also confirmed through calibration.

The numeric rating scale (NRS) is a standardized scale to measure the severity of the shortness of breath. To use this tool, the patients were asked to rate their severity of the shortness of breath in a range of 0-10 (i.e., 0=the absence of shortness of breath, 1-3=mild shortness of breath, 4-6=moderate shortness of breath, and 7-10: severe shortness of breath). This tool has been confirmed in a study carried out by Mack Milan et al. (2003) using the concurrent criterion-related validity (0.88-0.94) (35). The reliability of this tool in the present study was evaluated by the test-retest method using spearman correlation coefficient. To this aim, two people (i.e., the researcher and research assistant) determined the shortness of breath in 10 patients during two sessions. Subsequently, the correlation between the scores of these two examinations was estimated, which rendered a correlation coefficient of 0.79.

After ensuring the participants about the confidentiality of their information, the researcher reminded the patients not to skip writing their names in the questionnaires. They also asked the participants to

respond to all the enquired information accurately and honestly. At the beginning of the study, the participants were given enough information about the study, therapeutic interventions, and disease through a face-to-face meeting and briefing. The physician and the research assistant completed the demographic data, the entry form of spirometric indices, the NSR form, and the Registration Form of Indices, representing the breathing pattern.

The participants were randomly divided into two groups of intervention (using motivational abdominal breathing device) and control (using conventional abdominal breathing) through coin flipping. The upper side of the coin denoted that the first subject was allocated to the intervention group, and the next person was assigned into the control group. Since the participants' age might have affected the dependent variables, in addition to random allocation, we tried to homogenize the two groups in terms of their age.

To this aim, at the outset, the age variable was divided into three clusters (cluster I: 18-30 years, cluster II: 31-45 years, and cluster III: 46-65 years). Then, the sampling was performed by distributing the subjects as every other one; subsequently, they were equally assigned into the two groups until the sample size was completed. Due to the need for employing age-homogeneous participants, limited numbers of referrals to the clinic, and lack of having sufficient motivational abdominal breathing devices available, the sampling and intervention took place continuously over six months.

The patients in the intervention group were placed in the supine position with an angle of 30°, and the motivational abdominal breathing device was fastened around their abdomen. Subsequently, the patient was asked to perform abdominal breathing for 100 times (in the morning and evening) in 10 steps. Accordingly, the patient expanded the muscles in the abdominal wall and passed the air inside the plastic tube into the balloon. The criterion for the proper performance of this technique is viewing the filling and emptying the balloon. Additionally, the patient was asked to do normal breathing for a minute between each 10 abdominal breathing (Figure 2).

Figure 2. (abdominal breathing in intervention group)

In the control group, the patient was asked to put one hand on the abdomen and the other hand on the chest and perform abdominal breathing for 100 times (within 10 steps). During the inhalation and exhalation, the hand on the chest had the least motion and the one on the abdomen had the greatest displacement. Likewise, the normal breathing in this group was performed for a minute between each 10 abdominal breathing. The evidence for the proper performance of this technique was the increased abdominal girth, compared to the normal breathing during the inhalation.

These interventions were implemented twice a day (i.e., in the morning and evening) for 14 days. The patients performed the interventions in the Chenaran Samen Al-Aemmeh Hospital on the first day for receiving proper training and skill acquisition. Likewise, they were asked to refer to the center 7 and 14 days before doing the technique in the afternoon to collect data and ensure its proper performance. However, on the other days, the patients carried out the technique at home. Additionally, the researchers made follow-up phone calls during specified hours to remind the technique and ensure the accuracy of its implementation. On the 7th and 14th days of the intervention, the physician and the research assistant completed the entry form of spirometric indices, NSR form, and Registration Form of Indices for the intervention and control groups.

After achieving the approval of the Ethics Committee of Mashhad University of Medical Sciences and introducing the researcher to the hospital officials, the required arrangements were made for sampling and implementing the study. Subsequently, the written informed consents were obtained from the patients' family members due to the disruption in the patient's level of consciousness, and they were enrolled in the study. Upon the completion of data collection, the forms were encoded and entered into the computer.

Statistical analysis

The data analysis was performed using Kolmogorov-Smirnov and Shapiro-Wilk tests (to test the normality of the quantitative variables), Chi-square test (to analyze the dependent variables), exact Chi-square test (to examine the qualitative variables), independent t-test (to analyze the quantitative variables with normal distribution), Mann-Whitney tests (to test the quantitative variables with non-normal distribution)

Furthermore, the intergroup comparison was performed using the repeated measures ANOVA test (for quantitative variables with normal distribution) and Friedman test (for quantitative variables with non-normal distribution). Additionally, the two-way ANOVA was employed to investigate the relationship between the individual variables and the effectiveness of the intervention. The statistical analysis was set at the confidence level of 95% and significance level of 0.05. The data were analyzed through SPSS version 11.5.

Results

According to the results of the study, out of 70 patients in this study, 30 (42.9%) were male. The average age of the COPD patients was 50.9±9.4 and 49.5±9.8 in the intervention and control groups, respectively. The results of the independent t-test, Chi-square, exact Chi-square, and Mann-Whitney tests showed that the intervention and control groups were homogeneous in terms of the demographic variables (e.g., age, gender, height, weight, literacy level, occupation, history of smoking, duration of smoking, and the number of cigarettes smoked per day) and disease-related variables (e.g., the duration of disease and the number of hospitalizations) (Table 1).

Table 1. Comparison of demographic characteristics of patients between the two groups

Variables		Groups		P-value
		Motivational abdominal breathing	Conventional abdominal breathing	
		Mean±SD	Mean±SD	
Age (years)		50.9±9.4	49.5±9.8	P=0.70*
Weight (kg)		70.5±10.6	69.3±11.5	P=0.60*
Height (cm)		164.5±7.8	168.5±9.1	P=0.33*
Duration of smoking (years)		13.1±4.7	15.7±5.3	P=0.52*
Cigarettes smoked per day (number)		5.0±1.6	4.7±1.8	P=0.72*
Disease duration (years)		9.6±4.7	8.8±6.1	P=0.28*
Number of hospitalizations (number)		2.8±1.7	2.6±1.8	P=0.65*
		Frequency (%)	Frequency (%)	P-value
Gender	Male	11 (31.4)	19 (54.3)	P=0.05***
	Female	24 (68.6)	16 (45.7)	
Literacy levels	Illiterate	23 (65.7)	23 (65.7)	P=1.0***
	Primary school	10 (28.6)	9 (25.7)	
	High school	2 (5.7)	3 (8.6)	
Occupation	Laborer	3 (8.6)	4 (11.4)	P=0.06****
	Housekeeper	24 (68.6)	15 (42.9)	
	Self-employed	5 (14.2)	5 (14.3)	
	Unemployed	2 (5.7)	2 (5.7)	
	Other	1 (2.9)	9 (25.7)	
Smoking history	Yes	11 (31.4)	13 (37.1)	P=0.62***
	No	24 (68.6)	22 (62.9)	

*Independent t-test, ** Mann-Whitney test, *** Chi-square test, **** Exact Chi-square test

Table 2. Comparison of respiratory rates between the two groups before, on the seventh day, and after intervention

Respiratory rate	Groups		Independent t-test or Mann-Whitney
	Abdominal breathing with a device	Abdominal breathing without a device	
	Mean±SD	Mean±SD	
Before intervention	15.9±1.5	16.4±1.9	P=0.31
On the seventh day	15.7±1.2	16.1±1.6	P=0.32
After intervention	15.2±1.4	15.5±1.6	P=0.47
Difference between the pre- and post-intervention stages	0.7±2.3	0.8±1.9	P=0.78
Friedman test	Chi-square=3.98 P=0.14	Chi-square=3.72 P=0.16	

Due to the possible influences of intervening and underlying variables (i.e., gender, age, weight, height, literacy level, occupation, duration of the disease, history of smoking, duration of smoking, number of cigarettes smoked daily) on the main variables of the study, their impacts were evaluated using the ANCOVA. The results demonstrated that the effects of such variables were lower than the intervention effect; therefore, none of the underlying and intervening variables had any confounding effects on the dependent variables.

The independent t-test showed that the respiratory rates were not significantly different between the two groups before the intervention (P=0.31), at the end of the seventh day of the intervention (P=0.32), after the intervention (P=0.47), and between the pre- and post-intervention stages (P=0.78). The Friedman test also indicated that the procedure of changes was not statistically significant in the intervention (P=0.16) and control (P=0.14) groups during the three stages of the study (Table 2). Likewise, the independent t-test showed no significant difference for the mean depth of breathing before the intervention (P=0.52) and at the end of the seventh day (P=0.19) in the two groups.

However, the two groups were significantly different in terms of their depth of breathing at the end of the 14th day of the intervention and between the pre- and post-intervention stages (P<0.001). Moreover, the intragroup comparison revealed that the depth of breathing had a significantly increasing trend in both groups at the three stages (P<0.001) (Table 3).

Table 3. Comparison of the depth of breathing between the two groups before, on the seventh day, and after intervention

Depth of breathing	Groups		Independent t-test
	Abdominal breathing with a device	Abdominal breathing without a device	
	Mean ± SD	Mean ± SD	
Before intervention	7.0±1.0	6.8±1.0	P=0.52
On the seventh day	7.3±1.1	7.0±0.9	P=0.19
After intervention	7.7±1.0	7.0±0.9	P=0.01
Difference between the pre- and post-intervention stages	0.7±0.1	0.2±0.3	P=0.001
Intragroup test	Chi-square=70.00* P<0.001	f=13.21 P<0.001	

*Friedman test, **Repeated measures ANOVA test

Additionally, the Mann-Whitney test showed a significant difference in the mean shortness of breath before the intervention in the two groups (P=0.61). However, this variable was significantly different between the two groups at the end of the seventh day of the intervention (P=0.01), after the intervention (P=0.006), and between the pre- and post-intervention stages (P=0.001). The Friedman test also showed a significant difference between the two groups of the abdominal breathing with (P<0.001) and without a device (P<0.01) (Table 4).

Table 4. Comparison of shortness of breath between the two groups before, on the seventh day, and after intervention

Shortness of breath	Groups		Mann-Whitney
	Abdominal breathing with a device	Abdominal breathing without a device	
	Mean±SD	Mean±SD	
Before intervention	4.5±2.0	5.6±1.5	P=0.61
On the seventh day	4.3±1.9	5.3±1.6	P=0.01
After intervention	13.5±2.5	3.7±1.9	P=0.006
Difference between the pre- and post-intervention stages	0.6±0.5	4.9±1.7	P=0.001
Friedman test	Chi-square=48.29 P<0.01	Chi-square=24.03 P<0.001	

Discussion

The present study was conducted to compare the effects of the motivational abdominal breathing device with normal abdominal breathing technique on the respiratory function of THE COPD patients. As the findings of the present study indicated, the use of the motivational abdominal breathing device had no significant effect on the respiratory rate. However, the results of a study (2014) entitled "respiratory pattern of diaphragmatic breathing and pilates breathing in COPD subjects" conducted by Cancelliero et al. are not in line with those of the present study.

In the mentioned study, which was conducted on 30 patients with stable COPD who were at the moderate and severe stages of disease, it was shown that the diaphragmatic breathing significantly decreased the respiratory rate, compared to the normal and pilates breathings (28). The pulmonary rehabilitation programs have been shown to increasingly improve the clinical signs like respiratory rate in the patients with severe and very severe COPD (36). Accordingly, in the aforementioned study, the intervention was effective in the patients who were at the severe and very severe stages of COPD, which explains the significant reduction of the respiratory rate observed in that study. However, the patients in the present study were at the moderate stage with stable condition, which can be the reason for the inconsistency between the findings of Cancelliero et al. and our results.

The results also showed that the use of the motivational abdominal breathing device had significant effect on the depth of breathing when compared to the conventional abdominal breathing. Accordingly, the difference in the depth of breathing of the intervention group between the pre- and post-intervention stages was 204% percent higher than that of the control group. Our findings are consistent with a study conducted by Seo Kyo Chul et al. (2013) entitled "the effects of combination of inspiratory diaphragm exercise and exspiratory pursed-lip breathing exercise on pulmonary functions of stroke patients". In the mentioned study, a significant difference was found in the depth of breathing during the intergroup comparison (37).

The abdominal breathing causes the contraction of the abdominal organs by activating the diaphragm during inhalation and minimizing the activity of the accessory chest muscles (31), which in turn leads to further expansion and better inward and outward movements of lower ribs, better forward and backward movements of the upper ribs, and subsequently an increase in the lung volumes and depth of breathing (38).

However, the results of this study are not in line with those obtained by Arnoldus et al. (2011) conducting a study entitled "the effects of controlled breathing during pulmonary rehabilitation in patients with COPD" (39). According to the findings of the mentioned study, the depth of breathing showed no significant difference between the two groups. This discrepancy could be due to the lack of any perfect visual feedback in the mentioned study.

According to the findings of the present study, the use of motivational abdominal breathing device caused greater improvements in the shortness of breath in the intervention group, compared to the conventional abdominal breathing. The two groups showed a significant reduction in the level of shortness of breath at the post-intervention stage, compared to the pre-intervention stage.

This finding is consistent with those of a study carried out by Paz Diaz (2007) entitled "pulmonary rehabilitation improves depression, anxiety, dyspnea, and health status in patients with COPD". The results of the mentioned study indicated significant differences in the shortness of breath in the intergroup comparison (40). Likewise, the findings of a study conducted by Yamagoti et al. (2012)

entitled "diaphragmatic breathing training program improves abdominal motion during natural breathing in patients with chronic obstructive pulmonary disease: a randomized controlled trial" are also in line with those of the present study, showing that the shortness of breath were significantly decreased in the intervention group after four weeks ($P<0.05$) (14).
One of the limitations of this study was the limited cooperation of the patients in doing exercises, which was resolved by providing proper communication, continuous follow-ups, and transportation facilities.

Conclusion

The results obtained from the present study indicated that the motivational abdominal breathing device could be efficient to provide effective feedback on the severity of shortness of breath and depth of breathing in the COPD patients. Therefore, using this innovative device can be useful in the implementation of pulmonary rehabilitation techniques and cause a reduction in the severity of symptoms in the patients with COPD.
Since this device was newly designed and applied for the first time, further studies are needed to investigate its effects on the respiratory status of the hospitalized COPD patients to better control the rate of patient's cooperation.

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Conflicts of interest

The authors declare no conflicts of interest in this study.

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