A quasi-experimental study of the effects of yogic practices on pulmonary functions and exercise-induced bronchial lability in children with controlled asthma

Rajani Bala Jasrotia[1], Sunita Mondal[2], Asha Gandhi[2], Virendra Kumar[3]

[1]Department of Physiology, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India, [2]Department of Physiology, Lady Hardinge Medical College and Associated Hospitals, New Delhi, India, [3]Department of Paediatrics, Lady Hardinge Medical College, Kalawati Saran Children's Hospital, New Delhi, India

Correspondence to: Rajani Bala Jasrotia, E-mail: dr.rajani.jasrotia@gmail.com

Received: August 26, 2019; **Accepted:** September 28, 2019

ABSTRACT

Background: It has been observed that regular practice of yogic postures (asana) and breathing exercises (pranayama) improves the airway dynamics of healthy persons. This can be helpful for reducing exercise-induced bronchial lability, and thus yoga and pranayama could be used as an effective management strategy for asthma. **Objectives:** The objective was to study the effect of 12 weeks of regular yogic practices on pulmonary functions and exercise-induced bronchial lability in asthmatic and healthy children. **Materials and Methods:** Thirty asthmatic children attending pediatrics outpatient department were enrolled as cases (Group I) and thirty apparently healthy children who were having no any family history of asthma were enrolled as controls (Group II). Both the groups were further divided into four subgroups namely Ia, Ib, IIa, and IIb (Groups Ia and IIa – not practicing yoga and Groups Ib and IIb – practicing yoga). The yoga groups (Ib and IIb) performed yoga regularly for 45 min daily for 12 weeks under the guidance of a yoga expert. Spirometry (lung volume and capacities as well as flow rates) along with exercise-induced bronchial lability testing was done at baseline and at 12 weeks in all participants. The responses to exercise were quantitated as the percentage rise and fall in the peak expiratory flow rate (PEFR) during and after exercise and Exercise Lability Index (ELI). **Results:** Group Ib (asthmatics, practicing yoga) had significant increases in vital capacity (VC), forced VC (FVC), forced expiratory volume in 1 s (FEV1%), and PEFR and a decrease in percentage fall in PEFR and ELI at 12 weeks. Group IIb (healthy, practicing yoga) had highly significant increases in VC, FVC, and FEV1 and a significant increase in PEFR and a decrease in ELI at 12 weeks. **Conclusions:** By improving pulmonary functions and reducing exercise-induced bronchial lability, yoga helps asthmatics as well as healthy children to cope better with vigorous physical activities.

KEY WORDS: Asthma; Bronchial Lability; Yoga; Exercise; Spirometry

INTRODUCTION

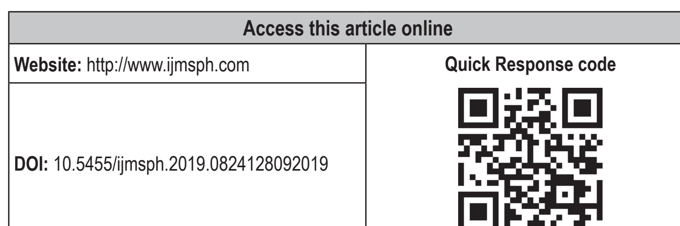
Bronchial asthma is characterized by airway hyper-responsiveness to a large variety of stimuli, including pollen grains, air pollutants, dust particles, cold air, and physical activities.[1] In India, the prevalence rate of bronchial asthma is very high in school-going children.[2] The prevalence of asthma has increased by almost two folds in the last two decades.[3] In studies done in different geographical regions of India, the prevalence of asthma in children was in the range of 6.5–10.3%.[4-7]

Access this article online

Website: http://www.ijmsph.com

DOI: 10.5455/ijmsph.2019.0824128092019

Quick Response code



Physical exertion as a trigger agent for bronchial asthma is being studied nowadays in much detail because of increased involvement of sports and games in the curriculum of schools and colleges as well as increasing popularity of sports and games

International Journal of Medical Science and Public Health Online 2019. © 2019 Rajani Bala Jasrotia, *et al*. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

at all levels.[8] The term exercise-induced asthma (EIA) stands for reversible obstruction of the airway particularly triggered by higher level of physical activity. EIA is a problem in all age groups, but is most frequently observed in children and young adults because of their enthusiasm for vigorous activities. This condition is characterized by symptoms of coughing, wheezing, shortness of breath, and chest tightness during or after exercise, and is associated with airway obstruction after exercise, as noted by a drop in forced expiratory volume in 1 s (FEV1) or other parameters of pulmonary function test. Bronchial lability is an inherited characteristic which must combine with a triggering mechanism to result in clinical asthma.[9-11] Exercise-induced bronchial lability is often considered an important disability for children suffering from asthma. On the other hand, exercise has been used as a stimulus to test bronchial lability because it can be generated in a controlled and reasonably repeatable reaction which mimics clinical asthma in a number of aspects.[12]

Till date, various studies have demonstrated the role of yoga in bronchial asthma in adults. They demonstrated that regular practice of yoga leads to significant improvement in pulmonary functions.[13-16] So far, research studies on the effects of yoga on children with bronchial asthma are very few. The present study is an attempt to assess the pulmonary functions and exercise-induced bronchial lability in asthmatic children and to explore the possibilities of yoga in the management of bronchial asthma in children. The understanding of the significance and usage of regular yogic practices is important in asthmatic children, as they are more prone to suffer from the deleterious effects of EIA. The objective of this study was to analyze the effect of 3 months of regular yogic practices on pulmonary functions and exercise-induced bronchial lability in asthmatic and non-asthmatic children.

MATERIALS AND METHODS

The study was conducted in the Department of Physiology and Pediatrics of Lady Hardinge Medical College and Associated Hospitals, New Delhi. The study design was quasi-experimental.

Ethical permission to conduct the research was granted by the institutional committee.

Thirty asthmatic children, attending the pediatrics outpatient department regularly for the management of asthma, were selected as the study group. They were all between the age group of 10 and 14 years. Informed written consent was obtained from the parents of the children before their enrollment as study participants. They were further divided into two subgroups based on their willingness to perform yogic practices for 45 min every day for 12 weeks, as follows: Group Ia (n = 15) and Group Ib (n = 15). The children belonging to Group Ib were assigned for practicing yoga as an additional intervention to the ongoing treatment protocol being followed in the hospital, whereas the children belonging to Group Ia were not assigned any additional intervention in the ongoing treatment protocol being followed in the hospital [as seen in Figure 1].

The diagnosis and grading of the severity of asthma were done as per the Global Initiative for Asthma guidelines. Children with tuberculosis, immunodeficiency, recurrent infection, cystic fibrosis, allergic rhinitis, and eczema were excluded from the study. A thorough physical examination and clinical history was undertaken in all the study participants to exclude any chronic cardiopulmonary disease, thoracic cage abnormality, or neuromuscular disorder.

Another thirty apparently healthy children from a nearby school, having no family history of bronchial asthma or any allergic conditions, were selected as the control group. Again, they were all between the age group of 10 and 14 years. Informed written consent was also obtained from their parents before their enrollment as study participants. They were further divided into two subgroups based on their willingness to perform yogic practices for 45 min every day for 12 weeks, as follows: Group IIa (n = 15) and Group IIb (n = 15). The children belonging to Group IIb were assigned for practicing yoga, whereas the children belonging to Group IIa were not assigned any intervention [as seen in Figure 1].

All the children selected for yogic interventions in the respective groups (Groups Ib and IIb) regularly performed the following yogic practices for 45 min daily for 12 weeks under the supervision of a yogic expert with approximate time given as follows: Sukshma Vyayama (for 5 min), Sthula Vyayama (for 3 min), Asanas (for 22 min), Pranayama (for 10 min), and Dharna and Dhyana (for 5 min).

A predesigned pro forma was used to record the clinical and investigative details. The anthropometry (height, weight, and body mass index) and pulmonary function test (or spirometry) details were recorded in all the four subgroups of children. Spirometry was performed by a spirometer (DATOSPIR 110/120 developed by SIBELMED, Barcelona), and the following parameters were recorded: Vital capacity (VC), forced VC (FVC), FEV (as in % of FVC) in 1 s (FEV1%), maximum mid expiratory flow rate (MEFR), peak expiratory flow rate (PEFR).

For the assessment of exercise-induced bronchial lability, all the children were asked to perform the cycling exercise for 6 min with the help of Jaeger's Bicycle Ergometer. During cycling, the children were asked to seat comfortably by adjusting the height of the bicycle and it was made sure that they were placing their foot properly on pedals. Constant load exercise tests were performed. The work rate was increased to 75–80% of the maximal work capacity and maintained (the maximum work capacity was defined as the greatest work

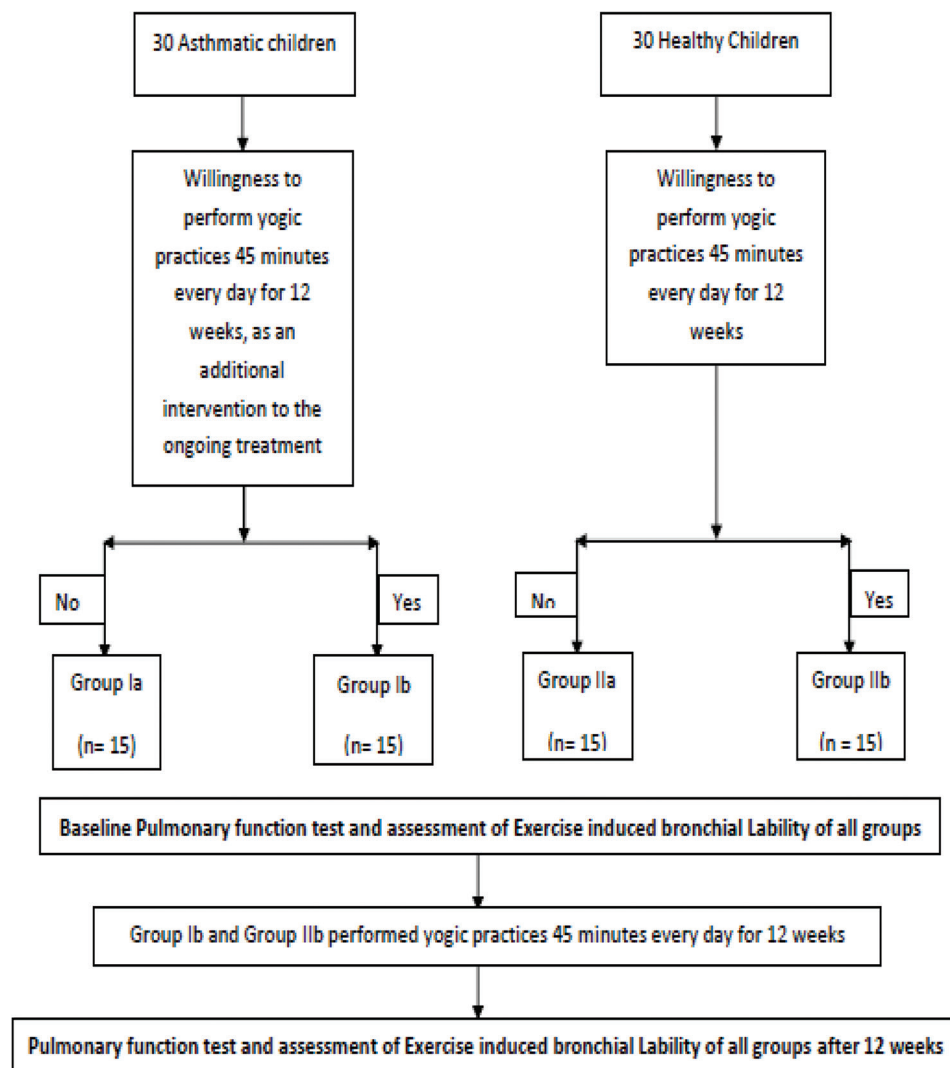


Figure 1: Flowchart depicting the research methodology

rate that the child was able to maintain for >30 s, and it varied between 25 and 50 W). The child pedaled at a frequency of 50–70/min. Thus, a steady-state exercise was achieved, and the target heart rate was 160–170/min so as to achieve moderate exercise[17] or till clinically unsafe.

Spirometry was performed at 2, 4, and 6 min in between the exercise, and it was also repeated every 5 min till 30 min after the completion of exercise.

The indices of exercise-induced bronchial lability were calculated using the following calculations: %rise in PEFR = (highest PEFR during exercise – initial PEFR)/initial PEFR × 100; %fall in PEFR = (initial PEFR – lowest PEFR)/initial PEFR × 100; and Exercise Lability Index (ELI) = highest peak expiratory flow during exercise – lowest peak expiratory flow after exercise/initial peak expiratory flow × 100.

All children were evaluated twice, first at the beginning (i.e., baseline) of the study and at the follow-up evaluation for the analysis at 12 weeks.

Statistical analysis was done using Microsoft Office Excel and IBM SPSS Statistics Software version: 25.0; United States. The mean and standard deviation of each parameter were calculated. The analysis of variance (ANOVA) followed by *post-hoc* tests was used to compare the means of various parameters among all the four groups. For comparing the baseline and 12 weeks' intervention, paired *t*-test was used. $P < 0.5$ was considered statistically significant.

RESULTS

Table 1 shows the baseline anthropometric measurements of all the four subgroups. Table 2 indicates statistically significant differences in VC, FVC, FEV1%, and PEFR after 12 weeks of yogic practices in asthmatic children (Group Ib) and significant differences in VC, FVC, FEV, and PEFR in healthy children (Group IIb). When comparing all the four groups at baseline and after 12 weeks by ANOVA followed by *post-hoc* analysis, it was found that both groups of asthmatic

children (Group Ia and Ib) differ significantly from healthy children in pulmonary function test parameters.

Table 3 and Figure 2 indicate statistically significant differences in %fall in PEFR and ELI after 12 weeks of yogic practices in asthmatic children (Group Ib) and significant differences in %fall in PEFR in healthy children (Group IIb). When comparing all the four groups at baseline and after 12 weeks by ANOVA followed by *post-hoc* analysis, it was found that both groups of asthmatic children (Group Ia and Ib) differ significantly from healthy children in exercise lability indices as well as %rise and %fall in PEFR.

DISCUSSION

This study was conducted to analyze the effect of yogic practices on pulmonary functions and exercise-induced bronchial lability in asthmatic as well as in healthy children in the age group of 10–14 years. On spirometry, there was statistically significant increase in VC, FVC, FEV1, and PEFR in Group Ib (asthmatic children) and a statistically significant increase in VC, FVC, FEV1%, and PEFR in Group IIb (healthy children). Children of both these groups followed yogic practices for 12 weeks. On assessing bronchial lability

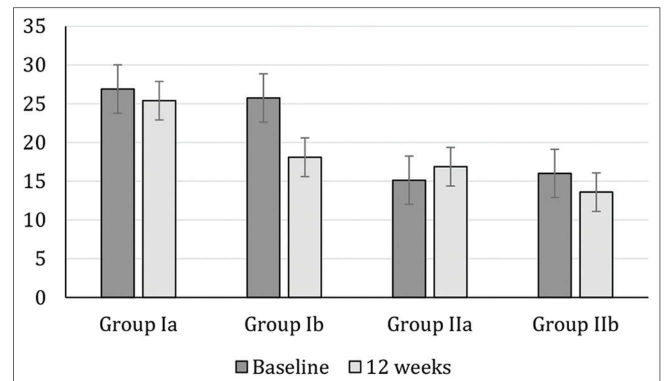


Figure 2: Exercise Lability Index of all the four subgroups at baseline and 12 weeks

Table 1: Baseline anthropometric measurements of all the four subgroups (means±standard deviation)

Parameter	Group Ia (*n*=15)	Group Ib (*n*=15)	Group IIa (*n*=15)	Group IIb (*n*=15)	Analysis of variance
Age (years)	11.73±1.28	12.17±1.55	11.67±2.23	12.53±0.92	NS
Height (cm)	141.93±11.83	144.93±14.67	146.13±10.63	147.53±8.12	NS
Weight (kg)	36.47±10.03	38.47±13.26	41.53±12.25	39.80±10.73	NS
Body mass index	19.07±1.14	20.14±2.32	20.31±1.69	19.76±1.84	NS

NS: No statistically significant difference

Table 2: Pulmonary function test (lung volumes and capacities and flow rates) of all the four subgroups at baseline and 12 weeks

Parameters	Group Ia (*n*=15)	Group Ib (*n*=15)	Group IIa (*n*=15)	Group IIb (*n*=15)	ANOVA (followed by *post-hoc* analysis)
Vital capacity (L)					
Baseline	1.98±0.52	2.04±0.79	2.22±0.48	2.27±0.38	Ib versus IIb
12 weeks	2.07±0.50	2.26±0.82*	2.29±0.36	2.53±0.36***	1b versus IIa; Ib versus IIb
Forced vital capacity (L)					
Baseline	1.75±0.51	2.01±0.78	2.17±0.39	2.13±0.37	Ib versus IIa; Ib versus IIb
12 weeks	1.88±0.54	2.34±0.72**	2.14±0.27	2.32±0.34***	Ia versus IIa; Ib versus IIa; Ib versus IIb
FEV1 (L)					
Baseline	1.59±0.33	1.69±0.60	1.98±0.43	1.82±0.36	Ia versus Ib
12 weeks	1.53±0.54	1.73±0.65	2.13±0.30	2.09±0.36***	Ia versus IIa; Ib versus IIa; Ib versus IIb
FEV1%					
Baseline	75.59±11.21	76.21±10.35	90.68±6.69	93.56±8.71	NS
12 weeks	78.05±13.42	81.46±9.97*	91.11±4.96	89.43±9.62	Ia versus IIa; Ib versus IIa; IIa versus IIb
PEFR (L/sec)					
Baseline	3.19±0.80	3.57±1.41	4.15±1.01	4.42±0.91	Ia versus Ib
12 weeks	3.37±0.92	4.09±1.25*	4.65±1.01	4.84±0.88**	NS
Maximal mid-expiratory flow rate (L/sec)					
Baseline	1.89±0.69	1.86±0.88	2.97±0.71	3.23±0.72	NS
12 weeks	1.91±0.93	1.93±0.72	3.25±0.68	3.15±0.87	NS

NS: No statistically significant difference in ANOVA. Baseline and 12 weeks intervention using paired t-test: *P<0.05, **P<0.01, ***P<0.001. ANOVA: Analysis of variance, FEV1: Forced expiratory volume in 1 s

Table 3: Changes in %rise in PEFR, %fall in PEFR, and ELI in children of all the four subgroups at baseline and 12 weeks

Parameters	Group Ia (*n*=15)	Group Ib (*n*=15)	Group IIa (*n*=15)	Group IIb (*n*=15)	ANOVA (followed by *post-hoc* analysis)
% rise in PEFR					
Baseline	7.04±7.9	5.48±3.7	6.39±4.72	5.85±3.82	Ia versus Ib; Ia versus IIb
12 weeks	8.4±6.9	6.14±4.4	7.39±4.78	4.08±3.47	Ia versus IIb
% fall in PEFR					
Baseline	13.19±9.2	18.57±12.92	8.74±4.84	10.16±3.76	Ia versus IIa; Ia IIb; Ib versus IIa; Ib versus IIb
12 weeks	17.2±10.6	10.71±7.8**	9.49±5.37	9.52±2.94	Ia versus IIa; Ia versus IIb; Ib versus IIb; IIa versus IIb
ELI (%)					
Baseline	26.90±7.70	25.75±11.9	15.13±5.45	16.01±3.10	Ia versus IIb; Ib versus IIa; Ib versus IIb; IIa versus IIb
12 weeks	25.4±10.4	18.1±6.9**	16.88±0.78	13.60±3.48*	Ia versus IIa; Ia versus IIb; Ib versus IIa; Ib versus IIb; IIa versus IIb

NS: No statistically significant difference in ANOVA. Baseline and 12 weeks intervention using paired *t*-test: *$P<0.05$, **$P<0.01$. ELI: Exercise Lability Index, PEFR: Peak expiratory flow rate

in response to physical exertion, significant decrease in ELI was observed in both Ib and IIb groups, again showing the positive effect of yogic practices on the broncho-pulmonary system. The healthy as well as asthmatic children who did not practice yoga (Group IIa and Group Ia, respectively) had not shown any improvement in pulmonary functions and bronchial lability indices.

The findings of this study are in accordance with a study by Jain *et al*. where they reported a decrease in ELI in asthmatic children after practice of yoga.[18] Singh *et al*. found that regular breathing exercise (akin to Pranayama) reduces the airway reactivity of histamine.[19] Deshpandae and Bhole found a significant fall in absolute eosinophil count (AEC) after 5 weeks of yoga therapy and suggested a possible fall in allergic sensitivity.[20] Gandhi *et al*. also reported a fall in AEC and immunoglobulin E levels in asthmatic young adults after regular practices of yoga.[21] Several studies had also reported similar increase in VC, FVC, FEV1, PEFR, and MEFR. The improvement in VC and FVC was due to increased development of respiratory musculature incidental to the regular practice of yogic exercise. In the present study, there was no significant improvement in MEFR in patient groups at 12 weeks of the study. This may be because in our patients the acute exacerbations are controlled before we enroll them into the study. Bronchial asthma is a disorder of breathing cycle, and there occurs significant air trapping during expiration.[22] Hence, regular yogic practices in the form of asana (postural adjustments) and Pranayama (breathing modulation) are quite helpful. The ability to cope up with stress and tolerance to allergens owing to improvement in immunity is another mechanism by which yoga helps in asthma. Balancing autonomic reactivity and optimizing cortisol secretion is another way to attenuate the immune functions as well as breathing patterns. Yogic meditational practices, postural adjustments (asana), and breathing modulations (Pranayama) act through external as well as internal signals. The external signals include our five sensory organs, and the internal signals correspond to proprioceptors, visceroceptors, and chemoceptors. These

Figure 3: Few representative photographs of asthmatic children performing yogic practices. (a) Vakasthala sakti vikasaka, (b) Gomukhasana, (c) Bhujangasana, (d) Nadi shodhan Pranayam

signals modulate the cerebrocortico–limbic–hypothalamus system of the brain and provide beneficial effects due to the functional coupling of "autonomic, endocrine, and somatic" responses which could be correlated with homeostatic responses set up to negate the undesirable stress effects.[23-25]

Yoga has been practiced by asthmatic patients for many years at various yoga centers in India and other countries. Several research studies had also demonstrated the role of yoga in bronchial asthma with some definitive improvement in pulmonary function tests. However, very few studies had reported the effects of yoga on bronchial lability in asthmatic as well as healthy children. Contrary to the general belief that children may not cooperate for practicing yoga, in the present study, we found them quite enthusiastic and efficient to perform it [as seen in Figure 3]. It was ensured from the investigator's side that none of the patients had worsening of symptoms or disease during the study period. The limitation of this study was the small sample size in the study subgroups, so these statistically significant findings in the result might not be useful for generalization. Another problem that arose during this study was to give

personalized attention to individual children, which was overcome to a large extent by maintaining a yoga diary, to perform in group, and involvement of their parents.

CONCLUSIONS

Regular practices of yoga reduce exercise-induced bronchial lability in asthmatic children. This may help children to cope up better with vigorous physical activity. Healthy children may also be benefited by sound physical health.

ACKNOWLEDGMENTS

We owe our special thanks to the Indian Council of Medical Research for granting financial support for completing this research project. We are also extremely grateful to yoga instructors from the Central Council for Research in Yoga and Naturopathy, New Delhi, for instructing us and asthmatic as well as healthy children the various yoga, asana, and Pranayama during the course of this study.

REFERENCES

1. Hargreave FE, O'Byrne PM, Ramsdale EH. Mediators, airway responsiveness, and asthma. J Allergy Clin Immunol 1985;76:272-6.
2. Narayana PP, Prasanna MP, Narahari SR, Guruprasad AM. Prevalence of asthma in school children in rural India. Ann Thorac Med 2010;5:118-9.
3. Sheehan WJ, Phipatanakul W. Difficult-to-control asthma: Epidemiology and its link with environmental factors. Curr Opin Allergy Clin Immunol 2015;15:397-401.
4. Tundia MN, Thakrar DV. An epidemiological study of asthma and its risk factors in school going children in Bhavnagar city, Gujarat, India. Int J Community Med Public Health 2018;5:2317-22.
5. Sharma CM. Prevalence of asthma in school children of rural areas of Kanpur, Uttar Pradesh. J Evol Med Dent Sci 2013;29:5298-1.
6. Jain A, Vinod Bhat H, Acharya D. Prevalence of bronchial asthma in rural Indian children: A cross sectional study from South India. Indian J Pediatr 2010;77:31-5.
7. Kumar GS, Roy G, Subitha L, Sahu SK. Prevalence of bronchial asthma and its associated factors among school children in urban Puducherry, India. J Nat Sci Biol Med 2014;5:59-62.
8. Farias C, Valério C, Mesquita I. Sport education as a curriculum approach to student learning of invasion games: Effects on game performance and game involvement. J Sports Sci Med 2018;17:56-65.
9. Milgrom H. Exercise-induced asthma in the competitive athlete. In: Szefler SJ, Pederson S, editors. In: Childhood Asthma. New York: Taylor and Francis; 2006. p. 540-59.
10. Jasrotia RB, Kanchan A. Exercise induced asthma (EIA), exercise induced bronchospasm (EIB), airway hyper-responsiveness (AHR) and exercise induced bronchial lability (EIBL): Are they same? Int J Cur Res Rev 2013;5:89-93.
11. König P, Godfrey S. Prevalence of exercise-induced bronchial lability in families of children with asthma. Arch Dis Child 1973;48:513-8.
12. Godfrey S, Konig P. Exercise-Induced bronchial lability in wheezy children and their families. Pediatrics 1975;56 Suppl:851-5.
13. Agarwal D, Gupta PP, Sood S. Improvement in pulmonary functions and clinical parameters due to addition of breathing exercises in asthma patients receiving optimal treatment. Indian J Allergy Asthma Immunol 2017;31:61-8.
14. Agnihotri S, Kant S, Kumar S, Mishra RK, Mishra SK. The assessment of effects of yoga on pulmonary functions in asthmatic patients: A randomized controlled study. J Med Soc 2016;30:98-102.
15. Singh S, Soni R, Singh KP, Tandon OP. Effect of yoga practices on pulmonary function tests including transfer factor of lung for carbon monoxide (TLCO) in asthma patients. Indian J Physiol Pharmacol 2012;56:63-8.
16. Khanam AA, Sachdeva U, Guleria R, Deepak KK. Study of pulmonary and autonomic functions of asthma patients after yoga training. Indian J Physiol Pharmacol 1996;40:318-24.
17. Weisman IM, Zeballos RJ. Clinical exercise testing. Clin Chest Med 2001;22:679-701, 8.
18. Jain SC, Rai L, Valecha A, Jha UK, Bhatnagar SO, Ram K, *et al.* Effect of yoga training on exercise tolerance in adolescents with childhood asthma. J Asthma 1991;28:437-42.
19. Singh V, Wisniewski A, Britton J, Tattersfield A. Effect of yoga breathing exercises (pranayama) on airway reactivity in subjects with asthma. Lancet 1990;335:1381-3.
20. Deshpande RR, Bhole MV. Effect of yogic treatment on eosinophil count in asthma patients. Yoga Mimamsa 1982;20:9-16.
21. Gandhi A, Das S, Mondal S. Comparative Evaluation Study of Integrated Yoga Practices vs Conventional Medical Treatment for Management of Health Disorders. World Health Organization Project No. WR/IND TRM 001/G SE/95/232944; 1999. p. 49-61.
22. Park SW, Park JS, Jeong SH, Lee YN, Hwangbo Y, Park JS, *et al.* Air trapping is a major determinant of persistent airway obstruction in asthmatics. Respir Med 2012;106:786-93.
23. Balaji PA, Varne SR, Ali SS. Physiological effects of yogic practices and transcendental meditation in health and disease. N Am J Med Sci 2012;4:442-8.
24. Brown RP, Gerbarg PL. Yoga breathing, meditation, and longevity. Ann N Y Acad Sci 2009;1172:54-62.
25. Bushell WC. Longevity: Potential life span and health span enhancement through practice of the basic yoga meditation regimen. Ann N Y Acad Sci 2009;1172:20-7.

How to cite this article: Jasrotia RB, Mondal S, Gandhi A, Kumar V. A quasi-experimental study of the effects of yogic practices on pulmonary functions and exercise-induced bronchial lability in children with controlled asthma. Int J Med Sci Public Health 2019;8(12):1046-1051.

Source of Support: Nil, **Conflict of Interest:** None declared.