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ORIGINAL RESEARCH

Is Yoga Training Beneficial for Exercise-induced Bronchoconstriction?

Fulya Tahan, MD; Hatice Eke Gungor, MD; Emine Bicici, MD

ABSTRACT

Background • Some studies have shown the beneficial effects of yoga for individuals with bronchial hyperreactivity with regard to (1) a reduction in the use of rescue medication, (2) an increase in exercise capacity, and (3) an improvement in lung function. Despite the fact that yoga is promising as a new treatment for pediatric patients, further studies are needed to assess the use of this training for asthma management.

Objective • This study was performed to assess the beneficial effects of yoga in exercise-induced bronchoconstriction (EIB) in children.

Design • The study was prospective, with no control group. Participants were randomly chosen among the new patients at the unit.

Setting • This study was conducted in the Erciyes University School of Medicine, Pediatric Allergy Unit, in Kayseri, Turkey.

Participants • Two groups of asthmatic children aged 6-17 y were enrolled in the study: (1) children with positive responses to an exercise challenge (n = 10), and (2) those with negative responses (n = 10).

Intervention • Both groups attended 1-h sessions of yoga training 2 ×/wk for 3 mo.

Outcome Measures • Researchers administered spirometric measurement to all children before and immediately after participating in an exercise challenge. This process was performed at baseline and at the study's end. Age, gender, IgE levels, eosinophil numbers, and spirometric measurement parameters including forced expiratory volume in 1 sec (FEV_1), forced expiratory flow 25%-75% ($FEF_{25\%-75\%}$), forced vital capacity (FVC), peak expiratory flow percentage (PEF%), and peak expiratory flow rate (PEFR) were compared using the Mann-Whitney *U* test and the Wilcoxon test. A P value < .05 was considered significant.

Results • At baseline, no significant differences were observed between the groups regarding demographics or pre-exercise spirometric measurements ($P > .05$, Mann-Whitney *U* test). Likewise, no significant differences in spirometric measurements existed between the groups regarding the change in responses to an exercise challenge after yoga training ($P > .05$, Wilcoxon test). For the exercise-response-positive group, the research team observed a significant improvement in maximum forced expiratory volume 1% ($FEV_1\%$) fall following the exercise challenge after yoga training ($P > .05$, Wilcoxon test). All exercise-response-positive asthmatics became exercise-response-negative asthmatics after yoga training.

Conclusion • This study showed that training children in the practice of yoga had beneficial effects on EIB. It is the research team's opinion that yoga training can supplement drug therapy to achieve better control of asthma. (*Altern Ther Health Med.* 2014;20(2):18-23.)

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Yoga is recognized as a form of mind-body medicine and includes a combination of breathing exercises (*pranayamas*), physical postures (*asanas*), and meditation (spirituality).[1,2] Yoga has been used to treat individuals with asthma for many years. Some studies have shown the beneficial effects of yoga for individuals with bronchial hyperreactivity with regard to (1) a reduction in the use of rescue medication, (2) an increase in exercise capacity, and (3) an improvement in lung function.[3-5] Despite the fact that yoga is promising as a new treatment for

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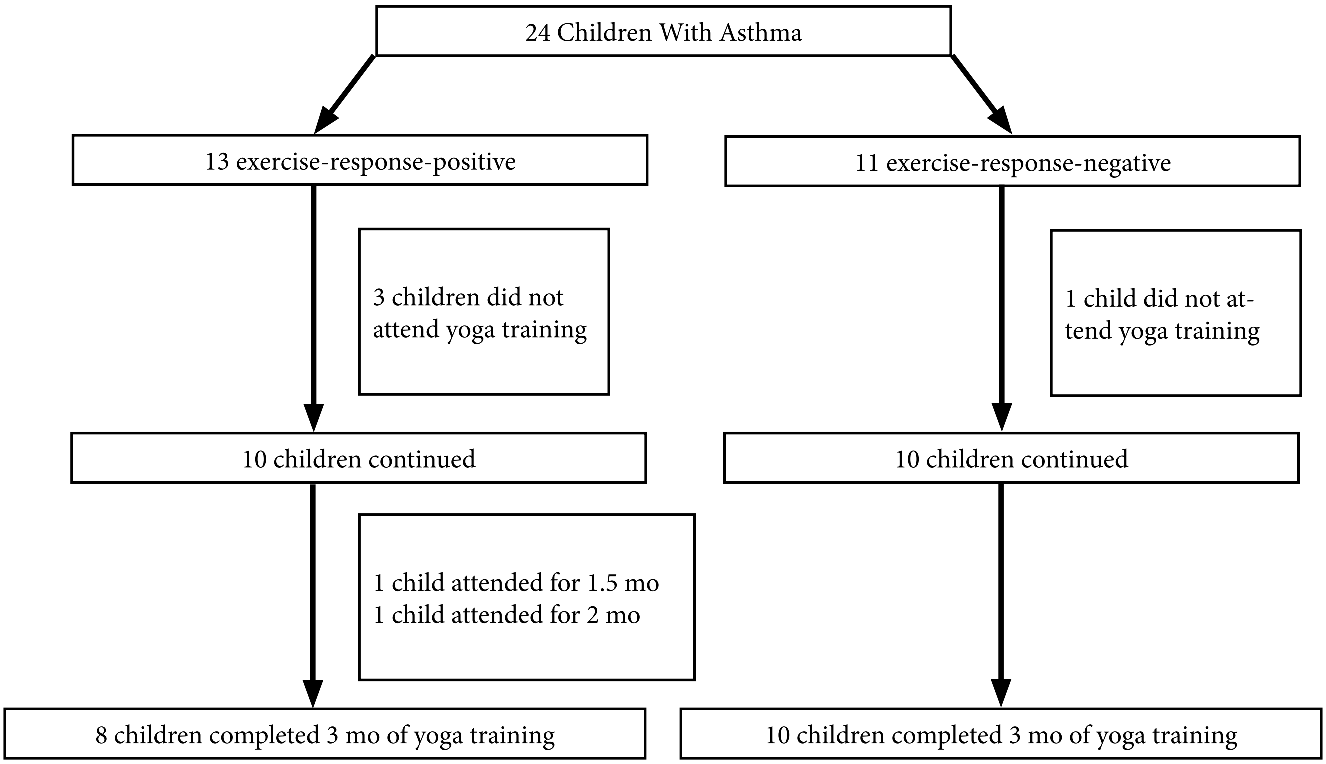
Figure 1. Summary of Participants Entered and Withdrawn From Trial



pediatric patients, further studies are needed to use this training for asthma management.

In the current study, the research team aimed to investigate the effects of yoga training on pediatric patients with exercise-induced bronchoconstriction (EIB).

METHODS

Participants

This prospective study was conducted on 24 children aged 6 to 17 years with moderate asthma in the Erciyes University School of Medicine, Pediatric Allergy Unit, in Kayseri,Turkey. Participants were randomly chosen among the new patients at the unit. The study's procedures were performed in accordance with a protocol already approved by the Institutional Review Board of Erciyes University. All participants and their parents gave written informed consent before the procedure. Also, all children gave verbal assent. After recruitment, 4 patients were excluded as they declined to undergo yoga training (Figure 1).

Asthma was diagnosed according to the Global Initiative for Asthma (GINA) published guidelines[6] by taking a history of a child's intermittent wheezing and by determining at baseline if a reversible airway obstruction was present. This obstruction was defined to be (1) at least a 12% improvement in forced expiratory volume in 1 second (FEV_1) following bronchodilator administration and (2) a therapeutic response to antiasthma treatment. Children who had an infection of the upper or lower airway or an asthma exacerbation within the prior 6 weeks were excluded from the study.

Yoga Training

All children participated in a yoga training program that included 1-hour sessions twice per week over a period of 12 weeks. The research team preferred the *hatha* yoga technique, as well as 12 weeks of yoga training, because the group hypothesized that 12 weeks might be enough time to affect the children's bronchial hyperreactivity. Each yoga session included a combination of breathing exercises (pranayamas, 10 min), physical postures (asanas, 40 min), and relaxation (10 min). All yoga sessions were conducted by the same qualified female yoga instructor who had studied yoga in India.

Outcome Measures

All children underwent a spirometric measurement test session comprising at least 3 acceptable maneuvers, in accordance with American Thoracic Society (ATS) 2005 guidelines for spirometry,[7] performed before and immediately after a standard exercise challenge, which was administered at baseline and at the end of the study. Exercise testing was conducted according to a previously described protocol,[8] with the child on a treadmill at submaximal workload for 6 minutes while breathing dry air. In accordance with ATS guidelines, the children had discontinued short-acting bronchodilators for at least 12 hours, long-acting bronchodilators for at least 48 hours, and leukotriene modifiers for at least 72 hours.[9] None of the participants had taken antihistamines during the week preceding the exercise challenge. Children who had used inhaled corticosteroids within the prior 2 weeks were generally excluded from the study.

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Table 1. Participants' Characteristics at Baseline

	Exercise-response-positive Asthma Participants (n = 10)	Exercise-response-negative Asthma Participants (n = 10)	*P* Value
Age, y[a]	7.5 (5.5-13)	9.5 (6-15.5)	>.05[b]
Gender Male (%) Female (%)	 5 (50) 5 (50)	 4 (40) 6 (60)	>.05[c]
FEV_1% predicted[a]	118.9 (107.6-155.1)	112.8 (98.9-150.7)	>.05[b]
Maximum % fall after exercise[a]	19 (15-35.6)	9 (0-14)	<.05[b]
Skin-test positivity, %	50	30	>.05[c]
Eosinophil count[a]	200 (60-410)	135 (60-690)	>.05[b]
IgE (kU/L)[a]	49 (4.9-394)	52.5 (6.6-128)	>.05[b]

Abbreviation: FEV_1% = forced expiratory volume 1%.

[a]Median (interquartile range).
[b]Mann-Whitney *U* test.
[c]χ^2 test.

On the treadmill, all children increased their exercise efforts until their heart rates had reached 90% of the predicted maximum for their age group within 1 minute of starting the challenge and they maintained that rate during 6 minutes of exercise.

Spirometry. Airflow metrics were measured with a Jaeger MasterScope Body (CareFusion Germany, Hoechberg, Bavaria, Germany) using the ATS maneuver defined for forced vital capacity (FVC) and FEV_1. The research team conducted spirometry immediately (at 0 min) after the exercise challenge and then at 5, 10, 15, and 20 minutes after exercise had stopped. A reduction in FEV_1 of at least 15% of the pre-exercise value was considered to be a positive reaction.[10] Additional spirometric analysis parameters were derived from the time and volume curves generated in response to the basic FVC/FEV_1 maneuver.

IgE Levels. These levels were measured with UniCap technology in accordance with the specifications of the manufacturer (Pharmacia, Kalamazoo, MI, USA).

Eosinophil Counts. These counts were determined from Coulter counter leukocyte measurements.

Skin Testing. At presentation to the clinic, the child received a battery of tests, which were done on their upper backs, using 23 antigens, including 15 aeroallergens and 8 food allergens, with appropriate positive and negative controls. Reactions with an induration > 3 mm higher than that of the negative control were considered positive.

Statistical Analyses

Age, gender, IgE levels, eosinophil numbers, and FEV_1, forced expiratory flow 25%-75% ($FEF_{25\%-75\%}$), FVC, and peak expiratory flow percentage (PEF%) were compared using the Mann-Whitney *U* test and Wilcoxon test. A *P* value < .05 was considered significant.

RESULTS

Participants

Overall, 24 children with moderate asthma were screened for exercise response. Thirteen children with positive exercise responses and 11 children with negative exercise responses were included in the study. Three children from the exercise-response-positive group and 1 child from the exercise-response-negative group did not attend the yoga training. One child attended the yoga training program for only 1.5 months, and 1 child attended the program for 2 months.

No significant differences existed at baseline between the groups regarding age, gender, IgE levels, eosinophil numbers, atopy status, and forced expiratory volume 1% (FEV_1%) ($P > .05$) (Table 1). The atopic asthmatics were specifically sensitized to house dust mite or grass pollens.

Spirometric Measurements

No significant difference was observed in the pre-exercise spirometric indices of pulmonary function between the groups ($P > .05$, Mann-Whitney *U* test). There was no difference in FVC, FEV_1, the FEV_1/FVC ratio, PEF rate, or average FEF_{25-75}% rate during the expulsion at the beginning

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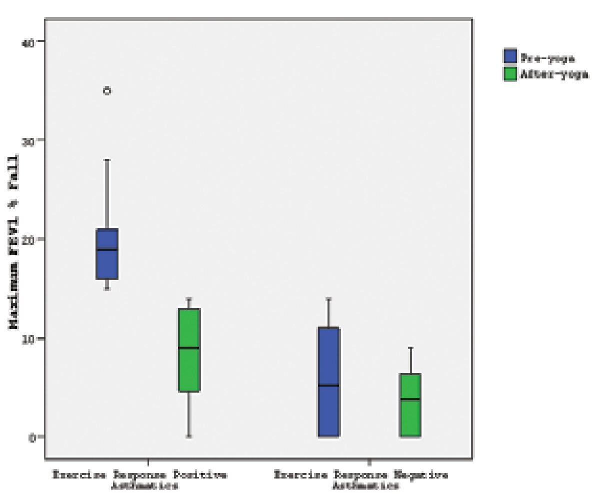
Table 2. After-exercise Values Before and After Yoga Training for FEV_1%, FVC (%), and Maximum FEV_1% Fall

Participants	Before Yoga Training			After Yoga Training		
	FEV_1%	FVC (%)	Maximum FEV_1% fall after exercise	FEV_1%	FVC (%)	Maximum FEV_1% fall after exercise
Exercise-Response-Positive Group	107.6	97.4	**21.0**	124.6	111.4	**2.4**
	155.0	154.9	**16.1**	141.7	135.0	**8.2**
	111.6	126	**16.3**	117.1	129.3	**0.0**
	120.8	138.2	**3.6**	113.4	112.3	**0.0**
	142.8	135.4	**15.0**	93.7	105.1	**0.0**
	111.7	108.8	**19.8**	106.6	106.1	**10.0**
	117.0	122.6	**16.0**	117.5	113.1	**12.0**
	126.9	135.4	**28.0**	129.7	87.3	**14.5**
	127.3	109.6	**19.0**	129.7	115.0	**11.3**
	108.4	103.6	**19.0**	114.5	117.3	**2.0**
Exercise-Response-Negative Group	114.9	113.2	**14.0**	123.5	114.4	**9.0**
	110.8	98.5	**13.0**	98.2	113.0	**7.5**
	150.7	145.4	**0.0**	121.6	115.0	**5.5**
	132.9	128.5	**4.6**	128.1	130.0	**0.0**
	110.3	95.6	**11.0**	112.7	124.1	**6.2**
	131.4	135.2	**13.0**	122.3	122.4	**1.2**
	108.6	111.9	**1.8**	114.1	129.8	**6.4**
	98.9	92.4	**8.0**	109.9	101.7	**2.0**
	101.4	99.9	**10.0**	96.3	105.4	**0.0**
	117.2	101.5	**6.0**	113.3	101.9	**0.0**

Abbreviations: FEV_1 = forced expiratory volume in the first second of expiration; FVC = forced vital capacity.

Figure 2. Maximum FEV_1% Fall Before and After Yoga Training



Abbreviation: FEV_1% = forced expiratory volume 1%.

or end of yoga training in both groups (P > .05, Wilcoxon test). After 12 weeks, we observed significant improvement in participants' fall of maximum FEV_1% after exercise (P> .05, Wilcoxon test). All exercise-response-positive asthmatics became exercise-response-negative asthmatics following yoga training. There was no difference in the exercise-response-negative group.

DISCUSSION

To the best of the research team's knowledge, the current study is the first that has investigated the role of 3 months of yoga training on the bronchoconstrictor response observed in asthmatic children. Through this study, the team has observed that practice of yoga training has beneficial effects on EIB.

A substantial body of evidence exists on the efficacy of yoga in the management of bronchial asthma. In addition to those effects, many studies have reported significant improvements in pulmonary functions and quality of life and reductions in airway hyperreactivity, frequency of attacks, and medication use. Also, a few studies have attempted to understand the effects of yoga on EIB or exercise tolerance capacity.[3-5]

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How can yoga training have this kind of effect? Researchers do not know the exact reason; however, a variety of explanations are available for the observed benefits. Most important, yoga includes breathing exercises. Yoga breathing exercises involve mental concentration to cause a reduction in breathing frequency, a 1:2 ratio of inspiration to expiration, and a pause at the end of inspiration and expiration.[11] Changes in breathing pattern may alter airway hyperreactivity. Airway hyperresponsiveness appears to be 1 manifestation of airway inflammation. Chronic inflammation observed in asthma leads to airway hyperresponsiveness, which is defined as an abnormal increase in airflow limitation following exposure to a nonallergic stimulus, such as exercise.[12,13]

Many yoga and meditation practices include exercises designed to alter the pattern of breathing. In a controlled trial of different breathing techniques, asthmatics receiving active treatment had significant reductions in β_2 agonist use, suggesting that the breathing exercises reduced asthma symptoms. Udupa et al[14] analyzed the effects of pranayama training on cardiac function in normal young volunteers. The researchers found that pranayama training effectively modulated ventricular performance by decreasing sympathetic output and, thereby, increasing parasympathetic output.

An alternative hypothesis may be that altering the pattern of breathing alters airway hyperreactivity by a direct effect on the dynamics of airway smooth muscle. Recent observations have suggested that the shortening velocity of airway smooth muscle may be an important determinant of airway hyperreactivity.[15,16] In addition, some in vitro evidence has suggested that the shortening velocity of airway smooth muscle may be affected directly by the volume of tidal breathing.[17] In this model, decreasing tidal volume decreased the amplitude of force fluctuations acting on the smooth muscle and led to reductions in the cycling rates of the actin-myosin crossbridge and the shortening velocity of the muscle, with a subsequent reduction in the amount of airway narrowing for a given stimulus. This model has not been tested in humans but provides a plausible explanation whereby changes in breathing pattern might alter airway hyperreactivity. Breathing techniques seem to have some potential benefits and should be tested rigorously in the future.[11]

Bronchial asthma is a multifactorial disease in which environmental, infectious, allergic, and psychological elements all play a part.[18] Some evidence has suggested that emotional stress can either precipitate or exacerbate both acute and chronic asthma.[19] Whatever precipitates an asthmatic attack, anxiety is likely to accompany it.

Relaxation therapies help patients with asthma to deal with symptoms associated with anxiety and stress.[20] Data from some studies have suggested that muscular relaxation may provide some improvement in lung function.[20] Some studies also have demonstrated that yoga practice can have an impact on stress management. Two studies have reported that yoga may improve cardiorespiratory parameters in children as a secondary effect of decreased anxiety.

Clance et al[21] analyzed the effects of yoga on body satisfaction. Results suggested that yoga may reduce stress and anxiety related to low body satisfaction or poor self-image in children. Furthermore, the breathing techniques used in yoga foster decreased anxiety.[22] One study aimed to compare the effects of yoga and games on the same physiologic measurements. This study found that yoga practice may reduce levels of fear and anxiety more than physical activity alone.[23,24]

Mast cells also may be activated by emotional stress and can induce asthma exacerbations.[25,26] Yoga might play a vital role in reducing mast-cell activation levels by improving the emotional function of asthmatics, thereby reducing the inflammatory condition. Another plausible explanation for the role of yoga in reducing mast-cell degranulation could be based on the frictional stress from air flowing through narrowed airways, damaging the airway mucosa, and thereby perpetuating airway inflammation and airway obstruction. At high airflow rates, high values of frictional stress could damage the airway's wall, especially during episodes of cough and particularly with mucosa that is as inflamed and friable as it is in asthmatic individuals.[27] The slow and gentle breathing in yoga may reverse the process by reducing frictional stress and, thereby, stabilize mast-cell degranulation.[28] The yoga group in the current study showed a significant trend that suggested a decrease in EIB. Yoga improves quality of life, reduces rescue medication use in bronchial asthma, and achieves that reduction earlier than conventional treatment alone. The current trial supports the use of yoga in the management of bronchial asthma.[29]

The limitation of this study included the lack of a control group.

CONCLUSION

The research team proposes that practice of yoga has beneficial effects on EIB. When used in conjunction with medication, yoga training can be considered useful in achieving better control of asthma.

AUTHOR DISCLOSURE STATEMENT

The authors have no conflicts of interest to disclose.

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