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Review Article

EFFECTS OF PRANAYAMA ON RESPIRATORY SYSTEM

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ABSTRACT

Respiratory diseases are increasing rapidly and drastically, the reason behind is mainly changed breathing pattern along with environmental pollution. *Pranayama* is the procedure of regulated breathing, giving a solution for this problem with its multi dimensional effects. It is a unique and is one among the *Ashtanga Yoga*. In many research works it is found that *Pranayama* is having multi- systemic benefits on the body. Respiratory system is one among those beneficiary systems. Respiratory system is directly involved in the *Pranayama*. Rate and rhythm of respiration, lung volumes and capacities, breath holding time etc., will get significantly and positively influenced with the practice of *Pranayama*. Here an attempt is being made to explain the physiological benefits of *Pranayama* with special reference to respiratory system with probable reasoning.

Keywords: *Pranayama*, Lung volumes, Capacities, Respiratory System.

INTRODUCTION

Life has become very busy. The changed life style pattern is not allowing people take a deep breath also, which is further leading to rapid progress of different respiratory diseases. In a Multi-centric study conducted by Indian Council of Medical Research (ICMR), it was found that about 5 % of men and 3.2 % of women in India suffering with chronic respiratory diseases and the total number patients of COPD increased from 6.45 million in 1971 to 14.84 million in 2011¹

Lung volumes and capacities convey the condition of functional status of respiratory system in physiological as well as pathological situations². Regular practice of *Pranayama* is found to improve the lung volumes and capacities thereby helping in prevention^{3, 4} and management of different respiratory diseases⁵.

Here an attempt is being made to explain the reasons for the respiratory benefits of *Pranayama* by considering the physiological changes by the practice of *Pranayama*.

MATERIALS AND METHODS

Books and articles explaining about the importance of *Pranayama* were scrutinized for its respiratory benefits. Later, physiological aspects were studied from modern physiology books and supportive correlation was done between benefits of *Pranayama* and physiological changes behind those benefits.

AIMS AND OBJECTIVES:

1. To understand the physiological changes (in respiratory system) behind the benefits of *Pranayama* practice.

LITERATURE REVIEW

Pranayama

It is one among *Ashtanga Yoga*, which is a procedure of controlling mind by controlling the *Vayu* (air) in inspiration and expiration⁶. It is not only having psychological benefits but it is having many physical benefits also⁷. Considering its benefits it was given utmost importance in ancient texts like *Hathayoga Pradeepika*, *Bhavishtyapurana*, *Atharvanaveda*, *Kausheetaki Upanishat*, *Sharangadhara Paddhati*, *Taittiriyyopanishat*, *Manusmriti* and *Gheranda Samhita* etc⁸. There are three steps in the practice of *Pranayama* like *Puraka*, *Kumbhaka* (*Bahyaor Shunyaka* and *Abhyantara*) and *Rechaka*. Further *Pranayama* is sub-divided into 8 types like *Suryabhedana*, *Ujjayee*, *Sheetalee*, *Bhramaree*, *Bhastrikaa*, *Sheetkaaree*, *Moorchaa*, *Plaavinee*⁹.

All the types of *Pranayama* involves deep inspiration, with holding of air and deep expiration respectively which will show their influence on different physiological entities involved in respiration thereby significantly improve lung volumes and capacities^{10,11,12}.

Physiology of respiration¹³

Breathing is the only autonomic function that can be consciously controlled and it is the key in bringing

sympathetic and parasympathetic nervous system into harmony¹⁴. Air that is inspired through nares will pass via trachea, bronchi, bronchioles and finally end up in the alveoli, where the actual process of gaseous exchange between lungs and blood takes place (external respiration) through respiratory membrane. Again at the level of tissues, exchange of gases takes place between blood and tissues (internal respiration).

Mechanics of respiration¹⁵

INSPIRATORY MUSCLES	EXPIRATORY MUSCLES
Primary- Muscles of Diaphragm & External intercostal muscles	Primary- Internal intercostal muscles
Accessory- Sterno- cleidomastoid, Pectoralis etc.,	Accessory- Abdominal muscles

Movements of Thoracic Cage¹⁷

- Movement of four units like thoracic lid, upper costal series, lower costal series and diaphragm causes movement of thoracic cage thereby elevation of ribs and descent of diaphragm.

Movements of lungs¹⁸

- During inspiration because of enlargement of thoracic cage negative pressure is increased in the thoracic cavity. It causes expansion of lungs. During expiration thoracic cage decreases in size thereby negative pressure also comes back to pre-inspiratory position, which compresses the lungs, air is expelled out.
- **Pulmonary Compliance** is the expansibility of lungs & thorax.
- **Pulmonary surfactant** is the secretion of type 2 alveolar cells. It is the surface acting material which lines the epithelial lining of alveoli and decreases the surface tension of the alveolar membrane thereby avoid the

Respiration occurs in two phases i.e. inspiration and expiration. During inspiration (active process) thoracic cage enlarges and lungs expand. During expiration (passive process), thoracic cage and lungs decrease in size.

Muscles of respiration¹⁶

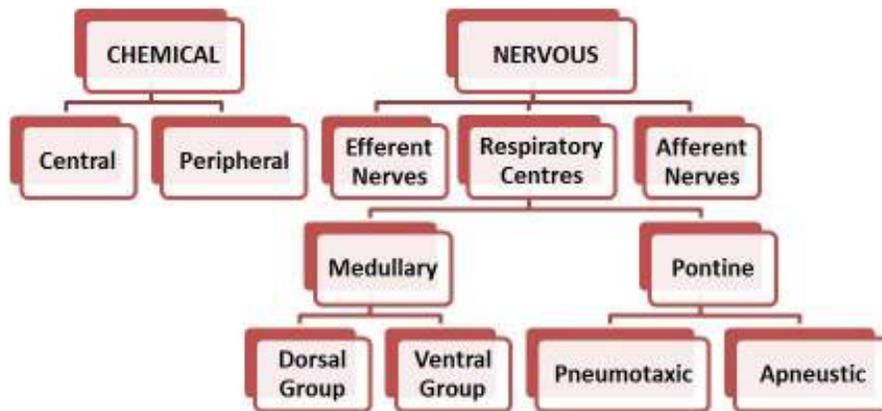
These are skeletal muscles (with a capability to increase in their bulk with regular efficient usage).

collapse of alveoli. Prostaglandins are the chemicals secreted by the parenchyma cells of lungs which reduce the bronchiolar smooth muscle tone.

- **Respiratory Pressures:** Intra- pleural & Intra-alveolar pressures allow the respiration phases like inspiration and expiration.
- **Receptors:** Stretch, Baro, Irritant, Chemo, Proprio, Pain, Thermo etc., get stimulated to different stimuli and act accordingly and does different functions.

Regulatory mechanisms¹⁹

Process of respiration is under the control of two mechanisms like Chemical and Nervous mechanism. Chemical mechanism is again of two types like central and peripheral. Nervous mechanism is under the control of Medulla oblongata (Medullary) and Pons (Pontine). Medulla oblongata has two groups of neurons like Dorsal and Ventral. Pons also have 2 group of neurons – Pneumotaxic & Apneustic. Pontine centres can control Medullary centres.



Control of inspiration and expiration period

Medullary Doral Group controls inspiration process in normal quiet breathing (unconscious), Ventral Group can control inspiration and expiration in forceful breathing (conscious). Pneumotaxic centre controls conscious process of breathing and Apneustic centre controls unconscious breathing.

Breath holding time

Length of time one can voluntarily stop breathing is called breath holding time. Increased Carbon dioxide (Hypercapnea)/ decreased oxygen levels in the blood stimulates

Chemoreceptors of the lungs to send the sensory reflex to the brain centres thereby, Medullary dorsal group of neurons will get activated which will further initiates the process of inspiration. So, breath holding time is under the control of stimulation of Chemoreceptors of the lungs to increased carbon dioxide levels.

Pulmonary function tests²⁰

These are the tests conducted to know the functional status of lungs in both physiological and pathological conditions. These are of two types' static and dynamic lung function tests. Static

test will be conducted to know the lung volumes and capacities in specific condition of thorax and lungs whereas dynamic tests will be conducted to know the rate of air flow into the lungs.

Spirometry is the generally used method for measuring the lung volumes and capacities. Spirogram is the report obtained through spirometry.

Restrictive and obstructive respiratory diseases²¹

Diseases with difficulty in inspiration are called as restrictive diseases and diseases with difficulty in expiration are called as obstructive diseases. The reduction of pulmonary function test values especially dynamic lung function tests values is more significant in obstructive lung diseases compared to restrictive lung diseases. FEV₁ and PEF_R serve the purpose of differentiating between obstructive and restrictive lung diseases.

Effect of *Pranayama* on Lung Volumes and Capacities^{22, 23}

In all the *Pranayama* procedures the only respiratory parameter that will reduce is the rate of respiration and all the other parameters including volumes and capacities will increase depending on the regularity of practice.

DISCUSSION

The reasons for the increase of respiratory parameters can be justified in the following ways:

1. Increased volumes & capacities can be justified with the following reasoning

A. Increased strength of respiratory musculature²⁴

Regular efficient usage of muscles of respiration causes their bulk to increase and Elastic & Collagen fibres will get strengthened and extensibility will increase thereby will allow efficient contraction, improving the inspiratory and expiratory power, Cleansing of airway secretions thereby decreasing the resistance to the air flow which will aid in full and free utility of alveoli.

B. Release of lung surfactant & prostaglandins²⁵

Lung inflation near to total lung capacity in *Pranayama* acts as a major physiological stimulus for the secretion of pulmonary surfactant and prostaglandins.

Pulmonary surfactant increases the lung compliance and Prostaglandins reduce the bronchiolar smooth muscle tonicity thereby allowing more and more air to enter into lungs which leads to increase of lung volumes and capacities.

C. Stimulation of stretch receptors²⁶

Inflation of the lungs nearly to total lung capacity stimulates the stretch receptors, which reflexively relaxes smooth muscles of larynx and Tracheo- bronchial tree, thereby improving the lung volumes and capacities.

D. Removal of undue tension²⁷

Practice of *Pranayama* in relaxed state of body and mind, relaxes the skeletal muscles which help the thoracic cage to relax better than before and it will also cause withdrawal of the Broncho- constrictor effect by relaxing smooth muscles of Bronchi, thereby we can appreciate hike in the values of pulmonary function parameters.

2. Decreased rate of respiration²⁸

Respiration during *Pranayama* practice (i.e. conscious process of respiration which is very much regulated one) is under the control of Pneumotaxic respiratory centre. Pneumotaxic centre

will control the Apneustic centre which has its role in normal quite breathing. So this regulated pattern of breathing during *Pranayama* may be adopted by Apneustic centre in normal quiet breathing leading to decreased rate of respiration.

3. Extended expiratory period²⁹

With a regular practice of *Pranayama* Dorsal group neurons responsible for inspiration in normal quite breathing may be inhibited by Apneustic and Pneumotaxic centres leading to extended expiratory period.

4. Increase in the voluntary breath holding time^{30, 31,32}

This may be due to acclimatization of the chemoreceptors of lungs to hypercapnea and hypoxia (decreased oxygen levels) or decreased responsiveness of respiratory centre or increased development of respiratory musculature leading to increased muscle endurance and delayed fatigue.

CONCLUSION

Pranayama aids in, strengthening of respiratory muscles, release of surfactant & prostaglandins, stimulation of stretch receptors, release of undue tension, adaptation of regulatory mechanisms and acclimatization of chemoreceptors. It is beneficial for the improvement of lung volumes and capacities in healthy and diseased (of restrictive & obstructive respiratory diseases).

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