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Yoga Training Improves Quality of Life in Women with Asthma

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Abstract

Objectives: Individuals with asthma frequently suffer with a decrease in quality of life. Yoga has been shown to improve autonomic function in the healthy population and has been used as an alternative therapy to help improve symptoms associated with various diseases.

Purpose: The purpose of this study was to assess whether 10 weeks of yoga training can improve quality of life and heart rate variability (HRV) in patients with asthma.

Design: Nineteen (19) females were randomly assigned to a yoga group or a control group for a 10-week intervention while still following guidelines established by their physician. All subjects answered the St. George's Respiratory Questionnaire (SGRQ) to assess quality of life and performed an isometric handgrip exercise test to assess HRV.

Results: Based on the SGRQ, significant improvements (45%, $p<0.05$) in quality of life were observed with the yoga training, while no changes were found in the control group. Resting hemodynamic measures improved significantly in the yoga group compared to the control group ($p<0.05$). The yoga group decreased parasympathetic modulation (HFnu [normalized units]) pre- to postintervention (0.45 ± 0.60 to 0.35 ± 0.06 nu, $p<0.05$, respectively) in response to the isometric forearm exercise (IFE), whereas the control group did not change. Additionally, the yoga group increased sympathetic (LFnu) (pre 0.47 ± 0.07 to post 0.60 ± 0.07 nu, $p<0.05$) and sympathovagal modulation (logLF/HF) (pre 4.61 ± 0.39 to post 5.31 ± 0.44, $p<0.05$, respectively) during IFE with no change in the control group.

Conclusions: Yoga training improved quality of life in women with mild-to-moderate asthma and resulted in decreased parasympathetic and increased sympathetic modulation in response to an IFE.

Introduction

Asthma is a chronic inflammatory disorder of the airways associated with widespread but variable airflow obstruction and an increase in airway response to a variety of stimuli.[1] Asthma affects ~8%–10% of the U.S. population and is the leading cause of hospitalization among young children[2]; it impacts the productivity and quality of life in adults and children.[3] This disease has been attributed to certain aspects of Western culture including outdoor and indoor air pollution, childhood immunizations, and cleaner living conditions.[2] To minimize the number of asthma attacks, these individuals must avoid contact with environmental "triggers" and take pharmacological interventions to keep their airways open.[4] Current therapies include anti-inflammatory drugs and bronchodilators, but unfortunately these therapies are often associated with many side-effects.[5] Thus, a possible role for alternative therapies aimed at controlling the asthmatic condition and improving quality of life has emerged.

Yoga, an ancient discipline from India, is considered a mind–body exercise in which both physical and mental disciplines are brought together to achieve peacefulness of mind and body, resulting in a more relaxed state to better manage stress and anxiety.[6] Since asthmatic conditions are often exacerbated when the individual goes into a state of panic as symptoms arise,[7] it seems that yoga training may be a viable option for management of asthmatic symptoms. Yoga has previously been investigated as a clinical treatment for a range of medical conditions including asthma[8]; however, many of these studies have not been well controlled.[8]

Recently, a randomized controlled clinical trial demonstrated both objective and subjective improvements in patients

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with bronchial asthma, using a comprehensive lifestyle modification program based on yoga.[8] While this program achieved significant clinical improvements, the time-intensive nature of the program (4 hours/day for the first 2 weeks) may render it unrealistic for many individuals. Additionally, this treatment included not only breathing techniques and postures, but also education, meditation, and dietary practices.[8] Thus, gaining an understanding of the benefits of the yoga-only portion of these programs is warranted.

The purpose of this study was to assess whether a 10-week yoga training program (3 times/week) can help reduce anxiety associated with asthma symptoms, thus improving quality of life. It was hypothesized that yoga training can improve quality of life in asthmatics as assessed through the St. George's Respiratory Questionnaire (SGRQ). This assessment is used to determine whether medical treatments and lifestyle interventions are effective in improving function and adaptation to the disease.[9]

Furthermore, individuals with asthma tend to have higher basal parasympathetic tone, culminating in cholinergic hyperactivity of the airways.[10] The parasympathetic (cholinergic) component of the autonomic nervous system (ANS) is the dominant neural pathway in the control of airway smooth-muscle tone and secretion in human airways.[10] The cholinergic component of the ANS has a role in reflex bronchoconstriction and alteration of the sensitivity of the muscarinic receptors leading to airway hyperresponsiveness to cold air, rapid breathing, sulphur dioxide, citric acid, and histamines.[10] Patients with bronchial asthma show an increased parasympathetic tone with a subsequent decrease in sympathetic tone, and such increases may predispose a patient to acute episodes of asthmatic attacks.[11] Additionally, individuals with asthma also have poor functioning of the β-adrenergic receptors.[12] These receptors are responsible for bronchodilation of the smooth-muscle tissue, but have reduced respiratory function in patients with asthma, leading to impaired relaxation of the airway smooth-muscle tissue, resulting in increased cholinergic tone.[12]

Heart rate variability (HRV) can be used as a measure of cardiac autonomic function since the high frequency (HF) component is associated with heart rate (HR) modulation caused by the respiratory influence.[13] Modulation of the pattern of rhythmic variation of the HR is linked to respiratory frequency, and thus is mediated by the vagus nerve.[13] Isometric exercise is a convenient, easy method of activating the ANS as it evokes a large increase in mean arterial pressure and HR.[14] Thus, a secondary purpose of this study was to determine whether yoga training modifies autonomic function as assessed via an isometric forearm exercise (IFE). It was hypothesized that yoga training for 10 weeks will improve parasympathetic modulation in response to an IFE, thus attenuating the vagal hyperactivity.

Materials and Methods

Study subjects

Nineteen (19) female subjects, 20–65 years old, with clinical and functional evidence of mild-to-moderate asthma as assessed by their physician, volunteered for the study. Subjects were recruited from flyers at various physicians' offices as well as campus news. All participants signed an informed consent approved by the Syracuse University Institutional Review Board. Inclusion criteria were as follows: a forced expiratory volume in 1 second/forced vital capacity (FEV_1/FVC) ratio of $<80\%$ of predicted, use of a bronchodilator at least once daily, and symptoms of wheezing and/or coughing for a minimum of 2 years that improves either spontaneously or with drug therapy. Subjects were excluded if they were smokers (smoking ≥ 2 cigarettes/day), participated in yoga therapy in the previous 12 months, were diagnosed as having hypertension, major orthopedic injuries prohibiting the performance of various yoga postures, and/or currently taking any medications that would alter autonomic function (e.g., β-blockers).

Study design

Subjects visited the Human Performance Laboratory on two separate occasions. During the initial visit, the subjects completed the informed consent, physical activity questionnaire, and the SGRQ. This questionnaire was used to assess quality of life in patients suffering from asthma.[15] Subjects had anthropometric measurements, pulmonary measurements, and HRV assessment performed pre- and post-intervention. After pretesting, subjects were randomly assigned to either a yoga training group or a control group for a 10-week intervention period. Following the intervention, subjects returned to the laboratory to complete the same testing as was performed during the initial visit.

Yoga training group. Within a week of the pretesting visit, the yoga training was initiated, which consisted of two 1-hour supervised yoga sessions/week for 10 weeks. The classes were conducted by a certified yoga instructor (YogaFit®) trained in relaxation and yoga poses. Each class consisted of 10 minutes of relaxation/deep breathing in which subjects were taught to use the three-part breathing techniques consisting of deep inhalation and exhalation and focused on the sequential recruitment of the abdomen and lower and upper areas of the chest to ensure utilization of the full lung capacity. Forty (40) minutes of various *asanas* (postures) were then performed in which subjects held the poses for 10–40 seconds while deep breathing, and finished with 10 minutes of meditation to control stress levels. The yoga *asanas* included forward and backward bends, isometric lunges, balance poses, and static stretching, all part of a traditional Hatha yoga practice.[16] Additionally, the participants were required to perform one 30-minute session/week at home, which was based on a written lesson plan (5 minutes of deep breathing, 20 minutes of *asanas*, and 5 minutes of meditation and relaxation). Weekly discussions regarding the at-home practice was conducted to ensure compliance. Subjects were required to participate in 20 1-hour yoga sessions in a group setting (2/wk for 10 weeks) and 10 30-minute sessions (1 time/wk for 10 weeks) in which there was a 98% compliance rate for subjects attending and participating in the in-class yoga sessions and 100% compliance for the home sessions as reported by a brief questionnaire given on a weekly basis.

Control group. Control group participants were instructed not to participate in any yoga or related breathing practices for the duration of the study. In addition, they were instructed not to begin any new activities, but simply to follow the guidelines provided by their physicians. At the end of the 10-week period, control group participants were questioned about adherence to these instructions; all stated that they had been compliant.

Methods

On the testing days (pre and postintervention), the subject came to the laboratory 4 hours postprandially and abstained from caffeine ingestion 12 hours prior to testing. They completed a physical activity questionnaire and the SGRQ. Height and weight were measured. Percent body fat was determined using air displacement plethysmography (Bod Pod, Life Measurements, Inc., Concord, CA). Following these measurements, pulmonary function tests were performed, which included spirometry measurements of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), and peak expiratory flow rate (PEFR). These tests were performed on the Cosmed Quark b Metabolic Cart (Cosmed USA, Chicago, IL).

Isometric forearm exercise. Isometric forearm exercise was used to assess autonomic function and was assessed using a hand dynamometer (Biopac Systems, Inc., Goleta, CA) by performing three maximum voluntary contractions (MVC). The average of three trials was defined as the maximum isometric force, and 30% MVC was calculated. Following 10 minutes of quiet rest, IFE was conducted at 30% MVC for 3 minutes following 3 minutes of quiet recovery.[17] Isometric force was recorded during rest, IFE, and recovery at a frequency of 1000 Hz using a 16-bit data acquisition card (MP100, Biopac Systems, Inc. Santa Barbara, CA).

Beat-to-beat hemodynamic measurements. Beat-to-beat blood pressure (BP) and HR measurements were also recorded during the IFE task (Finometer, TNO, Netherlands). A continuous electrocardiogram (ECG) was recorded using a modified CM5 ECG lead, interfaced with data collection and interpretation software (Biopac Systems Inc., CA) at a sampling rate of 1000 Hz. The ECG tracings were used to assess HRV.[17]

Analysis

St. George's Respiratory Quality of Life Questionnaire analysis

Part 1 of the questionnaire represents "patients' recollection" of their symptoms over the preceding month. Part 2 addresses the patient's current state. These scores were used to define quality of life in three categories: *Symptoms* (effect of respiratory symptoms, their frequency and severity), *Activity* (activities that cause or are limited by breathlessness), and *Impacts* (social functioning and psychologic disturbances resulting from airway disease).[15] A total score was calculated, giving an indication of the impact the disease has on the patient's overall health status. Scores were expressed as a percentage of overall impairment, with a score of 100 indicating the worst health status, whereas 0 represents the best health status.[15]

Heart rate variability. The WinCPRS computer software package (Absolute Aliens Oy, Turku, Finland) was employed to generate R-R time event series from the ECG tracings. HRV was evaluated in the time and frequency domain.[18] The power spectral densities of the R-R interval variability spectrum were calculated in the frequency domain with the low-frequency (LF) (both sympathetic and parasympathetic activity: 0.04–0.15 Hz) and high-frequency (HF) (parasympathetic mediation and respiration; 0.15–0.40 Hz) components and reported in normalized units. The logLF/HF ratio was also calculated. LF and HF powers were calculated using an autoregression model.[18]

Statistical analysis

A 2×2×2 mixed-model analysis of variance (ANOVA) (group×task×time) with repeated measures was conducted for HRV, BP, and HR variables. A *post hoc* analysis using the Tukey test was used if any significant interactions occurred. A two-way ANOVA with repeated measures (time: pre/post×group) was used to assess scores for the SGRQ and spirometry measurements. Differences in descriptive characteristics between groups were examined using an independent *t*-test (age, weight, height, % body fat, resting blood pressure, and HR). All data were analyzed using SPSS software, version 17.0 (Chicago, IL) and are expressed as mean ± standard error. The significance level of all analyses was set at $p < 0.05$.

Results

Descriptive statistics

The two groups were well matched, with no significant differences between groups for age, height, weight, percent body fat, BP, resting HR, and mean arterial pressure (MAP), SGRQ, and pulmonary function tests ($p < 0.05$, Table 1). The subjects tended to be overweight (BMI > 25 kg/m^2), but there were no group differences in BMI (yoga group: 27.3 ± 1.7 kg/m^2 and control: 30.2 ± 0.9 kg/m^2; $p > 0.05$).

St. George's Respiratory Quality of Life Questionnaire

At baseline (pre-intervention), there were no differences in SGRQ scores between groups (Table 1); however, after the

Table 1. Subject Characteristics at Baseline

	Yoga group (n = *12*)	*Control group* (n = *8*)
Age (years)	43 ± 4	40 ± 4
Height (cm)	163 ± 4	164 ± 3
Weight (kg)	72 ± 2	81 ± 2
Body fat (%)	38 ± 4	39 ± 2
Body mass index (kg/m^2)	27.3 ± 2	30.2 ± 0.9
Systolic blood pressure (mm Hg)	126 ± 2	126 ± 5
Diastolic blood pressure (mm Hg)	70 ± 1	68 ± 2
Heart rate (bpm)	71 ± 3	71 ± 2
Mean arterial pressure (mm Hg)	89 ± 5	87 ± 7
St. George's Respiratory Questionnaire (a.u.)	29.5 ± 5	27 ± 2
Forced vital capacity (FVC)	2.47 ± .3	2.48 ± 0.3
Forced expiratory volume $_{1.0\ sec}$ ($FEV_{1.0}$)	1.88 ± .8	1.84 ± 0.9
FEV_1/FVC (%)	75 ± 3.2	74 ± 3.1

Values are mean ± standard error; $p < 0.05$.
bpm, beats per minute; a.u., arbitrary units.

intervention, the yoga group (16.01 ± 3.0) demonstrated a decreased score (45% improvement) compared to the control group (31.85 ± 5.0; $F = 7.996$; $p < 0.05$, Fig. 1A). The mean change in the three aspects of the questionnaire (symptoms, activity, and impact) significantly improved (a lower score is better) in the yoga group as compared to the control group, who showed no improvement ($p < 0.05$, Fig. 1B).

Heart rate variability response

Before and after the intervention, there were no differences in resting HFnu, LFnu, and logLF/HF between groups. In response to the IFE task, however, there was a significant decrease in the HFnu response following the yoga training compared to the control group ($F = 3.693$; $p < 0.05$, Fig. 2A). There was also a significant increase in the LFnu ($F = 5.123$; $p < 0.05$; Fig. 2B) and logLF/HF ($F = 3.293$; $p < 0.05$; Fig. 2C) response to IFE after the yoga intervention, whereas there were no changes in the control group. There were no significant group differences seen for total power at any point (data not shown).

Hemodynamic response

There were no baseline group differences for systolic blood pressure (SBP), diastolic blood pressure (DBP), or mean arterial pressure (MAP). There was a significant main effect on resting SBP, with both groups demonstrating a significantly decreased SBP postintervention; however, no differences were seen between groups ($F = 12.29$; $p < 0.05$; Fig. 3A). There was a significant decrease in resting DBP (Fig. 3B) and MAP

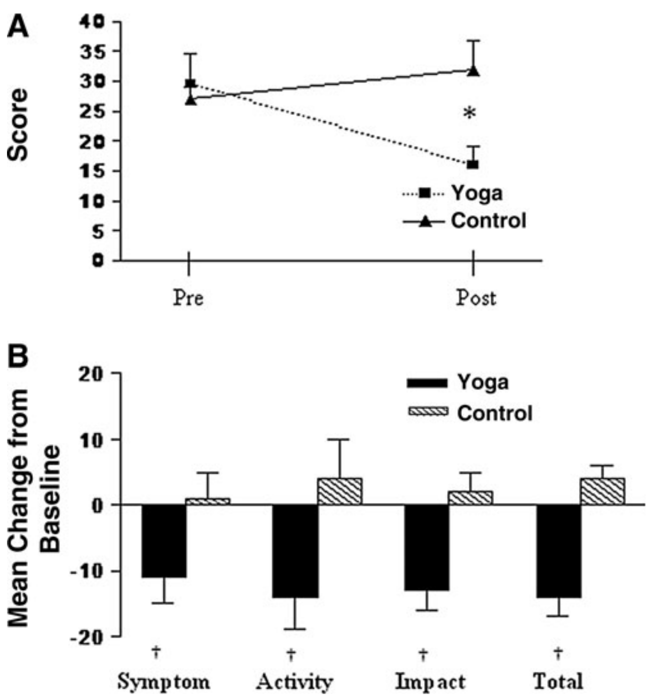

FIG. 1. **A.** Differences in the St. George's Respiratory Questionnaire pre- to post-yoga training. *($p < 0.05$) group by time interaction. **B.** Mean change from pre-intervention in each category for the St. George's Respiratory Questionnaire scores. †($p < 0.05$) yoga versus control group. Data are expressed as mean ± standard error.

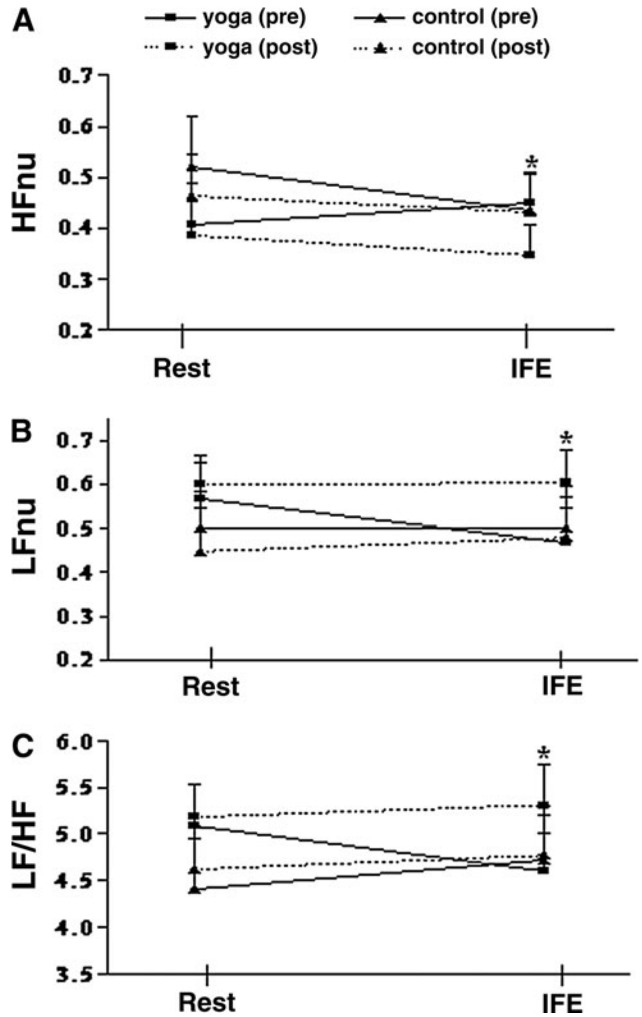

FIG. 2. Change in heart rate variability pre- to post-intervention for **(A)** parasympathetic modulation (HFnu), **(B)** sympathetic modulation (LFnu), and **(C)** sympathovagal modulation (LF/HF) between groups at rest and during a 3-minute isometric forearm exercise. *($p < 0.05$) yoga versus control group due to the intervention. Data are expressed as mean ± standard error.

($F = 7.20$; $p < 0.05$; Fig. 3C) from pre to postintervention in the yoga group compared to the control group. No changes in HR were evident in either group pre to post training. There were no significant changes in BP, HR, and MAP in response to the IFE pre- or postintervention (Table 2).

Spirometry response

Tidal volume was similar between the yoga and control groups prior to the intervention, and tidal volume increased significantly in the yoga group only after the 10-week intervention ($F = 5.485$; $p < 0.05$; Fig. 4). There were no differences in FEV_1, FVC, or PEFR in either group prior to the intervention, and no changes were demonstrated after the intervention.

Discussion

A key outcome for physicians treating patients with asthma is to achieve and maintain control over asthmatic

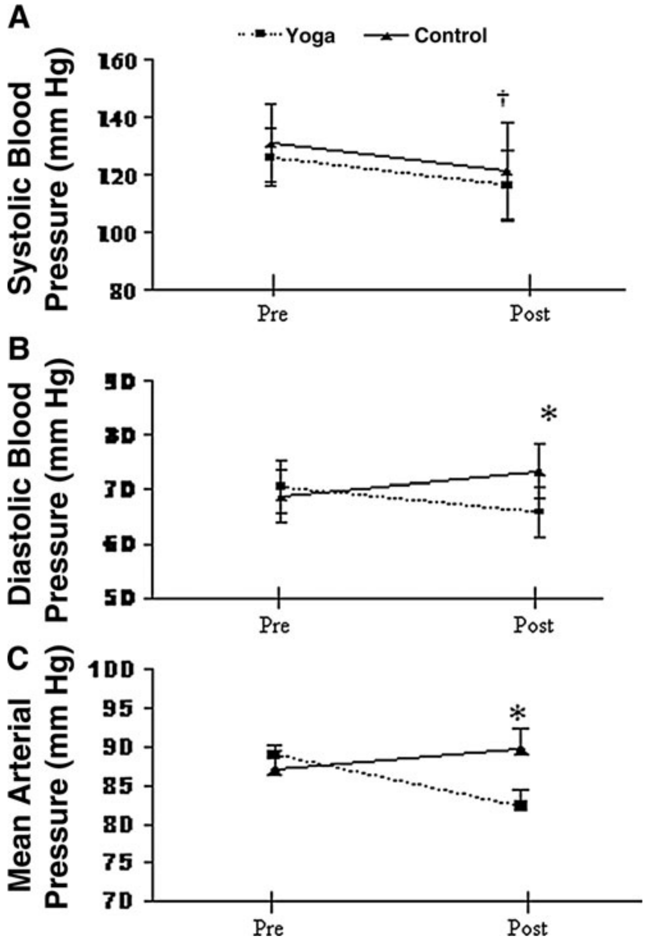

FIG. 3. Changes in resting systolic **(A)**, diastolic **(B)**, and mean arterial **(C)** pressure pre- and postintervention. †($p<0.05$) main effect of intervention. *($p<.05$). Data are expressed as mean ± standard error.

symptoms, which is expected to improve the patients' quality of life. This is usually attained through the use of various medications such as inhaled corticosteroids and β-agonists.[19] Recent studies have indicated that these therapies are frequently suboptimal at achieving long-term relief, and many of these drug therapies result in numerous side-effects.[20] The present study examined the effects of a yoga training program involving breathing practices, *asanas*, and meditation/relaxation elements on quality of life in patients with asthma. The present findings provide evidence that following a 10-week yoga intervention of three sessions/week resulted in a 45% improvement (13 units) in quality of life, and a secondary finding of a reduction in parasympathetic activity in response to an IFE stressor.

The St. George's questionnaire has been validated as a reliable tool to assess daily quality of life in patients with asthma.[21] A score of 6 units is indicative of an average, healthy adult, with a higher score representing a decrease in respiratory quality of life.[21] At the onset of the intervention in the current study, the yoga and control groups had a score of 29 units and 27 units, respectively. After the intervention, the yoga group decreased their score by 13 units while the control group increased their score by 4 units, although the control group was still under physician supervision. This reflects a 45% improvement in the quality of life questionnaire for the yoga group. Jones et al.[22] have suggested that a change of 4 units in the SGRQ score is indicative of clinical significance; thus, the yoga program implemented as part of this study has significant clinical ramifications. These improvements in quality of life with yoga training were greater than previously reported in studies using drug therapy[23] or other types of alternative medicine.[24] A study examining the effect of the inhaled anti-inflammatory agent Nedocromil demonstrated an 8-unit improvement in patients' SGRQ score.[23] Likewise, a study examining the effects of acupuncture and acupressure on quality of life in patients with chronic obstructive asthma showed an 18.5% and 6.5% improvement, respectively, in quality of life for these treatments.[24] Potentially, the discrepancies in the degree of change in the quality of life scores between these studies may be due to differences in the severity of asthma between the study groups, but the present study clearly indicates that yoga training improves quality of life in those with mild-to-moderate asthma.

While there was no significant difference in the resting parasympathetic modulation between study groups in the present study, yoga training decreased parasympathetic stimulation in response to IFE. Typically, patients with asthma have a blunted response to the IFE and do not demonstrate a decrease in parasympathetic modulation due to the increased hyperactivity of the vagal nerve.[25] In the present study, in response to the IFE task, there was a 29% decrease in parasympathetic modulation in the yoga group with no changes occurring in the control group. Telles et al.[26] demonstrated that one acute bout of yoga breathing resulted in a reduction in resting parasympathetic modulation, as evidenced by decreased high-frequency HRV changes in healthy males.[26] However, Telles et al. only performed specific yoga breathing and did not assess changes after a

Table 2. Hemodynamic Values Between the Yoga and Control Group Pre and Post Training

	Yoga group (n = *12*)		*Control group* (n = *8*)	
	Pre	*Post*	*Pre*	*Post*
Systolic blood pressure (mm Hg)	126.5 ± 10	128.9 ± 4	135.0 ± 13	127.2 ± 5
Diastolic blood pressure (mm Hg)	75.0 ± 4	72.3 ± 3	81.6 ± 4	75.5 ± 3
Heart rate (bpm)	77.8 ± 2	81.0 ± 3	76.2 ± 3	81.6 ± 4
Mean arterial pressure (mm Hg)	94.2 ± 5	90.9 ± 2.8	102.5 ± 6	92.5 ± 3.4

Values are mean ± standard deviation; $p<0.05$.
bmp, beats per minute.

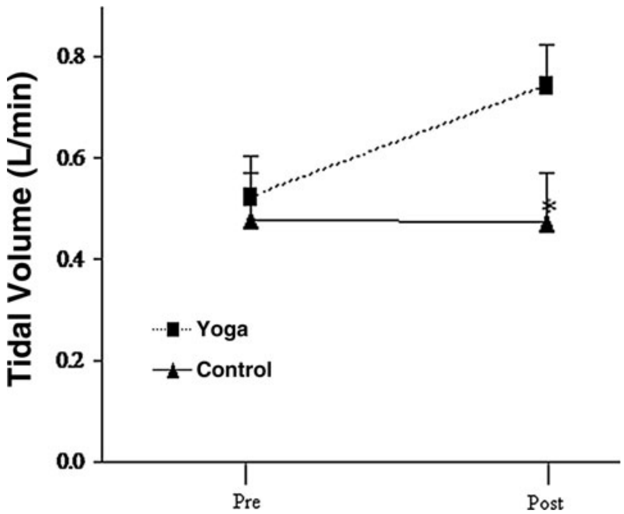

FIG. 4. Change in tidal volume in response to the yoga training in both groups. *($p < 0.05$) group by intervention interaction. Data are expressed as mean ± standard error.

session of yoga involving *asanas* along with breathing techniques.[26] Further research needs to be conducted on parasympathetic modulation to a variety of stimuli in this population.

Parasympathetic hyperactivity is not the only factor involved in the pathogenesis of asthma. Recent research has also indicated that the sympathetic portion of the ANS in those with asthma is altered due to underfunctioning of the β_2-adrenoreceptors.[27] These receptors mediate relaxation of the bronchioles and are widely distributed in the smooth muscle tissue of the bronchioles.[28] This defect will lead to impaired relaxation of the airway and subsequently could increase cholinergic tone and mediate a release of mast cells.[29] In the present study, an increase was observed in both the LF and logLF/HF component of HRV in response to the IFE in the yoga group. These components are representative of both parasympathetic and sympathetic nervous system involvement and may illustrate improvements in sympathovagal modulation through alterations in the β_2-adrenoreceptors and possible improvements in β_2-adrenoreceptor function.[29]

Although pulmonary function is usually compromised in patients with asthma, there are conflicting reports as to whether yoga enhances pulmonary function in healthy or asthmatic individuals.[8] These discrepancies are most likely due to the number and duration of yoga sessions performed in the various studies. Research has indicated that a lack of improvements in pulmonary function may be a result of structural damage of the lung in asthmatic individuals due to long-standing asthma preventing functional ventilatory improvements.[30] This may have been the case in the present study, because no changes in FVC of FEV_1 were apparent. Yoga training in the present study, which included breathing techniques, resulted in a 30% increase in tidal volume. This increase may be because these breathing techniques developed the subjects' lung capacity, allowing the subject to utilize more of their lung capacity and thus deepen each breath, resulting in increased tidal volume.[31]

Conclusions

In conclusion, this study provided preliminary evidence that 10 weeks of yoga training, involving breathing practices, *asanas*, and meditation/relaxation elements, improves the quality of life in asthmatic individuals and these changes may be associated with improvements in autonomic modulation. Mechanisms behind such improvements to the ANS need to be studied further. Additionally, the improvements in tidal volume may allow the person with asthma to better cope with an attack by utilizing their full lung capacity.

Disclosure Statement

No competing financial interests exist.

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