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## Effect of Short Term Pranayama and Meditation on Respiratory Parameters in Healthy Individuals

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### ABSTRACT

**Context:** Pranayama is a technique of controlling and modulating breath and meditation, a process through which one attains a state of deep rest yet active state of mind. Recent studies on long-term yogic practices have shown improvements in respiratory functions.

**Aim:** The present study was done to evaluate the effects of pranayama and meditation on respiratory parameters.

**Settings and Design:** The present study was a comparative prospective study consisting of 50 (24 male and 26 female) healthy subjects of 20-60 years age.

**Methods and Material:** Participants fulfilling the inclusion and exclusion criteria underwent two hours daily yoga program for 15 days taught by yoga teacher. Pre and post yoga respiratory functions were assessed by measuring chest expansion, breath holding time and peak expiratory flow rate. The parameters were analyzed by Student t test.

**Results:** There was significant increase in chest expansion, breath holding time and peak expiratory flow rate compared to pre yoga practice. The response was similar in both genders, both age groups <40 yrs and >40yrs and both groups of BMI <25 kg/m<sup>2</sup> and >25 kg/m<sup>2</sup>.

**Conclusions:** This study showed beneficial effects of short term (15 days) regular pranayama and meditation practice on respiratory functions irrespective of age, gender and BMI in normal healthy individuals.

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**Keywords:** *Yoga, meditation, peak expiratory flow rate*

**Running title:** Pranayama And Meditation on Respiratory Parameters

### Introduction

Yoga, an ancient Indian science, aims to bring about functional harmony between body and mind through three main practices: asanas, pranayama and meditation. Pranayama means control of 'prana'. "Prana" in Indian philosophy, refers to all forms of energy in the

universe. Life force in an individual is symbolized by breathing. Breath is a dynamic bridge between the body and mind.<sup>[1]</sup>

When the life force is disrupted, it results in physical, mental, emotional and spiritual disharmonies. Pranayama helps in bringing conscious awareness to breathing and the reshaping of breathing habits and patterns.

The essence of the pranayama practice is slow and deep breathing which is economical as it reduces dead space ventilation. It also refreshes air throughout the lungs, in contrast with shallow breathing that refreshes air only at the base of the lungs. Thus, a yoga practitioner, through pranayama, can at some stage control other physiological functions and finally control manifestations of prana even outside the body.<sup>[1]</sup>

Meditation is a technique of extending our ordinary consciousness to reach higher states of consciousness and there by discovering more about ourselves. When we gain this insight we can change our habits and our deeper, inner personality has a better chance to show through. Our whole life changes for the better. Also meditation is often looked upon as a relaxation technique to be used for treating stress and stress related illnesses. Thus pranayama and meditation as a natural way of cleansing breath has been suggested as a route to healthy body and mind.<sup>[2]</sup>

Growing number of evidences have claimed that yoga practices increases longevity,<sup>[3]</sup> has therapeutic<sup>[4]</sup> and rehabilitative effects.<sup>[5]</sup> The beneficial effects of six weeks practice of different pranayamas are well reported and have sound scientific basis.<sup>[6]</sup> Different types of pranayama along with asanas produce different physiological responses in normal young individuals. Breathing exercises for three weeks are reported to influence cardiorespiratory and autonomic functions.<sup>[7]</sup> Raja yoga meditation has shown to reduce the resting respiratory rate, increase tidal volume and minute volume.<sup>[8]</sup> All these studies reported the effects of individual pranayama or meditation practice for minimum of three weeks to six months. Some studies also included the effects of asanas.

Since Pranayama and meditation have proven to have beneficial and therapeutic effects, in normal and diseased states alike, this study

was taken up to know the physiological effects of short term (15days) combined practice of pranayama and meditation in influencing respiratory status in healthy individuals of 20-60 yrs.

## **Subjects and Methods**

Ethical clearance for the study protocol was obtained from institute ethical committee (No. SNMC/ 2009-10/2351). 50 healthy subjects, 24 males and 26 females of age group 20-60 years were selected randomly from a group of participants visiting the yoga center who had not yet started practicing yoga but were keen on learning. The same subjects were chosen as both study as well as control group in order to minimize the confounding factors and make the study more reproducible.

Healthy individuals in the age group of 20-60 years with apparently no major illness, joining first time to yoga training were included. Subjects who were trained in yoga before, subjects with history of respiratory diseases, cardiovascular diseases and diabetes were excluded from the study. We also excluded subjects with neurological disorders and those who were not able to perform respiratory function tests. Subjects who smoked, consumed alcohol, or any drugs were excluded after taking their history.

The health of the subject was assessed by noting the present, past, family and personal history and also by a thorough general and systemic examination.

The subjects were explained about the importance and procedure of the study. An informed consent was obtained from all the members. The subjects were asked not to change their lifestyle during the 15 days of the study and were instructed not to perform any other physical exercises if they were not doing the same regularly.

All the data was collected from 5pm to 6pm. Data on physical characteristics such as age, height, weight and body mass index (BMI) was obtained. BMI was calculated as weight (kg) / height (m)<sup>2</sup>.

The study involved noninvasive procedures with no financial burden on the subjects. The subjects were informed about the procedures in brief and were asked to relax physically and mentally for 30 minutes in supine position in a silent room.

The chest expansion, breath holding time and peak expiratory flow rate were measured for assessing respiratory functions in standing posture.

Measurement of chest expansion during deep inspiration after deep expiration was done using a measuring tape at the level of the fourth intercostal space. Three such readings were taken at an interval of 5 minutes and the maximum reading was noted in centimeters<sup>4</sup>.

Breath holding time was measured in seconds from the time of holding breath after deep inspiration till the breaking point of the held breath by using a stop watch. The maximum value of three similar trials at 5 minutes interval was noted<sup>6</sup>.

PEFR was measured in liters per minute by mini Wright's peak flow meter (Air Zone peak flow meter, Clement Clarke International Ltd. England). The subject was asked to take a deep breath, place the mouthpiece of the peak flow meter firmly between the teeth and lips and then to blow out with a short sharp blast. The reading on the scale was noted. Each subject was given such three readings at an interval of 5 minutes and the maximum reading was noted<sup>6</sup>.

All the subjects were under uniform dietary habits and received same yoga training for a

period of 15 days for 2 hours daily between 6pm to 8pm.

The yoga practice schedule consisted of:

1. Prayer - 10 min.
  2. Pranayama - 45 min.
  3. Short break - 5 min.
  4. Lecture or film on fundamentals in nutrition, stress management, meditation and yogic attitude in daily life - 30 min.
  5. Meditation - 20 min.
  6. Prayer - 10 min.
1. The different types of Pranayama<sup>[2]</sup> practiced were –
  2. Vibhagiya Pranayama (sectional breathing)
    - Adama (Kanista) Vibhagiya Pranayama (diaphragmatic/abdominal breathing)
    - Madhyama Vibhagiya Pranayama (Thoracic/intercostal breathing)
    - Aadya (Jesta) Vibhagiya Pranayama (upper lobar/clavicular breathing)
    - Poorna mudra Pranayama (Full yogic breathing)
  3. Nadishuddi Pranayama (Alternate nostril breathing)
  4. Kapalabathi Kriya (cleansing breath)

- |   |  |
|---|--|
| 5. Bahya Pranayama (the external breathing) | 64.21±9.24 and the mean BMI (kg/m <sup>2</sup> ) was 25.31±3.29. Both the genders were age matched with significant variation in height (P<0.001), weight (P=0.003) and BMI (P=0.025). |
| 6. Cooling Pranayama                        |  |
| ➤ Sitali Pranayama                          |  |
| ➤ Sitkari Pranayama                         |  |

The session was concluded by meditation and prayer.

After 15 days, once again the respiratory status was assessed clinically in terms of chest expansion, breath holding time and PEFR recordings as before the start of pranayama and meditation training.

Results were presented as Mean ± SD. Student t test (two tailed, independent) has been applied using software (SPSS 15.0, Stata 8.0, MedCalc 9.0.1 and Systat 11.0) to find the significance of study parameters on continuous scale between two groups (Male vs. Female) and Student t test (two tailed, dependent) has been used to find the significance of study parameters on continuous scale within each group. P value less than 0.05 was considered as significant.

## Results

The age of the subjects ranged from 20-60 yrs, the mean age being 38.60±8.89 years. There were 6 cases in the age group of 21-30 years, 23 cases in the age group of 31-40 years, 17 cases between 41-50 years and 4 cases between 51-60 years.

Out of the 50 cases, 24 cases were males and 26 were females.

On analysis of the physical characters of the 50 subjects, the mean age (years) was 38.60±8.89, the mean height (cm) was 159.38±9.97, the mean weight (kg) was

### *Effect on Chest expansion*

The chest expansion of the participants significantly increased at end of 15 days yoga practice, irrespective of age, gender and BMI [Table 1].

### *Effect on Breath Holding Time (BHT)*

At the end of 15 days regular yoga practice, the mean breath holding time increased significantly [Table 2].

### *Effect on peak expiratory flow rate (PEFR)*

The mean PEFR of all the participants, at end of 15 days regular practice of yoga, increased significantly [Table 3].

## Discussion

On analyzing the effect of 15 days regular practice of pranayama and meditation in the present study, it was found that there was a highly significant increase in chest expansion, breath holding time and PEFR after yoga practice. Other studies have also reported significant increase in chest expansion<sup>[4, 9]</sup> and PEFR after yoga practice.<sup>[6, 10, 11]</sup> The increased chest expansion and PEFR due to regular practice of pranayama and meditation can be explained on the following basis:

Usually breathing is not a conscious event and is regulated automatically by the nervous

system through the respiratory centers located in the medulla oblongata and pons. These are the dorsal and ventral group of neurons located in the medulla, the pneumotaxic center and the apneustic center located in the pons. The activity of these respiratory centers is in turn modified by supra-pontine influences, in the conscious being. While the basic respiratory rhythm in normal situations is maintained by the impulses discharged by the dorsal group of neurons, the pneumotaxic center indirectly controls the duration of inspiration and helps in relaying the suprapontine impulses which promote voluntary inspiration and expiration.<sup>[6]</sup> We believe that during daily practice of pranayama the basic activity of the bulbo-pontine complex is modified in such a way as to slow down its rhythm. Thus after continuous practice of pranayama for few weeks, the bulbo-pontine complex is adjusted to the new pattern of breathing which is slower than its basal rhythm. Also by voluntarily prolonging the phase of inspiration and expiration, the respiratory muscles are stretched to their full extent and the respiratory apparatus is able to work to their maximal capacity represented by increased chest wall expansion and lung volumes.<sup>[12]</sup>

Regular practice of slow and deep breathing exercises improves muscle strength and flexibility due to work hypertrophy.<sup>[13]</sup> Vibhagiya pranayama (sectional breathing) practice increases thoracic-pulmonary compliances by more efficient use of diaphragmatic and abdominal muscles, thereby emptying and filling the respiratory apparatus more efficiently and completely. Pranayama cleanses airway secretions, acts as a major physiological stimulus for the release of lung surfactant and prostaglandins into alveolar spaces which increases lung compliance.<sup>[6]</sup> Stimulation of pulmonary stretch receptors due to maximum inflation of the lungs reflexly relaxes smooth muscles of

larynx and tracheo-bronchial tree which modulates the caliber of airways and reduces airway resistance. Thus opening of small airway and reduced airway resistance increases PEF. Also pranayama practice for short term increases maximum expiratory pressure and flow rate. Like other types of exercises, yoga practice decreased reaction time, indicating improvement of neuromuscular system.<sup>[7]</sup> Pranayama along with meditation has calming effect on mind and reduces emotional stresses in asthma patients. Further deep and controlled breathing desensitize the sensory nerve endings and reduce the allergic conditions of the environment.<sup>[4]</sup>

The significant increase in BHT in the present study is consistent with previous studies.<sup>[6-8]</sup> In normal breathing after a particular degree of stretching or even before this, stretch receptors in alveoli are stimulated and send information to the respiratory centers so that exhalation sets in. But in pranayama there is continuation of the phase of inhalation with strong voluntary control so that lungs are expanded considerably and the walls of the alveoli are stretched to the maximum extent. Thus the chest continues to get expanded under cortical control. The stretch receptors are thus trained to withstand more and more stretching. This helps in holding the breath for a longer time. As the duration of breath holding during pranayama is gradually increased by practice, the respiratory center is acclimatized to withstand higher and higher carbon dioxide concentrations in the alveoli and the blood. Also, the subject keeps his voluntary muscles relaxed and immobile while at the same time exercising a close and continuous voluntary control over respiratory muscles, thus consciously and persistently over-riding the usual excitatory stimuli to respiratory centers. Also the receptors get acclimatized to the increased concentrations of carbon dioxide

gradually by regular practice of pranayama.<sup>[14]</sup>

In addition, increased development of respiratory musculature and endurance due to regular practice of pranayama delays the onset of fatigue, thus allowing the breath holding for longer time. Practice of meditation along with pranayama produces a hypometabolic state<sup>[15]</sup> of the body characterized by decreased carbon dioxide production and decreased oxygen consumption, thus allowing breath holding for a longer time.<sup>[6]</sup>

In the present study, the responses to 15 days of regular combined practice of pranayama and meditation were also assessed with respect to age, gender and BMI. It revealed that both males and females responded similarly to the yoga practice. Similar observations in both genders in respiratory parameters were also reported by previous study.<sup>[6]</sup>

When compared age wise, it revealed similar response to 15 days of pranayama and meditation practice in both age group  $\leq 40$  years and age group  $>40$  years. Similarly when compared with respect to BMI, there was significant improvement of respiratory functions in both BMI  $< 25$  and BMI  $> 25$  kg/m<sup>2</sup>.

Although a significant increase in chest expansion, BHT and PEFr after the yoga practice in the present study is in accordance with the findings of other studies on physiological effects of yoga practice in healthy individuals, the present study has some differences. The present study involved regular combined practice of pranayama and meditation for 15 days, whereas other studies reported the effects of individual pranayama or meditation practice for minimum of 4 weeks to 6 months. Some studies also included the effects of asanas.

Most of the studies conducted so far have generalized their results irrespective of age, gender and BMI of the subjects. Very few studies have been conducted on subjects above 40 years. In the present study, an attempt was made to fill up these lacunae.

Thus in a nutshell, with this study, it is proved beyond doubt, that regular practice of pranayama and meditation for minimum of 15 days is beneficial in improving the respiratory functions even in healthy individuals irrespective of age, gender and BMI. The results of this study and their explanations would justify the incorporation of yoga as part of our lifestyle in promoting health and thereby preventing age related respiratory diseases.

However, it remains to be assessed whether these changes persist after resuming normal respiration and whether long term practice will lead to stable modifications of respiratory control.

## Limitations of the study

The limitations of the present study are reduced population and lack of measurement of others respiratory parameters.

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**Table 1: Effect of yoga on Chest expansion (cm)**

Group	No. of cases	Before yoga	After yoga	t value	P value
Total	50	2.90 ± 1.28	3.82 ± 1.36	14.29	<0.001
Males	24	3.45 ± 1.45	4.45 ± 1.53	10.14	<0.001
Females	26	2.40 ± 0.87	3.25 ± 0.86	10.19	<0.001
Age <40yrs	29	3.27 ± 1.45	4.33 ± 1.43	12.094	<0.001
Age >40yrs	21	2.46 ± 0.89	3.22 ± 0.98	8.949	<0.001
BMI<25	25	3.20 ± 1.19	4.12 ± 1.28	9.753	<0.001
BMI>25	25	2.60 ± 1.32	3.53 ± 1.39	5.749	<0.001

**Table 2: Effect of yoga on Breath Holding Time (sec)**

Group	No. of cases	Before yoga	After yoga	t value	P value
Total	50	33.23 ± 10.48	38.59 ± 11.23	8.740	<0.001
Males	24	37.18 ± 12.09	41.83 ± 12.49	4.662	<0.001
Females	26	29.57 ± 7.19	35.60 ± 9.19	8.205	<0.001
Age <40yrs	29	36.28 ± 9.89	42.53 ± 10.17	13.395	<0.001
Age >40yrs	21	29.65 ± 10.19	33.96 ± 10.82	3.852	<0.001
BMI<25	25	32.76 ± 10.98	38.29 ± 12.32	7.540	<0.001
BMI>25	25	33.69 ± 10.15	38.89 ± 10.28	5.206	<0.001

**Table 3: Effect of yoga on Peak Expiratory Flow Rate (liters/min)**

Group	No. of cases	Before yoga	After yoga	t value	P value
Total	50	373.40±101.83	401.70±103.19	10.846	<0.001
Males	24	430.80±111.79	458.75±111.57	8.402	<0.001
Females	26	321.15±53.99	349.04±58.75	7.036	<0.001
Age <40yrs	29	394.81±91.75	427.59±92.27	8.592	<0.001
Age >40yrs	21	348.26±109.19	371.30±108.93	7.129	<0.001
BMI<25	25	379.20±68.19	408.80±75.41	6.648	<0.001
BMI>25	25	367.60±128.27	394.60±126.29	9.647	<0.001