Original Article

Effects of the Self-training Breathing Exercise on Pulmonary Function in Teachers

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Objective: To determine the effectiveness of the self-training breathing exercise on pulmonary function in teachers.

Materials and Methods: Thirty-four teachers performed the four steps of the self-training breathing exercise program every day for 13 weeks. The pulmonary functions were measured at pre-training and the end of the study.

Results: The self-training breathing exercise program significantly improved pulmonary functions at post-training test for force vital capacity (mean difference [MD] = 0.55; 95% confidence interval [CI] = 0.34, 0.76); forced expiratory volume in one second (MD = 0.57; 95% CI = 0.36, 0.77), and peak expiratory flow rate (MD = 1.47; 95% CI = 0.54, 2.40). Vocal nodules in 4 teachers dramatically disappeared at the end point of the study.

Conclusion: The self-training breathing exercise significantly improves pulmonary functions and remedies vocal pathologies in the teachers. This program can be applied for enhancing pulmonary function in other professional voice users, patients with abnormal lung functions as well as people with cleft palate who need more lung volume to compensate air leakage to nasal cavity from velopharyngeal insufficiency.

Keywords: Breathing exercise, Pulmonary function, Self-training breathing, Cleft palate

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Breathing is a physiological function that has an important role in removing carbon dioxide and supplying oxygen via the specialized pulmonary circulation and gas exchange[1]. Deep and slow pulmonary ventilation breathing can be helpful to increase lung function and volume. These type of breathing can also reduce stress, anxiety, post-traumatic stress, chronic pain, and depression[2]. Breathing exercise can improve lung function and can perform by anyone with or without health problems such as joint pain, poor balance, alcoholism, Parkinson's disease, chronic obstructive pulmonary disease [COPD], as well as children with cleft palate who need more pulmonary volume to compensate the acoustic energy that leaks through nasal cavity from velopharyngeal insufficiency, etc.

Slow and deep inspiration is considered to be a therapeutic breathing exercise. Taking deep breathes and holding at the maximal inspiration increase the transpulmonary pressure which leads to a greater alveolar stability, increase recruitment of the lungs and respiratory muscles. These results could improve lung volume and gas exchange[3-5]. Therefore, exhalation and inhalation exercises can help to improve pulmonary function[6].

Diaphragmatic breathing exercise is used to augment diaphragmatic descent while inhalation and diaphragmatic ascent while expiration[7,8]. Abnormal breathing or misrepresented diaphragmatic breathing can adversely affect lung volumes[9]. Previous studies suggested that breathing exercise helps to improve pulmonary function[10,11].

The objective of this study was to investigate the effectiveness of self-training breathing exercise on pulmonary functions in teachers.

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Materials and Methods

Study design

Prospective study.

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Participants

Thirty-four Thai teachers of high schools in Suwannakhuha, Nong Bua Lamphu Province, Thailand were invited to participate in the study. The participants with respiratory diseases, neuromuscular disorders, orthopedic problems and chronic pulmonary infection were excluded. Number of participants were calculated from a study which explored the main of objective of the effectiveness of the self-training program on maximum phonation time before and after treatment[12] and variance of mean difference of maximum phonation time in a previous study[13], setting a type error of 0.01 and type II error of 0.90 with 20% of dropout. The present study was approved by the Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki (HE592233). Information of about the study was provided to each subject. Written informed consent was obtained prior to starting the study.

Procedure

History taking was individually performed via a questionnaire. Before the program started, the participants underwent physical and ear, nose, throat [ENT] examinations, conducting at the ENT Unit of Out-patient Department of Nong Bua Lamphu Hospital, Nong Bua Lamphu Province, Thailand. Knowledge about vocal hygiene was firstly provided for the participating teachers via video, then pulmonary functions were tested at pre- and post- self-training breathing exercise.

Pulmonary functions: forced vital capacity [FVC], forced expiratory volume in the one second [FEV_1], and peak expiratory flow rate [PEFR], were measured by a specialised nurse who had expertise in lung function test and worked in chest clinic both at the 1st week before and after practice on the self-training breathing exercise (at the 13rd week). All subjects were given sufficient explanation and demonstration for enhancing accuracy before measuring.

Spirometer (Spirobank G®, Medical International Research USA, Inc.) was used to measure pulmonary function while the subjects were seated on chair with nose clip and mouth piece. Practicing of pulmonary function test was continued until the subject could perform correctly, and before testing for individuals. The participants then took a deep breath and blew as fast and hard into a tube connected to a machine (spirometer) at for least 6 seconds. To ensure accurate and reliable data, the pulmonary function test was repeated 3 times after which the highest value was used.

The self-training breathing exercise program composed of 4 steps which had details in the previous study[13]. All subjects practiced daily life breathing exercise training for 20 repetitions/sessions (2 sessions/day). ENT examinations were performed again at the end of the study (the 13th week) for the 4 participants who had vocal pathologies.

Data analyses

SPSS statistical software was used to analyze the data. Descriptive statistics such as means and the standard deviations (mean $\pm$ SD) were presented. Differences within group of outcome parameters were assessed by paired sample t-test. Significance level for each test was set at 0.05 for all analyses.

Results

The majority of participants were females (67.60%) and in middle age (47.10%) (30 to 40 years with mean 41.61$\pm$10.48 years). General characteristics were displayed in Table 1. Most of ENT and physical examinations were normal. Four of the teachers had vocal nodules. Eleven of the teachers (32.40%) had underlying diseases, including diabetes mellitus, hypertension, and/or dyslipidemia. Other factors might relate to pulmonary function as displayed in Table 1.

Table 3 displays a significant improvement of pulmonary functions comparing between pre- and post-tests of FVC (mean difference = 0.55), FEV_1 (mean difference = 0.57), and PEFR (mean difference = 1.47) within 13 weeks.

Discussion

Respiration, the process in which oxygen in the air is sent to the tissues and carbon dioxide is emitted

Table 1. Characteristics of the participating teachers

Variables	Number	Percentage
Cigarette smoking		
No	32	94.10
Used to smoke but quit	1	2.90
Current smoking (no more than 5 cigarettes/day)	1	2.90
Alcohol drinking		
No	26	76.50
Used to drink but quit	2	5.90
Current drinking (no more than 3 glasses/week)	6	17.60

Table 2. The participating teachers' pulmonary functions

No.	Pre-test			Post-test		
	FVC	FEV1	PEFR	FVC	FEV1	PEFR
1*	3.36	2.40	6.16	4.11	3.41	6.39
2	3.04	2.01	5.59	4.00	2.82	5.84
3	3.05	2.21	5.39	3.09	2.49	6.27
4	4.17	3.61	8.85	4.32	3.94	8.17
5	2.73	2.41	4.01	3.72	3.13	8.36
6#	3.45	2.81	4.86	3.92	3.54	8.90
7	2.06	1.98	3.20	2.75	2.39	5.16
8	2.77	2.49	3.99	2.94	2.56	9.27
9	2.92	2.08	4.21	4.33	3.79	8.11
10	2.25	2.09	4.81	3.20	2.78	5.60
11	3.46	2.41	6.01	4.12	3.43	6.40
12	3.08	2.70	5.96	3.86	3.04	6.25
13	4.02	3.16	7.48	4.80	4.34	8.38
14	4.03	3.37	5.13	4.59	3.95	9.69
15*@	4.28	3.52	9.35	4.22	3.82	7.06
16*	2.72	2.24	3.61	3.02	2.48	5.70
17*	2.37	2.17	5.31	2.75	2.45	6.19
18	2.65	2.23	6.51	2.88	2.40	5.75
19	2.39	2.15	4.49	2.41	2.23	4.73
20*@	2.46	1.80	2.36	2.40	1.94	4.21
21#	2.59	2.47	5.05	3.22	2.78	4.57
22	1.57	1.39	4.85	3.06	2.80	7.74
23	3.09	2.72	5.98	3.87	3.05	6.23
24	4.27	3.50	9.20	4.30	3.83	7.84
25	2.29	2.50	4.72	3.10	2.75	5.45
26	4.05	3.47	5.23	4.69	4.05	9.70
27	2.71	2.35	3.87	2.92	2.54	9.16
28	2.91	2.06	4.12	4.23	3.89	8.21
29	3.06	2.60	5.76	3.26	3.14	6.05
30	3.46	2.83	4.84	3.93	3.52	8.70
31	4.01	3.05	7.28	4.60	4.14	8.27
32	2.30	2.12	5.20	2.65	2.35	6.05
33	3.05	2.20	5.35	3.02	2.50	6.25
34	3.32	2.42	6.10	4.10	3.42	6.41

FVC = forced vital capacity; FEV_1 = forced expiratory volume in one second; PEFR = peak expiratory flow rate
@ Used to smoking but quit and current smoking; * Current alcohol drinking 2 glasses or less/week; # Used to drink alcohol but quit

into the air. This can be basically divided into thoracic and diaphragmatic respiration[14,15]. Diaphragmatic breathing, abdominal breathing, belly breathing or deep breathing is breathing that is done by contracting the diaphragm, a muscle located horizontally between the thoracic and abdominal cavity. Air enters the lungs and the belly expands during this type of breathing. In this present study, the self-training breathing exercise program focused on diaphragmatic breathing in order to obtain more lung volume as the diaphragm is the most efficient muscle of respiration. The diaphragm is a large, dome-shaped muscle located at the base of the lungs. Abdominal muscles help move the diaphragm and give more power to empty the lungs.

Many studies found diaphragmatic breathing support pulmonary functions in many kinds of patients, e.g., stroke, COPD, Parkinson's disease, and cerebral palsy. These findings suggested that diaphragmatic

Table 3. Comparisons of pulmonary functions between pre- and post-tests

Pulmonary function	Pre-test Mean ± SD	Post-test Mean ± SD	95% CI	t	*p*-value
FVC (L)	2.95±0.72	3.50±0.73	0.34 to 0.76	5.613	0.000*
FEV_1 (L)	2.43±0.57	3.00±0.67	0.36 to 0.77	5.848	0.000*
PEFR (L/S)	5.30±1.70	6.77±1.62	0.54 to 2.40	3.320	0.003*

FVC = forced vital capacity; FEV_1 = forced expiratory volume in one second; PEFR = peak expiratory flow rate; L = liter; S = second

* Significant differences from the pre-test ($p<0.01$)

breathing increases muscle activities and enhances lung volume[16-20]. The study of breathing exercise in normal subjects produced positive results in enhancing lung volume such as the maximal inspiratory pressure in older adults[21], an increase in the tidal volume and reduced respiratory rate [RR] in healthy people[22]. The present study found the self-training breathing exercise program with arm elevation increased pulmonary functions of FVC, FEV_1, and PEFR. Post-test of pulmonary functions had significantly improved within 13 weeks. This indicated that the self-training breathing exercise enhanced the pulmonary function.

A previous study found that the pulmonary rehabilitation program for the patients with COPD could significantly improve pulmonary function of FVC within 10 weeks[10]. A study reported that breathing with mainly inspiration or expiration for healthy subjects could significantly improve pulmonary of FVC, FEV_1, and PEFR within 4 weeks[11] and breathing exercise for elderly smokers improved pulmonary function of FVC, FEV_1 and PEFR within 4 weeks[23]. This indicates that early benefit of breathing exercise program would be revealed in at least 4 weeks.

There have been several studies in which various forms of breathing exercise have been found to improve lung functions, but these training studies lasted over several weeks or months[24,25]. Intervention programs should be continued at least 12 weeks in order to see the effects on physical activities on respiration functions, including cardiovascular function[26]. If the interventions had continued for more than 12 weeks, the effects would have been maintained. In summary, an early benefit for the self-training breathing exercise program took at least four weeks and maintaining effects of the training took longer, which lasted more than 10 weeks.

Considering individual characteristics and lung volume improvement at the end point of the study (Table 2), there were only 2 teachers who used to smoke and current smoker, as well as 6 teachers who were still drinking alcohol. They likely had less lung volume at the starting point and less improvement rates of pulmonary functions at the end point compared to teachers who had not. These might be the effects of alcohol ingestion that impairs multiple critical cellular functions in the lung. These cellular impairments lead to increased susceptibility to serious complications from lung disease. Recent research cites alcoholic lung disease as comparable to liver disease in alcohol-related mortality[27]. Alcoholic patients have a higher risk of developing acute respiratory distress syndrome [ARSD] and experienced higher rates of mortality from ARSD when compared to non-alcoholic people. For smoking that directly effects to lung pathology, there were only 2 subjects who smoked or used to smoke. There was too small a sample size to discuss about related effects of the smoking and the self-training breathing exercise on pulmonary functions. The further research needs more samples to determine this factor. The breathing exercise program utilized in the present study could be applied for professional voice users such as street vendors, secretariats, singers, politicians, etc., in order to prevent and enhance pulmonary functions for maintain and support their career that needs to use speech for daily life working. In addition, further research should explore the effectiveness of vocal hygiene and self-training programs comparing them to other speech therapy programs in the treatments of vocal nodules.

Conclusion

The self-training breathing exercise significantly improves pulmonary functions, which indicates that it is encouraged to use this program continuously to improve pulmonary functions, treating vocal nodules in teachers and improve quality of life in

normal people. This program can also be applied to enhancing pulmonary functions in other professional voice users, patients with abnormal lung functions as well as people with cleft palate who need more lung volume to compensate air leakage to nasal cavity from velopharyngeal insufficiency.

What is already known on this topic?

Breathing exercise program provided positive effects to pulmonary functions in patients with some diseases. A few evidences found that breathing exercise also increased lung volume in healthy subjects or older adults. There is no report on the effects of the self-training breathing exercise in teachers.

What this study adds?

The self-training breathing exercise is an effective program to enhance pulmonary functions, cure vocal nodules and could be a good health promotion to improve quality of life in teachers. It may be applied as a health promotion for other professional users or anyone who are at risk for limited lung volume as well as children with a cleft palate that need more lung volume to compensate the air leakage through nasal cavity from velopharyngeal insufficiency.

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Potential conflicts of interest

The authors declare no conflicts of interest.

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ผลของโปรแกรมการฝึกหายใจด้วยตนเองต่อสมรรถภาพปอดของครู

เบญจมาศ พระธานี, ยงยุทธ ใสบาล, ภาธร ภิรมย์ไชย

วัตถุประสงค์: เพื่อศึกษาถึงประสิทธิภาพของการใช้โปรแกรมการฝึกหายใจด้วยตนเองต่อสมรรถภาพปอดของครู

วัสดุและวิธีการ: ครู 34 คน ได้รับโปรแกรมการฝึกหายใจด้วยตนเองซึ่งมี 4 ขั้นตอน โดยฝึกครั้งละ 20 รอบ วันละ 2 ครั้ง ทุกวัน เป็นเวลา 13 สัปดาห์ สมรรถภาพปอดจะถูกวัดในสัปดาห์ที่ 1 (ก่อนเริ่มโปรแกรม) และสัปดาห์ที่ 13 หรือหลังการฝึกโปรแกรม (สัปดาห์สุดท้าย)

ผลการศึกษา: โปรแกรมการฝึกหายใจด้วยตนเองสามารถเพิ่มค่าสมรรถภาพปอดได้อย่างมีนัยสำคัญทางสถิติ หลังจากฝึกโดยเพิ่มค่าปริมาตรของอากาศที่สามารถหายใจออกโดยเร็วและแรงเต็มที่หลังจากหายใจเข้าอย่างเต็มที่ force vital capacity [FVC]; mean difference [MD] = 0.55; 95% confidence interval [CI] = 0.34, 0.76 ปริมาตรของอากาศที่สามารถหายใจออกโดยเร็วและแรงในเวลาที่ 1 วินาที (forced expiratory volume in the one second: FEV_1 (MD = 0.57; 95% CI = 0.36, 0.77) และอัตราเร็วสูงสุดของการไหลของลมหายใจที่ออกจากปอด peak expiratory flow rate [PEFR] (MD = 1.47; 95% CI = 0.54, 2.40) ในเวลาเวลา 13 สัปดาห์ ส่วนปุ่มเนื้อที่สายเสียงในครู 4 คน หายไปอย่างชัดเจน เมื่อจบการศึกษา

สรุป: โปรแกรมการฝึกหายใจด้วยตนเองช่วยเพิ่มค่าสมรรถภาพปอดในครูได้อย่างมีนัยสำคัญทางสถิติ และสามารถรักษาปุ่มเนื้อที่สายเสียงในครูได้ ทั้งนี้สามารถประยุกต์โปรแกรมนี้ในการเพิ่มสมรรถภาพของปอดในกลุ่มผู้มีอาชีพที่ต้องใช้เสียง ผู้ป่วยที่มีหน้าที่ของปอดผิดปกติและผู้ป่วยปากแหว่งเพดานโหว่ ซึ่งต้องการปริมาณลมในปอดมากว่าคนปกติในการชดเชยลมที่ไหลออกทางจมูกจากการมีความบกพร่องของเพดานอ่อน และผนังคอหอย