Efficacy of Yogatherapyon Lung Functions and Lung Volumes in Children-A Experimental Study

Reema Joshi[1], Manisha Rathi[2], Neha Kulkarni[3], Farheen Kathewadi[4]

[1]Assistant Professor, [2]Professor, [3]Assistant Professor, [4]Postgraduate Student, Dr.D.Y. Patil College of Physiotherapy, Pune, India

Abstract

Background: The lungs go through 4 distinct histological phases of development and in late fetal development respiratory motions and amniotic fluid are thought to have a role in lung maturation.[1,2] Development of this system is not completed until the last weeks of fetal development, just before birth. Therefore premature babies have difficulties associated with insufficient surfactant (end month 6 alveolar cells type 2 appear and begin to secrete surfactant) [3-6]. Considerable structural changes in the chest wall may change infant and childhood predisposition to respiratory failure, lung injury, and ventilation-associated lung injury. Yoga respiration consists of very slow, deep breaths with sustained breath hold after each inspiration and expiration.Thus,previous studies considered Yoga as a method of breathing and chest expansion exercises. **Objectives**: To assess the effect of yogasana on lung volume, function and breath holding capacity on children. **Materials and Methods:** Experimental study was conducted 2 groups were formed .Group A was designated for yoga asanas**(**UttitaKumarsana, ArdhaMatsyandrasana , Parvatasana, Yoga Mudra, Dhanurasana and Bhujangasana) Group B was asked to continue regular playing activities for 30 Min 3 times a week for 12 sessions. **Result Analysis:** Chest expansion, FVC,FEV1,FEV25-75% and breath holding capacity has shown increased in both group whereas more in children performing yogaasanas. **Conclusion:** The study concludes that looking at increasing burden of studies & expectation it is necessary to keep children ready to combat with physical mental fitness Yoga session should be incorporated as routine from school itself.

***Key Words**: Yoga Asanas, FVC,FEV1, Chest expansion*

Background

The orientation of the ribs is horizontal in the infant; by 10 years of age, the orientation is downward. Ossification of the rib cage, calcification of the costal cartilage, and development of muscular mass develops progressively until adulthood. Lung Volumes: Functional residual capacity (FRC) is determined by the static balance between the outward recoil of the chest wall and the inward recoil of the lung. In infants, the outward recoil is quite small, and the inward recoil is only slightly less than that in adults.[7]

Yoga, originated in India thousands years ago, it is a method of learning that aims to attain the unity of mind, body, and spirit through three main Yoga structures: **Exercise, Breathing, and Meditation**[9].

It is separated into Six Branches.

1. Bhakti Yoga is the path of heart and devotion.

2. Raja Yoga is the path of Yoga that focuses on meditation and contemplation.

3. Jnana Yoga is the path of Yoga that deals with wisdom and knowledge or the Yoga of the mind.

Corrosponding Author:
Dr. Reema Joshi
Dr.D.Y.Patil College of Physiotherapy, Pune
Contact no. 9890437630

4. Karma Yoga is the path of service; it refers to the energy of action.

5. Tantra Yoga is the path of ritual, it also known as sorcery, witchcraft, magic spell or some mysterious formula.

6. Hatha Yoga is the most popular branch of Yoga. In general, when people mention about Yoga, they refer to Hatha Yoga. It is the physical training part combining postural exercise ("asana"), relaxation, and voluntary control of breathing ("pranayama"). Yoga practice consists of the five-principle including proper relaxation, proper exercise, proper breathing, proper diet, and positive thinking and meditation. Yoga literally means 'union' or 'to join' i.e. union with divine consciousness.

Breathing and chest wall expansion exercise, the treatment technique for chest physical therapy, have been used to treat various forms of respiratory dysfunction, both acute and chronic abnormalities resulting from medical or surgical conditions, and for health promotion[1]. Exercise training has been shown to improve respiratory capacity, airway resistance, exercise tolerance, and to reduce work of breathing.[2] Previously, it was reported that Yoga training (asans and pranayams) for 6 months improved lung function, respiratory muscle strength, skeletal muscle strength, and endurance in 12-15 years old Indian[10]. However, different Yoga training (three weeks duration) produced different results on the cardiopulmonary function in young Indian[11]. This experiment tested the hypothesis that short-term Yoga training improved chest wall expansion and lung volumes in young children. The Yoga Sutrasdescribes the components and process of yoga as "eight limbs". Through these practices, the goal of yoga ultimately was to discipline the mind and body for spiritual goals.

- Moral principles (yama)
- Observances (niyama)
- Posture (asana)
- Breath control (pranayama)
- Withdrawal of the senses (pratyahara)
- Concentration (dharana)
- Meditation (dhyana)
- Pure contemplation (Samadhi)

Proposed Mechanism of Biological Effect

As a mind body practice, the biological mechanism of yoga probably has multiple components. As a physical activity, part of the effect is similar to other types of exercise. Generally, yoga is considered a low- to moderate-intensity exercise. Exercise is known to improve health through improving cardiovascular fitness, muscle strength, and respiratory adaptations, modifying metabolism and immune function. Yoga's emphasis on relaxation in static and dynamic exercises distinguishes it from conventional exercise. By systematically contracting and relaxing muscles in coordinate sequences, changing breathing patterns, and cultivating mental attentiveness and awareness during practice, yoga attempts to synchronize the body and mind.In particular, yoga changes the sympatho-vagal balance, producing physiological effects systemically. Six positions of Hatha Yoga (UttitaKummersana, ArdhaMatsyendrasana, Parvatasana, Yoga Mudra, Dhanurasana and Bhujangasana) were assigned in this study because of their dominant effects on chest wall function.Spirometry can be reproducibly done from the age of 5 years but these values should be interpreted with individual considering age, sex, height and nutritional status[26]. Subdivision of lung volumes show changes in different lung diseases that help us to understand the nature of the defect[11].

Materials & Methodology

Study has been conducted on 40 school going children studying in VIthstandardbetween 11 to 15 age. School permission as well as parents consent was taken for both boys and girls those who are willing to participate. On screening those who have chest expansion <4 cms were included. Child with respiratory disease,trauma and recent illness,infections were excluded from study**.**

Procedure

40 subjects were selected for the study as per the inclusion & exclusion criteria after the approval from ethical committee of the institution. An informed consent was taken from the parents. Every step of the procedure was explained to them.Pre-assessment was carried out for BMI,Chest Expansion Measurement, Breath Holding

time with stop watch and spirometry was performed for FVC,FEV1,FEV25-75%.40 subjects were divided in two groups using chit method.

Group A was allocated for Yoga therapy UttitaKumarsana, ArdhaMatsyandrasana , Parvatasana, Yoga Mudra, Dhanurasana and Bhujangasana for 30 Min yoga-aasana session 3 times/Week 12 sessions for 4 weeks. Group B were asked to carry out Regular playing activities like walking, running, playing outdoor games for minimum 30 min. every day for 4 weeks .Post-assessment was done,data was obtained and result was analyzed.

Result & Data Analysis

TABLE 1:- Statistical Analysis for Chest Wall Expansion at Upper level in Group A& B

Groups	Treatment	CWE	Difference	SD	SE	Paired t test	unpaired t test
GROUP A	PRE	3.175	1.325	0.4667	0.1043	t = -12.698 p = 0.000	t = 9.077 p= 0.000
	POST	4.5					
GROUP B	PRE	2.95	0.2	0.2991	0.06689	t = -2.990 p = 0.008	
	POST	3.15					

TABLE 2:- Statistical Analysis for Chest Wall Expansion at Middle level in Group A& B

Groups	Treatment	CWE	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	3	1.425	0.5684	0.1271	t = -13.077 p = 0.000	t = 10.443 p= 0.000
	POST	4.425					
GROUP B	PRE	2.925	0.05	0.1539	0.03441	t = -1.453 p = 0.163	
	POST	2.975					

TABLE 3:- Statistical Analysis for Chest Wall Expansion at Lower level in Group A& B

Groups	Treatment	CWE	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	2.7	1.625	0.7048	0.1576	t = -10.311 p = 0.000	t = 9.072 p= 0.000
	POST	4.325					
GROUP B	PRE	2.675	0.1	0.2616	0.05849	t = -1.710 p = 0.104	
	POST	2.775					

TABLE 4:- Statistical Analysis for Breath Holding time in Group A &B

Groups	Treatment	BHT	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	23.5	16.45	9.254	2.069	t= -7.950 p = 0.000	t = 6.723 p= 0.000
	POST	39.95					
GROUP B	PRE	21.35	2.35	1.531	0.3424	t = -6.863 p = 0.000	
	POST	23.7					

TABLE 5:- Statistical Analysis for Lung Volume (FVC) in Group A & B

Groups	Treatment	Lung volume-FVC	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	76.5	13.05	9.162	2.049	t = -6.370 p = 0.000	t = 6.213 p= 0.000
	POST	89.55					
GROUP B	PRE	86.7	0.25	0.9665	0.2161	t = -1.157 p = 0.262	
	POST	86.95					
Groups	Treatment	Lung Volume-FEV1	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	86.8	14.4	13.52	3.023	t = -4.780 p = 0.000	t = 4.698 p= 0.000
	POST	101.2					
GROUP B	PRE	99.75	0.2	1.105	0.2471	t =-0.809 p = 0.428	t = 4.698 p= 0.000
	POST	99.95					
Groups	Treatment	Lung volume-FEF25-75%	Difference	SD	SE	Paired t test	Unpaired t test
GROUP A	PRE	87.55	17.5	12.47	2.789	t = -6.276 p = 0.000	t = 6.348 p= 0.000
	POST	105.1					
GROUP B	PRE	89.15	-0.25	0.9105	0.2036	t = 1.228 p = 0.234	t = 6.348 p= 0.000
	POST	88.9					

Discussion

Yoga has its ancient roots in India, where it is both a spiritual and physical practice integrating mind and body. The difference between Yoga and other exercise is the predominant focus on sensations in the body (Halvorson, 2002). Like other forms of exercise, the present data indicate that four-week Yoga training improves respiratory capacity especially chest wall expansion and lung volumes. Respiratory function depends on many factors including nervous system, respiratory muscle, and lung dimension. Yoga training also improves muscle strength and flexibility (Raub, 2002) and increased respiratory sensation (Villien et al., 2005), maximum expiratory pressure and flow rate (Joshi et al., 1992; Stanescu et al., 1981; Yadav and Das, 2001).[8,9] It is likely that the improvement of respiratory function and increased chest wall expansion in the present study were resulted from the increased respiratory muscle strength.

All the asanas practiced in this study especially bhujangasana&dhanurasana have their effect on improving chest wall expansion mainly at upper level. It stretches the anterior structures and strengthens the posterior structures of the upper chest & thus widens and opens the chest area thereby improving respiration at the upper level thus regular practice of these asanas results in improved chest wall expansion at upper level.

Asanas like ardhamatsyendrasana, parvatasana& yoga mudrasana have their effect on improving chest wall expansion at mainly middle level. With ardhamatsyendrasana, the spinal muscles of the back & abdomen are twisted laterally, especially the upper back, shoulder region is twistedthe chest is opened up; with regular practice of parvatasana lung capacity also increases thus improving chest wall expansion at the middle level.[15,16]

Dhanurasana, yoga mudrasana have their effect on improving chest wall expansion at mainly lower level. It widens and opens the chest area, while performing dhanurasana the spine is extended up to the umbilicus as well as the lower limbs are flexed & extended from hip thereby improving respiration at the lower level, stretches the chest as a whole thus regular practice of theseasanas results in improved chest wall expansion at lower level. The increased chest wall dimension indicates the possible increased ventilation-perfusion ratio and improved gas exchange capacity. Blood flow to this part is usually high in excess of ventilation.

Improvements in BHT could be attributed to the control of the neural respiratory centers during the various asanas. While performingyoga participants were instructed to consciously be in control of their breathing, which may indicate that the autonomic breathing stimulus was overridden resulting in increased breath holding time (Makwana et al. 1988). It was not clear if the improvement occurred at the level of neural reception or at higher centers in the brainstem. Improvements in Breath Holding Time point to a decreased responsiveness of the respiratory centers to CO2 levels along with an increased endurance of respiratory muscles with later signs of fatigue (Joshi and Joshi 1998).By consistently performing a variety of *asanas,* muscles of the thoracic cavity are constantly being recruited. This recruitment may lead to greater musculature and thereby result in improved FVC (Joshi et al.1992).

Performing Yoga stretching and balancing movement can lead to improvements of muscle strength and flexibility of all these muscles (Halvorson, 2002), by performing the asanas in this study the abdominal muscles get strengthened, it also helps in compression of the muscles of the chest which improves the lung's recoiling capacity which in turn improves forced expiration in 1st second. Abdominal breathing uses the diaphragm primarily, and is congruent with the shape of the lungs and the capacities of the breathing muscles. It performs respiration with the least effort and is associated with mental stability and calmness. In contrast, chest breathing utilizes primarily intercostal muscle plus accessory breathing muscles: trapizius, scalenes, pectoral, and sternomastoid (Chaitow and Bradley, 2002; Frownfelter, 1978; Levenson, 1992)[11,12]. Yogaasanas,train the muscles of the thoracic cavity and constantly get recruited. This recruitment may lead to greater musculature; also the asanas are maintained before releasing thus maintaining the stretch and thereby result in improved forced expiration at 25-75%.

Six positions of Hatha-Yoga used in this study has been reported to predominantly effect on prime mover and accessory respiratory muscle such as external and internal intercostal muscle, pectoral, latisimusdorsi,

erector spinae, rectus abdominis, serratus anterior and diaphragm[10]. A type of Yoga, the *Asanas,* involves a variety of effects including: relaxation, stretching, and balancing of muscles; mobilization of joints; improvement of posture; action on pressure points; improvement of breathing; calming of the nervous system; and promotion of homeostasis in cardiovascular, digestive, endocrine and other systems.The*Asanas*relaxes muscles through holding them in gently stretched positions (Monro, 1997)[9].

Study published states that Yoga practice can decreased reaction time, indicating improvement of neuromuscular system (Bhavanani et al., 2003)[11]. Although the chemoreceptor reflex adaptation and blood gases has been widely studied (Forster and Pan, 1995; Pianosi and Khoo, 1995), the possible role of nervous system on improved lung function in Yoga exercise especially in a short-term training period needs further experiments.[17,18].In summary, the present study suggests that short-term Yoga exercise improves respiratory breathing capacity by increasing chest wall expansion and forced expiratory lung volumes. These data provide more scientific evidence to support the beneficial effect of Yoga practice on respiration and muscle strength.

Conclusion

This study concludes that short term yoga exercises significantly improves chest wall expansion, lung volumes (FVC, FEV1, FEF25-75%) and breath holding time in children of 10-12 yrs which helps to improve cardiovascular endurance in children .

Conflict of Interest: None

Source of Funding: Self

References

1. Dr. MGore, Anatomy and Physiology of Yogic Practices, Published by,4th Edition, New Age Books,2005 page no 25-26
2. McGowan P, Jefferies A,. Crash Course Respiratory System 2nd Edition. London: Mosby 2004
3. Gary C. S., Steven B. Bleyl., Human Embryology Larsen's 4th EditionChapter 9; 2008 page no 229-260
4. Keith L. Moore, T. V. N. Persaud, The Developing Human: Clinically Oriented Embryology 6th edition, W.B. Saunders Company; 2003 Chapter 12 page no 271-302
5. Henry Gray "Anatomy of the human body" published by-Philadelphia: Lea &Febiger 1918 20th edition Page no.1396
6. S. Ammani Prasad and Juliette Hussey.Pediatric Respiratory Care, , Chapman & Hall, London. 1995 1st Edition Chapter 1-2 ,Page No.180-189.
7. Waugh A, Grant A Anatomy and Physiology in Health and Illness 2004, 9th Edition Published by-Churchill Livingstone Page no.215-243
8. Gilbert C. Yoga and breathing. J Bodywork Movement Therapy 3:44-54; Halvorson C. 2002 Stretching to breathe: Can yoga help your asthma? Asthma Mag 7:27-29 Page no.215-218.
9. Mandanmohan, Jatiya L, Udupa K, and Bhavanani AB, Effect of yoga training on handgrip, respiratory pressures and pulmonary function.Indian J PhysiolPharmacol 2003 page no. 47: 387-392
10. Madanmohan, Udupa et.al. Effect of slow and fast pranayams on reaction time and cardiorespiratory variables.Indian J PhysiolPharmacol 2005 49:313-318
11. Moll, JMH and Wright, V.et.al. An objective clinical study of chest expansion.Annal of the Rheumatic Disease, 1972 , Page 3191, 1-8
12. Carlson B. Normal chest Excursion. PhysTher 1973 (1): 10-14.
13. Harris J, et.al. Site of measurement and subject position affect chest excursion measurements. CardiopulmPhysTher 1997, 8 (4): 12-17
14. Moll J, Wright V. 1972. An objective clinical study of chest expansion. Ann Rheum Dis. 31 (1): 18.
15. Heikkila S, et.al, Sensitivity to change of mobility tests; effect of short term intensive physiotherapy and exercise on spinal hip and shoulder measurements in spondyloarthropathy. J Rheumatol 2000, 27: 1251-6
16. LN Joshi,VD Joshi "Effect of forced breathing on ventilatory functions of the lung".Journal Of Postgraduate 1998 Vol.44(3) Page 67-69

17. Robin Monro Yoga Therapy J.Bodywork and Movement Therapies 1997 Vol.1(1) Page 215-218 https://doi.org/10.1016/S1360-8592(97)80047-2
18. Chanavirut R.et.al "Yoga Exercise Increases Chest Wall Expansion And Lung Volumes In Young Healthy Thais"J.of Physiological Sciences April 2016 Vol.19 (1) Page no.1-7.