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EFFECT OF *PRANAYAMA* ON PULMONARY FUNCTIONS - AN OVERVIEW

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ABSTRACT

Pranayama practice has been reported to improve the lung functions in numerous studies. The benefits includes the prolongation of breath holding time, increase in PEFR (Peak Expiratory Flow Rate), FVC (Forced Vital Capacity), FEV1 (Forced Vital capacity in 1 second), MVV (Maximum Voluntary Ventilation) and lowered respiratory rate. Patients of chronic lung diseases like *Asthma*, Bronchitis, Emphysema, COPD, etc. may derive immense benefits from these changes in pulmonary functions. In the present paper a critical overview of recent researches in this regard, published in various international and indexed journals has been attempted.

Keywords: *Pranayama*, Pulmonary functions, Critical overview

INTRODUCTION

Yogic techniques are known to improve one's overall performance. *Pranayama* is an important, yet little known part of *Yoga*. Until recently, this art and science of yogic breathing was almost completely unknown to the common man like many other ancient Indian arts. Those who knew it used to be very reluctant to share their knowledge and experience with anyone, unless a student proved by tests that he was ready to receive it.

"Tasmin sati swas praswas yogartivich Pranayama"

This having been (accomplished) "*Pranayama*" which is control of inspiration and expiration[1] the inspiration of *prana-vayu* is *shwasa* and expiration is *prashwasa* and the cessation of both is characteristic of *Pranayama. Patanjali* in his *Yoga Sutra* describes – *Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana* and *Samadhi* as eight *angas* (parts) of *Yoga*. Amongst them, in the present materialistic world, the third and fourth part, *Pranayama* and *Asana* (Postures) are considered as very important part and prescribed by modern medicine too.

The beneficial effects of different *Pranayama* are well reported and has sound scientific basis. [2-3]There is reported evidences of *Pranayama* that it increases chest wall expansion and lung volumes. [4-5]

OBJECTIVES

Practice of *Pranayama* has been known to modulate cardio-respiratory functions. Keeping this in view, the present study is conducted to collect all the possible data from the published articles in the journals like Journal of Physiological & Biomedical Sciences and Indian Journal of Traditional Knowledge showing the efficacy of *Pranayama* on the pulmonary functions.

MATERIALS AND METHODS

Articles reviewed for the study (Original Clinical Research Database Articles)

1. Immediate effect of *'Nadi -Shodhana Pranayama'* on some selected parameters of Cardiovascular and Pulmonary functions[6]
2. Role of *Pranayama* breathing exercises in rehabilitation of coronary artery disease patients – A pilot study[7]
3. Yoga exercise increases chest wall expansion and lung volumes in young healthy thais[8]

Methodology (Article No-1)

This study was carried out in Human Physiology Laboratory, Department of Physiology, Sikkim Manipal Institute of Medical Sciences, Gangtok. The trainer involved in this study addressed the class of 30 students on the purpose of this study, the procedure to be followed and willingness of the subjects to participate in this investigation. After the address, the trainer demonstrated the mode of *Nadi–Shodhana Pranayama* to the subjects.

In the study group, a recording was done before and immediately (within 5 minutes) after performing *'Nadi-shodhana Pranayama'*. After an initial recording all subjects were put through *Nadi-shodhana Pranayama* for 20 minutes. They were asked to assume *'Sukhasana'* (the comfortable posture) and regulate the alteration of breathing

Methodology (Article No-2)

Twenty clinically documented patients of CAD from Guru Teg Bahadur Hospital were selected for the study. All the patients were male and their CAD was stable for the past 2-6 yrs. They all belonged to the age group 35-55 yrs (mean age 48±6.57). They served their own control in the study. Informed consent was taken and a standardized questionnaire related to cardio-respiratory health was worked out. The procedure of PFTs was properly explained to all the subjects.

Parameters of the PFTs recorded were: forced expiratory volume in 1 sec (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, peak expiratory flow rate (PEFR), forced mid expiratory flow (FEF25-75), peak inspiratory flow rate (PIFR) and maximum voluntary ventilation (MVV). After recording the basal PFTs, patients were taught *Pranayama* breathing exercise. They were advised to practice it (10 min) twice a day.

Methodology (Article No-3)

Fifty eight (58) healthy volunteers, 18-25 years of age, were recruited from the undergraduate students of Khon Kaen University and separated into two groups. General characteristics (age, body weight, height, and body mass index: BMI) were collected from all subjects. At the first day of study both groups came to the training room and their chest expansion and lung volumes were measured as pre-test data. The chest wall expansion was measured by a standard tape at three levels: upper (sterna angle), middle (rib 5) and lower (rib 8) levels.

The lung volumes including tidal volume (VT), forced expiratory volume in one second (FEV1), forced expiratory volume between 25-75% (FEF25-75%), and forced vital capacity (FVC) were measured by a standard Spirometer. Then the Yoga group was trained to perform Yoga exercise for 20 minutes while the control group was stay free in the same room. Both were allowed to live freely at their homes without other heavy exercise, drinking, and smoking. The Yoga group was asked to come to the study room three days a week for six weeks to perform 20-

min Yoga exercise. At the end of 6 weeks period, all studied parameters were measured as post test data with the same methods.

The Yoga group performed five yoga postures: *Uttita Kummersana* (cat position), *Ardha Matsyendrasana* (sitting and twist the trunk), *Vrikshasana* (tree position), *Yoga Mudra and Ushtrasana* (camel position) for 20 minutes a day, one time a day and 3 days a week until 6 weeks.

OBSERVATIONS AND RESULTS

Results (Article No-1)

The results of this study demonstrated the beneficial effect of *Pranayama* on cardiopulmonary function. A significant improvement in peak expiratory flow rate was observed in the study. It is an effort independent flow and is mainly dependent on lung volume.

The *'Nadi shodhana Pranayama'* involves using of lung spaces, not used up in normal shallow breathing. Therefore, the increased peak expiratory flow rate might be a consequence of small airway opening in lungs. The peak expiratory flow rate improved significantly (P<0.01) following *Pranayama practice*. No significant change in peak expiratory flow rate was observed. Results are shown in table 1. [9-10]

Table 1: Immediate effect of *Nadi-shodana Pranayama* on cardiovascular and pulmonary functions (Data were mean ± SD; n = 10)

Parameters	Before *Pranayama*	After *Pranayama*	Mean difference	't'	p
Basal heart rate (beats/min)	85.9 ± 4.6	74.6 ± 4.1	11.3 ± 4.0	8.9	<0.0001
Systolic blood pressure (mmHg)	120.9 ± 5.8	116.6 ± 4.6	4.3 ± 2.2	6.1	<0.001
Diastolic blood pressure (mmHg)	79.0 ± 2.3	78.2 ± 2.1	0.8 ± 1.4	1.8	NS
Peak expiratory flow rate (l/minute)	419.0 ± 67.4	483.3 ± 75.2	64.3 ± 50.4	4.0	<0.01
Problem solving ability (second)	90.8 ± 24.9	69.5 ± 21.8	21.3 ± 10.0	6.7	<0.0001

Results (Article No-2)

The pulmonary function tests before and after two weeks of *Pranayama* breathing exercises were assessed. FEV1%, PEFR, FEF25-75% and MVV are found to be significantly improved after 2 weeks of *Pranayama* breathing exercises. FEV1, FVC and PIFR also showed a trend towards improvement although not significant. Following the practice of *Pranayama* breathing exercises, significant improvements were seen in FEV1%, PEFR, FEF25-75% and MVV. This indicates that there is some degree of broncho-dilatation, which is leading to better oxygenation of the alveoli. Endurance power of the lungs also improved as shown by improvement in maximum voluntary ventilation.[11-12]

Improvement in PFTs in the study could be because of reduction of sympathetic reactivity attained with *Pranayama* training. This may allow bronchio-dilatation by correcting the ab-normal breathing patterns and reducing the muscle tone of inspiratory and expiratory muscles. Due to improved breathing patterns, respiratory bronchioles may be widened and perfusion of a large number of alveoli can be carried out efficiently.[11] In response to variations in breathing patterns a number of central and autonomic nervous system mechanisms as well as mechanical (heart) and hemodynamic adjustments are also triggered, thereby causing both tonic and phasic change in cardiovascular functioning.[12] Hence, it can be said that *Pranayama* breathing may prevent serious cardio-respiratory complications by emphasizing optimal physical and mental conditioning. Results are shown in table 2.[13]

Table 2: PFT parameters before and after *Pranayama* breathing exercises

Subjects	No. of sub-jects	FVC (L)	FEV1(L)	FEV1/FVC (%)	PEFR (L/sec)	FEF 25-75% (L/sec)	PIFR (L/min)	MVV (L/min)
Before *Pranayama*	20	2.10±0.65	1.58±0.67	76.46±16.34	3.14±1.26	2.58±1.87	2.21±.58	54.08±15.86
After *Pranayama*	20	2.23±0.72	1.86±0.69	82.78±13.96	4.16±1.64	3.18±1.12	2.43±0.6	66.15±14.56

Results (Article No-3)

At the beginning of the study (before or pre-test) all measured lung volumes were not significantly different between groups (Table 4). Yoga exercise significantly increased FVC, FEV1 and FEF 25-75% ($p < 0.05$) without any effect on tidal volume.[14] However, only the post-test FEF 25-75% of Yoga significantly increased when compared to control. No lung volumes of the control were significantly different when compared between before and after values.

As general characteristics and lung volumes, baseline chest wall expansion was not significantly differently between groups (Table 3). At the end of 6 weeks Yoga training, chest wall expansion significantly increased ($p < 0.05$) in all three levels when compared to their pre-test values and post-test control. The improvement was highest at the upper (38%) compared to middle (19%) and lower (15%) levels.[15]

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. Like other types of exercise, Yoga practice decreased reaction time, indicating improvement of neuro-muscular system (Bhavanani et al., 2003). Increased nerve conduction velocity was reported in dynamic exercise (Masuda et al., 2001; Ross et al., 2001), but not yet in the Yoga training.[16]

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 inter costal muscle plus accessory breathing muscles: trapizius, scalenes, pectoral, and sterno mastoid (Chaitow and Bradley, 2002; Frownfelter, 1978; Levenson, 1992). It is less efficient, aerates less of the lung, fatigues the neck and upper chest if used habitually and is associated with urgency and anxiety (Gilbert, 1999). Results shown below.[17]

Table 3: Lung volumes of control and Yoga groups

Lung Volume	Before		After	
	Control	**Yoga**	**Control**	**Yoga**
V_T(L)	0.55±0.03	0.53±0.03	0.57±0.03	0.55±0.03
FEV_1 (L)	2.54±0.13	2.46±0.10	2.46±0.14	2.78±0.11
FEV $_{25-75\%}$ (L/sec)	3.83±0.21	4.10±0.23	3.72±0.20	4.77±0.12
FVC (L)	2.53±0.13	2.49±0.12	2.51±0.14	2.82±0.12

Table 4: Chest wall expansion of control and Yoga groups

Chest Expansion (cm)	Before		After	
	Control	**Yoga**	**Control**	**Yoga**
Upper	**3.00**±0.09	**3.19**±0.07	**3.02**±0.10	**4.40**±0.14
Middle	**4.64**±0.11	**4.97**±0.13	**4.68**±0.10	**5.92**±0.13
Lower	**5.40**±0.14	**5.91**±0.18	**5.44**±0.14	**6.77**±0.14

OVERALL RESULT ASSESSMENT

While looking into the results obtained in all the three studies mentioned above, it can be understood that not only beneficial effect of *Pranayama* on cardiopulmonary function was achieved but some significant improvements in peak expiratory flow rate was also observed. It was observed from the studies that improvement of respiratory function and increased chest wall expansion were resulted from the increased respiratory muscle strength because of *Pranayama* effect. Moreover, from the results it can be said that *Pranayama* breathing may prevent serious cardio–respiratory complications.

CONCLUSION

Pranayama breathing may prevent serious cardio-respiratory complications by emphasizing optimal physical and mental conditioning. It also helps in tranquilizing the mind and as a result patients feel *Pranayama* is found to be so beneficial in improving the lung functions of CAD patients. It can be inferred that pulmonary functions can be improved and complications can be prevented by encouraging CAD patients to practice *Pranayama* breathing exercises regularly. The positive results found in all these studies shows that a few minutes practice daily helps in setting the mind better on works and studies. The daily practice could also be parts of physical fitness and life style modification programs in maintaining better physical and mental health. In summary, it can be said that *Pranayama* improves respiratory breathing capacity by increasing chest wall expansion and forced expiratory lung volumes.

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