

# Effects of the Self-Training Breathing Exercise on Maximum Phonation Time in Teachers

Yongyut Saiban BSc\*,  
Benjamas Prathanee PhD\*\*, Patorn Piromchai MD, PhD\*\*

\* Science Program in Exercise and Sport Sciences Program, Graduate School, Khon Kaen University,  
Khon Kaen, Thailand

\*\* Department of Otolaryngology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

**Background:** Teachers are professional voice users that routinely need voice for daily professional activities. The volume of air in the lung is the main factor that supports speech production. Maximum phonation time (MPT) is an indicator of this factor. Breathing exercises are used to augment diaphragmatic descent while inhalation and ascent during expiration to improve the MPT.

**Objective:** To examine the effects of self-training breathing exercise on increasing MPT in teachers.

**Material and Method:** Thirty-four teachers enrolled in the self-training breathing exercise program, comprising 4 steps, 20 sessions (2 sessions per day), and every day practice for 13 weeks. The MPT and maximum counting duration (MCD) were measured at 1<sup>st</sup> (pre-test), 4<sup>th</sup>, 7<sup>th</sup>, 10<sup>th</sup>, and 13<sup>th</sup> week.

**Results:** The self-training breathing exercise program significantly improved MPT at the end of the 4<sup>th</sup> week for /i/ and all vowel prolongation and MCD at 7<sup>th</sup> week. There were significantly increased of MPT and MCD in all vowels at the end of the study: /a/ {mean difference (MD) 2.89; 95% confidence interval (CI) = 1.44-4.34}, /u/ (MD 4.22; 95% CI = 2.8-5.60), /i/ (MD 5.86; 95% CI = 3.90-7.81), and MCD (MD 5.82; 95 % CI = 4.44-7.19).

**Conclusion:** The self-training breathing exercise significantly improved MPT and MCD in teachers. This program can be implemented to enhance MPT and MCD in other professional voice users, as well as children or people with cleft palate who are at risk for voice disorders.

**Keywords:** Breathing exercise, Maximum phonation time, Voice professional users, Cleft palate

**J Med Assoc Thai 2017; 100 (Suppl. 6): S153-S159**

**Full text. e-Journal:** <http://www.jmatonline.com>

The voice is the most important tool for one's work in many occupations, such as street vendors, secretaries, musicians and teachers<sup>(1)</sup>. The teacher is commonly regarded as a professional voice user who uses voice for working in daily life<sup>(2-5)</sup>. Therefore, teachers are considerably at risk for voice problems<sup>(5)</sup>. Voice or phonation is processed by expiratory airflow that comes from lungs. If there is respiratory dysfunction or inadequate respiration, there will be either a reduction of air to support phonation or resulted in running of airflow for speaking. This also effects to decrease maximum phonation time (MPT)<sup>(6)</sup>. MPT is measured by a simple clinical test that has been widely utilized for evaluating vocal functioning<sup>(7)</sup>. Maximum counting duration (MCD) is a common indicator to assess lung volume in speaking. The useful clinical features of MPT

and MCD are to: 1) serve as valid indicator of phonatory function<sup>(7-10)</sup>; 2) provide information on respiratory function control<sup>(6)</sup>; and 3) use as meaningful measure for screening voice disorders<sup>(8-10)</sup>.

Diaphragmatic breathing exercise is used to augment diaphragmatic descent while inhalation and diaphragmatic ascent while expiration<sup>(11,12)</sup>. Abnormal breathing patterns frequently result in failing to provide sufficient breath support for optimum voice. Abnormal breathing or misrepresented diaphragmatic breathing affords the negative lung volumes<sup>(13)</sup>. Previous studies have suggested that breathing exercise can help to improve pulmonary function<sup>(14)</sup>, and MPT<sup>(15)</sup>. The objective of this present study was to investigate the effectiveness of self-training breathing exercise on MPT and MCD in teachers.

## Correspondence to:

Prathanee B, Department of Otorhinolaryngology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.  
Phone: +66-43-348396, Fax: +66-43-202490  
E-mail: [bprathanee@gmail.com](mailto:bprathanee@gmail.com)

## Material and Method

### Participants

Thirty-four Thai teachers of high school in Suwannakhuha, Nong Bua Lamphu, Thailand were

invited to participate in the present study. Individuals with respiratory diseases, neuromuscular disorders, orthopedic problems and chronic infection that might effect to breathing exercises were excluded. Number of participants were calculated based on variance of mean difference of maximum phonation time in a previous before and after treatment of a previous study<sup>(16)</sup>, setting a type error of 0.01 and type II error of 0.90 with 20% of dropout. The study was approved by the Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki (HE592233). Description of information was provided to each subject and a written informed consent was obtained prior to involve them in the study.

### **Procedure**

The participating teachers were examined for ear, nose and throat (ENT) at the ENT Unit of Out-patient Department of Nong Bua Lamphu Hospital, Nong Bua Lamphu province, Thailand before starting the program. Vocal hygiene was firstly provided for teachers, then MPT and MCD assessments were performed pre- and post-self-training breathing exercise.

### **MPT and MCD assessments**

The participants were trained to perform MPT and MCD in sitting upright position. An instructor asked the participants to take a deep breath and prolong vowels in their optimal pitch and loudness via saying the Thai carrier phrases in: 'Painai ma\_\_' for /a:/, 'Paijabpoo\_\_' for /u:/, and 'Sawatdee\_\_' for /i:/. They were also trained to count for connected speech in optimal pitch, loudness and normal rate of speaking after taking deep breath for assessment of MCD. After the training, the participants took a deep breath, then prolong MPT of each /a:/, /u:/, /i:/, and MCD, three times as long as they possibly could after taking a maximal inhalation with a 30 seconds-rest period between each trial. Each trial was scheduled with application "voice memos" of smart phone and calculated for duration of prolongation of MPT and MCD for connected speech from the starting and the end points of sound wave, in which in seconds MPT and MCD were explored for 5 times: the 1<sup>st</sup> week or first visit before breathing exercise, at the 4<sup>th</sup> week, 7<sup>th</sup> week, 10<sup>th</sup> week, and at the end point (the 13<sup>rd</sup> week).

The participants were received knowledge about vocal hygiene after pre-assessment. Self-training breathing exercise was described and instructed. The breathing exercise composed of four steps as follows<sup>(15)</sup>:

Step 1. Supine position: the participants

performed lying supine with the left hand placing on abdomen and the right hand was placed beside trunk, they inhaled slowly and deeply with upward abdomen and downward diaphragm while the right hand/arm was raised to ear plane beside the head for 5 seconds, hold one's breath while the right hand/arm was stabilized beside the head for 5 seconds, they exhaled slowly and relaxed with downward abdomen and upward diaphragm while the right hand/arm was lowered to the starting point. Participant repeated the same procedure with the right hand was placed on abdomen and the left hand was placed beside the trunk and alternatively performed. Then, participants were asked to performed follow to program in compact disc (CD) for 6, 7, 8,....20 seconds, respectively. They practiced for 3 weeks (week 1<sup>st</sup>-3<sup>rd</sup>).

Step 2. Sitting position: the participants sit upright on a backrest chair with the left hand was placed on abdomen and the right hand was placed beside the trunk, then inhaled slowly and deeply with forward abdomen and downward diaphragm and right hand/arm was raised to the ear plane beside the head for 5 seconds, hold one's breath while the right hand/arm was stabilized beside the head for 5 seconds, they exhaled slowly and were relaxed with downward abdomen and upward diaphragm while the right hand/arm was lowered to the starting point. Participants repeated the same procedure with the right hand was placed on abdomen and the left hand was placed beside the trunk and alternatively performed. Participants were asked to performed follow to program in compact disc for 10, 11, 12,....20 seconds, respectively. They practiced for 3 weeks (week 4<sup>th</sup>-6<sup>th</sup>).

Step 3. Standing position: the participants stood up and the left hand was placed on abdomen, and the right hand was placed beside trunk. They inhaled slowly and deeply with forward abdomen and downward diaphragm and the right hand/arm was raised to the ear plane beside the head for 5 seconds, hold one's breath while the right hand/arm was stabilized beside the head for 5 seconds, they exhaled slowly and relaxed with downward abdomen and upward diaphragm while the right hand/arm was lowered to the starting point. Participants repeated the same procedure with the right hand was placed on abdomen and the left hand was placed beside the trunk and alternatively perform. Participants were asked to performed follow to program in CD for 10, 11, 12,....20 seconds, respectively. They practiced for 3 weeks (week 7<sup>th</sup>-9<sup>th</sup>).

Step 4. Walking position: the participants stood up and the left hand was placed on abdomen

and the right hand was placed beside trunk. They inhaled slowly and deeply while walking with forward abdomen and downward diaphragm and the right hand/arm was raised to the ear plane beside the head for 5 seconds, hold one's breath while the right hand/arm was stabilized beside the head for 5 seconds, they exhaled slowly and relaxed with downward abdomen and upward diaphragm while the right hand/arm was lowered to the starting point. Participants repeated the same procedure with the right hand was placed on abdomen and the left hand was placed beside the trunk and alternatively performed. Participants were asked to performed follow to program in CD for 10, 11, 12, ... 20 seconds, respectively. They practiced for 3 weeks (week 10<sup>th</sup> -12<sup>th</sup>).

All subjects practiced each step of breathing exercise training in daily life for 20 repetitions/sessions, two sessions/day. ENT examination was performed again for the teachers who had vocal pathologies at the end point (the 13<sup>rd</sup> week).

#### Data analyses

The main outcomes were the average MPT and MCD. SPSS statistical software was used. Descriptive statistics were expressed as mean and standard deviation (mean  $\pm$  SD). Differences within group of outcome parameters were assessed by paired sample t-test and repeated measures ANOVA was used to examine change in maximum phonation time. The significant level for each test was set at 0.05 for all analyses.

#### Results

The teachers' characteristics were displayed in Table 1. Most of them have taught for 10 years or less. All teachers taught 4 or less than 4 hours/day and approximately a half used microphone for teaching (47.10 %). ENT examination of all participants at 1<sup>st</sup> week was performed by an ENT physician. It also performed for 4 teachers who had vocal pathologies at the end of study. Findings are presented in Table 2.

Regardless of related factors e.g., age, number of teaching hours, laryngeal pathology, etc., investigation presented significant improvement in pre- and post-test of MPT /a/ { mean difference (MD) = 2.89; 95% confidence interval (CI) = 1.44-4.34 }, /u/ (MD = 4.22; 95% CI = 2.8-5.60), /i/ (MD = 5.86; 95% CI = 3.90-7.81), and MCD (MD = 5.82; 95% CI = 4.44-7.19) within 13 weeks (Fig. 1).

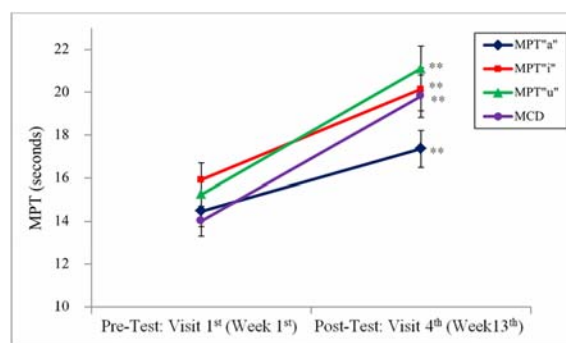
Repeated measures ANOVA revealed outcomes of the self-training breathing exercise on

**Table 1.** Characteristics of the participating teachers

Variables	Number	Percentage
Gender		
Males	11	32.40
Females	23	67.60
Age (years)		
$\leq 30$	4	11.80
31-40	16	47.10
41-50	5	14.70
51-60	9	26.50
$\bar{x} = 41.61, SD = 10.48$		
Underlying diseases		
None	23	67.60
Yes	11	32.40
Duration of working (years)		
$\leq 10$	20	58.80
11-20	5	14.70
21-30	4	11.80
$> 30$	5	14.70
$\bar{x} = 13.97, SD = 12.16$		

**Table 2.** ENT examination at 1<sup>st</sup> and 13<sup>rd</sup> week

Subject No.	1 <sup>st</sup> week	13 <sup>rd</sup> week
7	Bilateral vocal nodules	Normal
9	Unilateral vocal nodule	Normal
24	Bilateral vocal nodules	Normal
30	Bilateral vocal nodules	Normal



**Fig. 1** Pre-test and post-test MPT.

MPT as in Table 3. MPT of /u/ and speech counting duration had increased significantly at the 4<sup>th</sup> week ( $p < 0.01$ ). MPT of /i/ had significantly increased at the 7<sup>th</sup> week ( $p < 0.01$ ), however, there was no significant

difference at the 4<sup>th</sup> weeks. Phonation time of /a/ had significantly increased at the 10<sup>th</sup> week ( $p<0.01$ ), but no significant difference at 4<sup>th</sup> and 7<sup>th</sup> weeks (Table 3).

For subgroup observation, 4 teachers (4 of 34 teachers or 11.76%) had vocal nodules; their MPT and MCD at the end of the study were significantly increased in all outcomes. Mean differences were shown in Table 4.

### Discussion

Respiration, the process in which oxygen in the air is sent to the tissues and carbon dioxide is emitted to the air, can be divided into thoracic and diaphragmatic respiration<sup>(16,17)</sup>. The findings of this study showed that the self-training breathing exercise gave significant benefits for MPT of /u/ and MCD which had significantly increased at the 4<sup>th</sup> week, MPT of /i/ had significantly increased at the 7<sup>th</sup> week, and /a/ had significantly increased at the 10<sup>th</sup> week. In summary, the self-training breathing exercise improved MPT within 13 weeks. The results of this present study are similar to the previous studies which found that the self-training voice therapy for the patients with hoarseness could significantly improved MPT of /a/, /i/, and /u/ within 10 weeks<sup>(15)</sup> and voice training with breathing exercise for the patients with vocal cord polyps after the surgery were significantly increased in MPT within 12 weeks<sup>(18)</sup>.

For mean and standard deviation of MPT in

each visit (Table 3), the breathing exercise showed significant increase MPT for /u/ but not for /a/ and /i/ at the 4<sup>th</sup> week. This indicates that early benefit of self-training breathing exercise program take at least 4 weeks and generalized benefits for all MPT and MCD need approximately 7 weeks. This duration of improvement of the self-training breathing exercise program for prevention functional voice disorders (e.g., vocal abuse, muscle tension dysphonia) can be used as clinical information among teachers who have the highest incidence of functional voice disorders in the Speech Clinic, Srinagarind Hospital, Faculty of Medicine, Khon Kaen University<sup>(21)</sup> and the general population. It also can be applied in clinical practice for people with psychological voice disorders (e.g. hysterical aphonia, mutational falsetto voice) as well as other professional voice users (street vendors, secretariats, politicians) that risk vocal abuse<sup>(22)</sup> and need voice therapy because the self-training breathing exercise program can increase MPT, which indicate enhanced resource of air or lung volume, and which is a primary function for speech production.

The findings in Table 4 demonstrate that the self-training breathing exercise could significantly increase MPT and MCD. This result supports a previous study that found people with hoarseness got significant improvement in MPT within 10 weeks<sup>(15)</sup>. Therefore, the self-training breathing exercise program could benefit children or people with cleft palate and

**Table 3.** Mean and standard deviation of MPT in each visit

MPT	Pre	4 <sup>th</sup> week	7 <sup>th</sup> week	10 <sup>th</sup> week	13 <sup>rd</sup> week
Vowel /a/	14.47±5.08	15.62±4.95	16.13±4.53	16.28±3.96*	17.36±4.17*
Vowel /i/	15.92±4.84	17.18±6.32	18.26±6.85*	18.47±5.30*	20.14±6.23*
Vowel /u/	15.25±4.44	18.16±6.14*	18.92±5.84*	20.12±7.29*	21.11±7.19*
Count duration	14.01±2.99	16.19±4.23*	17.57±4.50*	18.42±5.09*	19.83±5.13*

Mean ± SD, \* Significant difference compared between pre- and post-test ( $p<0.01$ )

**Table 4.** MPT and MCD of teachers with vocal pathology at 1<sup>st</sup> and 13<sup>rd</sup> week

The participant ID	/a/ (seconds)		/u/ (seconds)		/i/ (seconds)		MCD (seconds)	
	1 <sup>st</sup> week	13 <sup>rd</sup> week	1 <sup>st</sup> week	13 <sup>rd</sup> week	1 <sup>st</sup> week	13 <sup>rd</sup> week	1 <sup>st</sup> week	13 <sup>rd</sup> week
No. 7	11.50	13.86	11.70	18.07	12.90	21.92	12.50	15.29
No. 9	7.63	17.64	8.00	15.46	9.44	16.42	7.82	14.82
No. 24	9.22	12.17	10.90	13.78	13.10	11.44	13.70	12.83
No. 30	14.60	16.96	13.90	16.35	13.80	19.85	15.50	20.19

hoarseness (incidence 9.2-25%)<sup>(23-25)</sup> as well as patients who are at risk of voice disorders or vocal nodules by providing health promotion, prevention or to remedy voice disorders.

These evidences could be used as information to convince educational administrators to promote or prevent occupational diseases among teachers and have this program or subject relate to professional voice users in a prerequisite course for teachers or students in the faculty of education.

### Conclusion

The results of this present study showed that self-training breathing exercises could significantly improve MPT, which indicated enhanced resource of air or lung function for speech production. This program can be applied to enhance MPT in other professional voice users, patients with hoarseness as well as people with cleft palate who need more lung volume to compensate for air leakage into the nasal cavity from velopharyngeal insufficiency.

### What is already known on this topic?

Vocal abuse or muscle tension dysphonia is the most common in professional voice users, particularly teachers and patients with cleft palate. Evidence-based data of promotion or prevention of vocal abuse among teachers was limited and not available in Thailand.

### What this study adds?

The self-training breathing exercise is an effective program to enhance MPT that indicates a primary air resource for speech production and results in good health promotion and prevention of vocal abuse among teachers. It might be also applied for health promotion for other professional voice users as well as children or people with cleft palates who are at risk of voice disorders.

### Acknowledgements

The authors gave appreciation to administrators and teachers of the high school in Suwannakhuha, Nong Bua Lamphu province, Thailand for their cooperation as well as special thanks to physicians and nurses of Nong Bua Lamphu Hospital for helping with ENT examination. This article was supported for publication by the Center of Cleft lip and Cleft Palate and Craniofacial Deformities, Khon Kaen University under Tawanchai Royal Grant Project and Tawanchai Foundation.

### Potential conflicts of interest

None.

### References

1. Vilkmann E. Voice problems at work: A challenge for occupational safety and health arrangement. *Folia Phoniatri Logop* 2000; 52: 120-5.
2. de Medeiros AM, Barreto SM, Assuncao AA. Voice disorders (dysphonia) in public school female teachers working in Belo Horizonte: prevalence and associated factors. *J Voice* 2008; 22: 676-87.
3. Roy N, Merrill RM, Thibeault S, Gray SD, Smith EM. Voice disorders in teachers and the general population: effects on work performance, attendance, and future career choices. *J Speech Lang Hear Res* 2004; 47: 542-51.
4. Lyberg AV, Rydell R, Lofqvist A. How do teachers with self-reported voice problems differ from their peers with self-reported voice health? *J Voice* 2012; 26: e149-e161.
5. Morrow SL, Connor NP. Comparison of voice-use profiles between elementary classroom and music teachers. *J Voice* 2011; 25: 367-72.
6. Reich AR, Mason JA, Polen SB. Task administration variables effecting phonation time measures in third-grade girls with normal voice quality. *Lang Speech Hear Serv Schools* 1986; 17: 262-9.
7. Isshiki N, Okamura H, Morimoto M. Maximum phonation time and air flow rate during phonation: simple clinical tests for vocal function. *Ann Otol Rhinol Laryngol* 1967; 76: 998-1007.
8. Harden JR, Looney NA. Duration of sustained phonation in kindergarten children. *Int J Pediatr Otorhinolaryngol* 1984; 7: 11-9.
9. Finnegan DE. Maximum phonation time for children with normal voices. *Folia Phoniatri (Basel)* 1985; 37: 209-15.
10. Prathanee B, Watthanathon J, Ruangjirachuporn P. Phonation time, phonation volume and air flow rate in normal adults. *J Med Assoc Thai* 1994; 77: 639-45.
11. Nancy H, Tecklin JS. Respiratory treatment in cardiopulmonary physical therapy: a guide to practice. In: Irwin S, Tecklin JS, editors. *Cardiopulmonary physical therapy*. St. Louis, MO: Mosby; 1995: 356-74.
12. Grams ST, Ono LM, Noronha MA, Schivinski CI, Paulin E. Breathing exercises in upper abdominal surgery: a systematic review and meta-analysis. *Rev Bras Fisioter* 2012; 16: 345-53.

13. Aronson E, Bless M. Clinical voice disorders. New York: Thieme Medical Publishers; 2009.
14. Kingkam N. The effect of pulmonary rehabilitation program on pulmonary function, exercise tolerance, dyspnea, and patients' satisfaction among chronic obstructive pulmonary disease patients at Prayuen hospital, Khon Kaen province [Master's independent study in Adult Nursing]. Khon Kaen: Faculty of Nursing Khon Kaen University; 2007: 81-3.
15. Prathanee B, Srirompotong S, Saeseow P, Sangnipankul R. The self-training voice therapy for patients with hoarseness. Routine to research focus. Khon Kaen: Department of Otorhinolaryngology Faculty of Medicine Khon Kaen University; 2011: 20-1.
16. Gardner WN. The pathophysiology of hyperventilation disorders. *Chest* 1996; 109: 516-34.
17. Fried R. The psychology and physiology of breathing in behavioral medicine, clinical psychology, and psychiatry. New York: Springer Science & Business Media; 1993.
18. Lin L, Sun N, Yang Q, Zhang Y, Shen J, Shi L, et al. Effect of voice training in the voice rehabilitation of patients with vocal cord polyps after surgery. *Exp Ther Med* 2014; 7: 877-80.
19. Woo SD, Kim TH, Lim JY. The effects of breathing with mainly inspiration or expiration on pulmonary function and chest expansion. *J Phys Ther Sci* 2016; 28: 927-31.
20. Song RY, Park IS, So HY, Kim HL, Ahn SH. Applicability and program effects of tai chi exercise in outpatients with coronary artery disease. *J Korean Acad Adult Nurs* 2008; 20: 537-47.
21. Prathanee B, Saengsa-ard S, Ard-samart T. Factors affecting vocal abuse. *Otolaryngol Head Neck Surg (Thailand)* 1995; 9: 28-35.
22. Williams N, Carding P. Occupational voice loss. Boca Raton: Taylor & Francis; 2005.
23. Hocevar-Boltezar I, Jarc A, Kozelj V. Ear, nose and voice problems in children with orofacial clefts. *J Laryngol Otol* 2006; 120: 276-81.
24. Prathanee B, Makarabhirom K, Pumnum T, Seepuaham C, Jaiyong P, Pradubwong S. Khon Kaen: A Community-Based Speech Therapy Model for an Area Lacking in Speech Services for Clefts. *Asia Pac J Trop Med* 2014; 45: 1-14.
25. Prathanee B, Thanawirattananit P, Thanaviratananich S. Speech, language, voice, resonance and hearing disorders in patients with cleft lip and palate. *J Med Assoc Thai* 2013; 96 (Suppl 4): S71-80.

---

## ผลของโปรแกรมการฝึกหายใจด้วยตนเองต่อเวลาในการเปล่งเสียงไวยาวยที่สุดในครู

ยงยุทธ ไสบาล, เบญจมาศ พระธานี, ภรณ์ ภริมย์ไชย

**ภูมิหลัง:** ครูเป็นอาชีพที่จำเป็นต้องใช้เสียงในการทำงานในชีวิตประจำวัน ปริมาณอากาศในปอดเป็นปัจจัยหลักที่ทำให้เกิดการพูด เวลาในการเปล่งเสียงไวยาวยที่สุดเป็นตัวบ่งชี้หนึ่งของปริมาณลมในปอดที่ใช้ในการพูด การฝึกออกกำลังกายด้วยการหายใจ จะทำให้แผ่นกระบังลมลดลง ขณะหายใจเข้าและเลื่อนขึ้นในขณะที่หายใจออกเพื่อเพิ่มเวลาในการเปล่งเสียงไวยาวยที่สุด

**วัตถุประสงค์:** เพื่อศึกษาถึงผลของการใช้การฝึกหายใจด้วยตนเองในการเพิ่มเวลาในการเปล่งเสียงไวยาวยที่สุด

**วัสดุและวิธีการ:** ครู 34 คนได้รับโปรแกรมการฝึกหายใจด้วยตนเองซึ่งมี 4 ขั้นตอน โดยฝึกครั้งละ 20 รอบ วันละ 2 ครั้ง ทุกวัน เป็นเวลา 13 สัปดาห์ เวลาในการเปล่งเสียงไวยาวยที่สุดและระยะเวลาในการนับเลขที่ยาวที่สุดถูกวัดในสัปดาห์ที่ 1 (ก่อนเริ่มโปรแกรม) 4, 7, 10, และ 13 หรือหลังการฝึก (สัปดาห์สุดท้าย)

**ผลการศึกษา:** โปรแกรมการฝึกหายใจด้วยตนเองทำให้เวลาในการเปล่งเสียงไวยาวยที่สุดเพิ่มขึ้นอย่างมีนัยสำคัญในการออกเสียง /i/ ที่สัปดาห์ที่ 4 และในการออกเสียงสระทุกเสียงและระยะเวลาในการนับเลขที่ยาวที่สุดที่สัปดาห์ที่ 7 ค่าเฉลี่ยของเวลาในการเปล่งเสียงไวยาวยที่สุดและระยะเวลาในการนับเลขที่ยาวที่สุดของสระทุกตัวหลังการฝึกเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติเมื่อจบการศึกษา: /a/ (mean difference: MD = 2.89; 95% confidence interval: CI = 1.44-4.34), /u/(MD = 4.22; 95% CI = 2.8-5.60), /i/ (MD = 5.86; 95% CI = 3.90-7.81), and MCD (MD = 5.82; 95% CI = 4.44-7.19)

**สรุป:** โปรแกรมการฝึกหายใจด้วยตนเองช่วยเพิ่มเวลาในการเปล่งเสียงไวยาวยที่สุดและระยะเวลาในการนับเลขที่ยาวที่สุดในครู ซึ่งสามารถประยุกต์โปรแกรมนี้ในการเพิ่มเวลาในการเปล่งเสียงไวยาวยที่สุดและระยะเวลาในการนับเลขที่ยาวที่สุดในอาชีพที่ต้องใช้เสียงอื่น ๆ รวมทั้งเด็ก หรือบุคคลเพดานโหว่ที่มีความเสี่ยงต่อเสียงผิดปกติได้

---