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EXERCISE

A modified breathing exercise program for asthma is easy to perform and effective

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ABSTRACT

Objectives: Breathing exercises are used by some asthmatic patients, yet are often difficult to perform and time-consuming. This study evaluated a simple, modified breathing exercise program regarding ease to perform and effectiveness as an adjunctive therapy. **Methods:** Subjects age 18 to 65 with a current diagnosis of persistent asthma were enrolled. A program that incorporated three different breathing exercises (yoga pranayama techniques, diaphragmatic breathing and pursed lip breathing) was taught to subjects. The program was designed to be completed in less than 10 minutes per day. Subjects completed the Asthma Control Test (ACT) and mini-Asthma Quality of Life Questionnaire (AQLQ) at baseline and at 1-month follow-up. They also completed a survey that asked them to rate the effectiveness and difficulty of the exercises, and whether they would recommend them in the future. **Results:** A total of 74 subjects were enrolled in this study. The intervention improved breathing for 52.9% of the subjects, while 67.6% felt that their daily activity was improved and 66.1% noted that the exercises allowed decreased use of a rescue inhaler. Most subjects (80.9%) recommended breathing exercises as a complementary therapy for asthma and 79.4% of the subjects stated the exercises took less than 10 minutes per day total. Overall, ACT scores improved significantly ($p = 0.002$) with a statistically non-significant improvement in AQLQ scores. **Conclusion:** A simple program of breathing exercises was found to be effective and could be completed in less than 10 minutes per day. Furthermore, there was a statistically significant improvement in ACT scores post-exercise.

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Introduction

Asthma is a chronic inflammatory disorder of the lungs that affects an estimated 25.7 million people in the United States, with approximately 1.8 million ED visits and 439,000 hospitalizations per year [1]. Despite major advances in pharmacological therapy for asthma, there has been an increasing interest in alternative therapies for asthma [2]. In fact, according to the 2007 National Health Interview Survey (NHIS), roughly 4 in 10 adults in the United States use some form of complementary and alternative medicine (CAM)[3]. Breathing exercises form an important part of complementary asthma management and some committees that issue guidelines for asthma recommend their use as a supplement to medications [4,5]. Though not fully known, the primary mechanism of breathing exercises is thought to be avoidance of hyperventilation and hypocapnia (triggers for bronchoconstriction) by reduction in minute volume [6,7]. This is done either via breathing retraining exercises aimed at decreasing hyperventilation by controlling both tidal volume and respiratory rate, or via yogic

exercises that focus on deep respirations and prolonged exhalation [6,8–13].

Despite multiple studies, the evidence for use of breathing exercises in clinical practice is unclear, given the various limitations of these studies and heterogeneity of published trials [14–18]. Moreover, patient's preferences for these programs have not been adequately evaluated. Unfortunately, many breathing exercise programs are complex, time-consuming and confusing, which may be a deterrent to their incorporation into asthma management. Subjects with asthma face unique challenges and for many, it may be very hard to incorporate such programs into their daily life routine.

Our aim was to design a simple breathing program that could be performed in a short amount of time and be integrated into one's fast-paced 21st-century lifestyle. The hypothesis was that such a program would be both well accepted and effective for asthma management. The specific objectives of this study were: 1) To determine the ease in performing these exercises; 2) To evaluate the willingness of subjects to incorporate these exercises into their daily routines; and 3) To determine the effectiveness

of these breathing exercises as a complementary therapy for asthma in terms of ACT (Asthma Control Test) and AQLQ (Asthma Quality of Life Questionnaire) scores.

Methods

Subjects age 18 to 65 with a current diagnosis of persistent asthma were included. Persistent asthma was defined as the need to use a daily controller medication to control asthma symptoms. Subjects with a history of COPD or any other lung disease, pregnant or lactating women and subjects who could not communicate in English were excluded. Subjects were recruited from the immunotherapy clinic of the Allergy and Immunology Division at the University of Michigan, Ann Arbor, MI. This study was reviewed and approved by the Institutional Review Board, and all subjects provided written informed consent.

At baseline, all subjects completed demographic and asthma-specific information. Subjects also completed an Asthma Control Test (ACT) and a mini Asthma Quality of Life Questionnaire (AQLQ) at baseline. A program that incorporated three different breathing exercises (viloma pranayama, which is one of many yoga pranayama techniques, diaphragmatic breathing and pursed lip breathing) was taught to all subjects. Teaching was demonstrated by one of the members of the study team (MK) and supplemented by a breathing exercise brochure containing detailed instructions. Subjects were also asked to demonstrate proper technique at their initial visit and then asked to repeat these exercises twice daily for a 1-month period.

At the follow-up visit 1 month later, subjects repeated the ACT and mini AQLQ. They also completed a survey about breathing exercises, which asked about the frequency at which subjects did the exercises and whether they did 1, 2 or all 3 exercises. They were asked to rate the difficulty of each exercise using a 5-point Likert scale (5 being the most difficult and 1 being the least difficult). Subjects were asked if the breathing exercises affected their overall breathing, their daily activity, and rescue inhaler use. Finally, they were asked if they would recommend these breathing exercises as a complementary therapy for asthma and if they planned to continue their use in the future. Questions were primarily dichotomous or based on a Likert response scale, although subjects were allowed to provide additional comments as appropriate.

Statistical analysis

Data were analyzed using SAS Software for Windows, Version 9.3 (Cary, North Carolina) for descriptive statistics including frequency analysis, as well as bivariate/proportional inferential analysis, including Chi square

tests and *t*-tests, and linear regression analysis for associative trends. Factors entered into the linear regression model included baseline ACT score, gender, and age.

A sample size calculation was calculated based on the ACT score. Based on our previous research, we expected a baseline ACT score of 17.4 and standard deviation of 4.3 [19]. With 80% power and α of 0.05, we calculated that 66 subjects would be needed to find a change of 3 points on the ACT. Assuming a 10% dropout rate, the final sample size was 73 subjects.

The breathing exercises

Steps of each exercise were to be repeated 5 times twice daily.

1. Viloma pranayama

Study subjects were taught a form of yoga breathing, specifically the viloma pranayama technique. For the viloma pranayama technique, subjects were asked to inhale deeply through the nose and then exhale with interruptions or pauses through their mouth. During exhalation, the mouth was partially open and their lips sealed around their teeth to create some resistance. Next, subjects were asked to inhale through the nose with interruptions or pauses and exhale normally. Finally, subjects were asked to inhale and exhale through the nose with interruptions for both inhalation and exhalation.

2. Diaphragmatic breathing

While seated or lying, subjects were asked to place one hand on the upper chest and the other just below their rib cage. They were asked to inhale through their nose while trying to push out the hand that is over the stomach and while keeping the hand that is on their chest as still as possible. For exhalation, they were asked to tighten their abdominal muscles, letting them fall inward as they exhale through pursed lips.

3. Pursed lip breathing

Subjects were instructed to inhale slowly through their nose for a few counts while keeping their mouth closed. Then they were told to hold their breath for a few seconds and then exhale slowly and gently through pursed lips while counting to 4. Pursed lip was explained as having their lips puckered as if they were going to whistle or gently flicker the flame of a candle.

Results

A total number of 74 subjects were enrolled in this study. All participants were receiving allergen immunotherapy

Table 1. Baseline characteristics.

	All subjects N = 74
Age (years)	45.08 ± 13.47
Gender (Male/female)	19 (25.7%)/56 (75.7%)
Medications*	
Leukotriene inhibitor	38 (51.3%)
ICS	34 (43.5%)
ICS/LABA	38 (51.3%)
Tiotropium Bromide	7 (9.5%)
Omalizumab	7 (9.5%)
Number of asthma exacerbation in the past year	2.9 ± 4.33
Number of oral steroid bursts in the past year	0.77 ± 1.09
Baseline ACT	19.7 ± 4.38
Baseline mini-AQLQ	5.49 ± 1.23

Note. ICS = inhaled corticosteroids; LABA = long-acting β agonist.

*Subjects were able to use different medication combinations.

and 7 were receiving omalizumab for severe persistent allergic asthma. The mean age of subjects was 45 years ($SD = 13.47$) and 75.7% were females. Subjects were on a number of different medication combinations including leukotriene inhibitors, inhaled corticosteroids, combination inhaled corticosteroids and long-acting β agonist, ipratropium bromide and omalizumab. Subjects were typically classified as moderate-to-severe asthma, as over 50% required an ICS/LABA combination therapy on a daily basis, and 9% required omalizumab. Participants had an average of 2.9 ($SD = 4.33$) asthma exacerbations over the past year prior to enrollment and required less than 1 course of steroid over that duration ($M = 0.77$, $SD = 1.09$). Their baseline ACT was 19.7 ($SD = 4.38$) indicating perception of suboptimal control of their asthma. During the study, 4 subjects withdrew from the study but did not give any specific reason for withdrawal. Two additional subjects were lost to follow-up leaving a total of 68 subjects who completed the entire protocol. Table 1 summarizes the baseline characteristics.

As shown in Table 2, a majority (64%) of subjects did breathing exercises for 3 or more days per week. Then 79.4% of subjects stated the exercises took less than 10 minutes per day total. A majority of subjects (80.9%) recommended the breathing exercises as a complementary therapy for asthma (Table 3). The most prevalent reason given for their recommendation was that breathing exercises provided control over their breathing and increased awareness of one's breathing pattern. Some also noted

Table 2. Duration of breathing exercises ($n = 68$).

Days per week breathing exercises were done	N (%)
0–2	23 (33.8)
3–4	31 (45.5)
>5	13 (19.1)
Time per day taken to do exercises	N (%)
≤10 minutes	54 (79.4)
>10 minutes	13 (19.1)

Table 3. Effect of breathing exercises perceived by subjects ($n = 68$).

	Agree N (%)	Disagree N (%)	Neither agree nor disagree N (%)
Recommend breathing exercises as a complementary therapy for asthma	55 (80.9%)	6 (8.8%)	2 (2.9%)
Breathing exercises improved my breathing	36 (52.9%)	28 (41.1%)	2 (2.9%)
Breathing exercise improved my daily activity	46 (67.6%)	16 (23.5%)	4 (5.8%)
Breathing exercises decreased use of rescue inhaler	45 (66.1%)	10 (14.7%)	10 (14.7%)
Will continue to do breathing exercises in the future	58 (85.2%)	3 (4.4%)	4 (5.8%)

Note. N = number of subjects.

that it helped with “taking deeper breaths,” “increased lung expansion” and “better overall airflow.” Other reasons included increased relaxation and calmness; 52.9% of the subjects stated that breathing exercises improved their breathing, and 67.6% felt that their daily activity was improved. Importantly, 66.1% of subjects felt that use of the breathing exercises allowed for a decreased rescue inhaler use (Table 3).

Eighty-five percent (85.2%, $n = 58$) of the participants expressed that they were going to continue doing the exercises in the future. Many of these stated that the exercises increased their control over their breathing and helped with relaxation. A few thought that one month of exercises was not enough to see a beneficial effect and indicated that they will be continuing the exercises for at least 3 months to determine its effect. Of the 4 subjects who indicated that they were not going to continue the breathing exercises, the cause cited in all cases was their busy and irregular life schedule. As noted in Table 4, most subjects found these exercises easy to perform (subjects that gave difficulty rating of 1 out of 5: 42.6% for viloma pranayama, 45.5% for abdominal breathing and 54.4% for pursed lip breathing).

When looking at secondary outcomes, overall ACT scores improved significantly after the intervention (21.3 vs. 19.7, $p = 0.002$), and while the exercises did appear to impact asthma related quality of life (AQLQ), this did not reach statistical significance (Figure 1). When

Table 4. Ease of performing breathing exercises.

Difficulty rating of exercises	Yoga pranayama N (%)	Abdominal breathing N (%)	Pursed lip breathing N (%)
1 (very easy)	29 (42.6%)	31 (45.5%)	37 (54.4%)
2 (easy)	14 (20.5%)	14 (20.5%)	14 (20.5%)
3 (neutral)	14 (20.5%)	10 (14.7%)	8 (11.7%)
4 (difficult)	4 (5.8%)	4 (5.8%)	2 (2.9%)
5 (very difficult)	1 (1.4%)	3 (4.4%)	1 (1.4%)

Note. N = number of subjects.

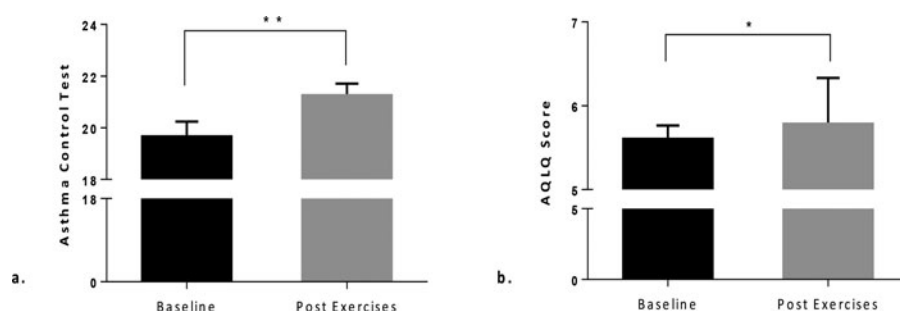


Figure 1. Asthma Control Test (ACT) and Asthma Quality of Life Questionnaire (AQLQ) scores pre and post-exercises. ** $p = 0.002$; * $p = 0.0214$.

performing a linear regression analysis, the improvement in ACT scores remained significant ($\beta = 1.58$, $t(71) = 3.24$, $p = 0.002$) even after controlling for gender and age. Of note, neither age nor gender was associated with changes in the ACT score. The beta values for factors included in the linear regression analysis are listed Supplementary Table 1.

The number of days per week spent doing breathing exercises seemed to influence changes to ACT scores and asthma-related quality of life. For the ACT, those doing exercises 3 or more days per week had an average increase of 2.3 points in comparison with those doing the exercises 2 days or less, who had an average increase of 0.30. When entered into a linear regression model, the p -value for those doing the breathing exercises ≥ 3 times/week (compared to $< 2 \times/\text{week}$) was 0.063 ($\beta = 1.58$, $t(71) = 14.9$).

For the AQLQ, those doing the exercises 2 days or less per week had a slight nonsignificant decrease in quality of life, while those doing the exercises 3 or more days per week had an increase (though this again was nonsignificant). When entered into a linear regression model, the p -value for those doing the breathing exercises ≥ 3 times/week (compared to $< 2 \times/\text{week}$) was 0.086 ($\beta = 0.519$, $t(73) = 1.36$). The effect size, mean change, and p -values for both the ACT and AQLQ scores separated by frequency of performing breathing exercises are presented in Supplementary Table 2.

Discussion

In our study, we demonstrated that a large proportion of subjects are willing to do a modified breathing exercise program and were able to incorporate these exercises into their daily schedules. Our objective was to develop a simple and short program that could be integrated into one's daily routine. The ease of performing these breathing exercises was demonstrated by the willingness of the majority of subjects to continue doing them in the future and to recommend these exercises to others as a complementary asthma management therapy. This is an important feature of our breathing exercise program since

compliance with any form of medical therapy is necessary for its success.

Asthma is a complex, multi-faceted chronic condition that affects subjects in many different ways. A variety of complementary or alternative therapies have existed for centuries to help in the treatment of various chronic disorders including asthma. In fact, in the United States, 27% of children with asthma reported some use of CAM [20]. Among those, 58% reported the use of a breathing technique to help manage asthma. Breathing techniques were the most common type of CAM used in that study. Although prior studies have evaluated the benefits of breathing exercises in terms of clinical outcomes, few have actually explored subject compliance, preference and willingness to perform these exercises.

Many of the breathing programs are time consuming and less likely to be followed by subjects in a regular fashion. Buteyko exercises (which are one of the most studied retraining exercises for asthma management) aims to reduce hyperventilation through periods of controlled reduction in breathing, known as 'slow breathing' and 'reduced breathing', combined with periods of breath holding, known as 'control pauses' and 'extended pauses' [21]. A formal Buteyko practice routine can take 40 minutes, and may involve maneuvers including mouth taping for prolonged periods of time at night [20,21].

In contrast, the breathing exercises developed for this study could typically be performed in less than 10 minutes per day. We used a combination of 3 simple exercises that seem to cross over in some form. Each component of our exercises has been previously evaluated in separate studies with demonstrable benefits in terms of improving quality of life and lung mechanics [22,23]. Almost all study subjects rated these exercises as being very easy with scores varying between 1 and 2 on a 5-point Likert scale (with 5 bringing the most difficult).

However, it is important to note that even with this simplified program, only 19% of subjects would be considered to have 'excellent' compliance – completing the exercises more than 5 days/week. Those that performed the exercises ≥ 3 times/week appeared to have greater

benefit than those who participated less frequently. To increase compliance, subject selection may need to be optimized, or a behavioral self-regulation component may need to be included. Alternatively, the breathing exercise protocol may need to be revised and shortened to 3×/week, as 45.5% of subjects were able to do the exercises 3–4×/week in this study.

The subjects in our study stated that breathing exercises improved their breathing and daily activity while decreasing the use of rescue inhaler. The overall ACT score did improve over the course of the study, and although the AQLQ score also improved, it did not reach statistical significance. There was a trend towards greater increases in ACT scores among subjects who did the exercises 3 or more days per week, although the final absolute ACT scores between the two groups were similar. Additional studies are therefore warranted to determine the true impact of this breathing exercise program on asthma control and quality of life.

There were limitations in this study. These include the lack of a control group and a relatively short follow-up period. Our sample population was selected from a pool of immunotherapy subjects and these may be more engaged and committed subjects, as immunotherapy requires additional time commitment. Hyperventilation, which is believed to be at the center of breathing retraining exercises, was not measured in our study. Finally, the subjects often had moderate to severe asthma as demonstrated by their medication requirement, and the results may therefore not be applicable to all asthmatic subjects.

In conclusion, there has been an increasing worldwide interest in non-pharmacological or alternative therapies for asthma including breathing exercises. Our novel program included simple breathing exercises that could be completed in under 10 minutes per day by most subjects, were easy to perform, and were favorably reviewed for effectiveness. Furthermore, there was a statistically significant improvement in ACT scores after performing the exercises over a 1-month time period. In the future, larger, randomized studies are warranted to determine if this complementary asthma management program can improve outcomes.

Declaration of interest

The authors report no conflicts of interest.

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Supplementary Table 1. Linear regression analysis for ACT score

Factor	Beta-value	Standard Error (S.E.)	p-value
Breathing Intervention	1.575	0.486	0.002
Age	-0.014	0.027	0.594
Gender	1.315	0.864	0.132

Supplementary Table 2. Effect of breathing exercises on ACT and min-AQLQ

	Overall		Breathing exercises < 2 days per week		Breathing exercises ≥3 days per week		p-value*
	n=68		n=23		n=44		
	Mean	SD	Mean	SD	Mean	SD	
ACT							
Baseline	19.71	4.38	20.70	3.51	19.20	4.77	
Post Exercises	21.31	3.31	21.00	3.32	21.50	3.37	
<i>Mean change</i>	<i>1.60</i>	<i>4.13</i>	<i>0.30</i>	<i>4.08</i>	<i>2.30</i>	<i>4.08</i>	0.063
<i>Effect size</i>	<i>0.39</i>		<i>0.07</i>		<i>0.56</i>		
	<i>P**=0.002</i>						

AQLQ

Baseline	5.62	1.20	5.95	1.05	5.43	1.32	
Post Exercises	5.80	1.16	5.82	1.34	5.87	0.94	
<i>Mean change</i>	<i>0.18</i>	<i>1.21</i>	<i>-0.12</i>	<i>1.43</i>	<i>0.44</i>	<i>0.88</i>	0.085
<i>Effect size</i>	<i>0.15</i>		<i>-0.08</i>		<i>0.50</i>		

$P^{**}=0.214$

**P-value for comparison in mean change from baseline to follow up visit after the breathing exercises between breathing groups using linear regression models, adjusted for gender and age.*

***From Paired t-test.*