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SHORT COMMUNICATION

Improvement in Ventilatory Function through Yogic Practices

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Abstract: *Objective:* The present study was carried out to evaluate the effect of three months yogic practices on ventilatory functions. *Methods:* Sixty (n=60) healthy male volunteers (age range 21–33 years and height of 174.8 ± 3.52 cm) drawn randomly from BSF personnel participated in the study. Participants practiced yoga under supervision of professional yoga instructor, two hours daily five days a week, along with their daily routine activities. Standing height, weight and dynamic lung function tests viz. Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1) and Maximum Voluntary Ventilation (MVV) were measured before and after 3 months of yoga training. Tiffeneau index (TI) was calculated before and after the said training. *Results:* After three months of yogic practice, there was no significant change in body weight with a trend of reduction. MVV increased significantly ($P < 0.01$) while the other parameters viz. FVC, FEV_1 and TI did not change significantly. *Conclusion:* Increase in MVV indicates that yogic practices improve the pulmonary capacity of practitioner which can help in enhancement of ventilatory functions.
Key words: Yoga, Maximum voluntary ventilation, Ventilatory function, Ventilatory muscle, Tiffeneau index.

Introduction

Yoga, the ancient Indian philosophical and religious tradition, is rapidly gaining its popularity as a major stream of complementary and alternative medicine. It is the science of simple living that enlightens all aspects of life – the physical, mental, emotional, psychic and spiritual. By the practice of asana, pranayama, mudra, bandha, shuddhi kriyas and meditation yoga help in balancing and harmonizing the body, mind and emotions [1]. Effect of yogic practices on respiratory function has been an important area of research for decades. Practicing yoga, in addition to its contribution in the improvement of pulmonary ventilation and gas exchange, helps in the prevention, cure and rehabilitation of many respiratory illnesses by improving ventilatory function [2-3]. Physical performance of an individual depends upon strength and endurance of both locomotive muscles (LM) and ventilatory muscles (VM). Maximal voluntary ventilation (MVV) measures the strength and endurance of respiratory muscles. It is a non-invasive method to assess respiratory muscle performance, using a short-term respiratory endurance task [4].

Specific training of respiratory muscles increases the strength and endurance of respiratory muscle and enhances MVV [5]. Nevertheless, there are reports to state that ventilatory muscle endurance training (VMET) can improve MVV and VM power as well as cycling and swimming endurance [6-7]. Though, reports are available on the effect of yogic practices on ventilatory function of sedentary Indian adults and diseased persons. Yet there is still paucity of information about the same with respect to physically active healthy Indians. Moreover there is very few or no report on the impact of specific yogic training package on the improvement of pulmonary function in physically active moderate workers, especially in paramilitary personnel. Literature is also meager about effect of yogic exercise on MVV and Tiffeneau index. The present study was therefore conducted to evaluate the effect of three months yogic practice on lung functions of physically active young healthy Indian male from paramilitary forces.

Material and Method

Sixty (n=60) healthy males with age range 21-33 years and height 174.8 ± 3.52 cm (M ± SD), selected randomly from BSF (one of the Indian paramilitary forces) personnel participated in the study. The volunteers did not have any previous exposure to yogic practices and were free from any clinical disorders. They had a uniform pattern of daily activity and diet from a common source canteen. All the participants were explained the purpose and value of the study and individual written informed consent was obtained from each of them. Yogic training was imparted for three months by certified professional Yoga Teacher, appointed by Morarji Desai National Institute of Yoga (MDNIY), New Delhi. The yoga training session consisted of practical class for ninety minutes in the morning followed by theory class for thirty minutes in the evening. Practical session included prayer, yogic sukshma and sthula vayama, suryanamaskar, shuddhi kriyas (yogic internal cleansing practices), yogasanas, pranayamas and meditation as prescribed by MDNIY, New Delhi. The details of practice in the sequential order are presented in Table 1.

Table-1: Contents of yogic package practiced by the volunteers for three months training programme

1. Prayer

2. Yogic Sukshma Vyama

i. Griva-shakti-vikasak
ii. Skandh-tatha-bahumal-shakti-vikasak
iii. Bhujbandh-shakti-vikasak
iv. Kohni-shakti-vikasak
v. Bakshasthala-shakti-vikasak
vi. Udar-shakti-vikasak
vii. Kati-shakti-vikasak
viii. Jhangha-shakti-vikasak
ix. Janu-shakti-vikasak
x. Padmul-shakti-vikasak
xi. Gulf, padprisht, padtal-sakti-vikasak

3. Yogic Sthula Vayama

i. Rekha -Gati
ii. Hridaya -Gati
iii. Utkurdana
iv. Urdhrava-Gati
v. Sarvnga-Pushti
vi. Sirsasana

4. Surya Namaskar

5. Shuddhi Kriyas

i. Dhauti: Vaman Dhauti (Kunjal)
ii. Vasti: Shankhaprakshalana
iii. Neti: Sutra Neti and Jala Neti
iv. Nauli
v. Trataka
vi. Kapalbhati

6. Yogasana

Meditative Asanas

i. Sukhasana
ii. Siddhasana
iii. Padmasana
iv. Vajrasana

Cultural Asanas

Standing Posture Asanas

i. Tadasana
ii. Urdhava-hastotanasana
iii. Kati Chakrasana
iv. Ardha Chakrasana
v. Padahastasana
vi. Trikonasana
vii. Virbhadrasana

Sitting Posture Asanas

i. Utthita Padmasana
ii. Ardha Matsyendrasana
iii. Ustrasana
iv. Gomukhasana
v. Simhasana
vi. Uttana Mondukasa
vii. Parvatasana
viii. Janu Sirshasana
ix. Paschimottanasana

Prone Lying Posture Asanas

i. Bhujangasana
ii. Shalabhasana
iii. Dhanurasana

Supine Lying Posture Asanas

i. Ardha Halasana
ii. Pavanmuktasana
iii. Matsyasana
iv. Halasana
v. Karnapidasana
vi. Chakrasana
vii. Uttanapadasana

Relaxative Asanas

i. Savasana
ii. Makrasana

7. Pranayama

i. Nadi Shodhana Pranayama
ii. Surya Bhedi Pranayama
iii. Ujjayi Pranayama
iv. Shetali Pranayama
v. Sheetkari Pranayama
vi. Bhramari Pranayama (all with Kumbhaka)

8. Banhas and Mudras

Bandhas

i. Jalandhara Bandha
ii. Uddiyana Bandha
iii. Moola Bandha

Mudras

i. Yoga Mudra
ii. Shanmukhi Mudra
iii. Simha Mudra
iv. Viparita Karani Mudra

9. Meditation

Parameters were recorded before and after the yogic training. There was no dropout of volunteers during the entire course of the experiment. The standing body height in cm and body weight in kg was measured using standard anthropometer and electronic weighing machine (Delmar, India) respectively. Pulmonary function test (PFT) was performed by using digital spirometer (Pony FX, COSMED, Italy). After getting adapted to the instrument set-up and process involved, the volunteers were instructed to perform the pulmonary function test for three times and the best of the three results was considered for record. The parameters recorded were Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1) and Maximum Voluntary Ventilation (MVV). Tiffeneau index was derived as the ratio of FEV_1 to FVC multiplied by 100. Statistical analysis was done using SPSS 13.0 and values were expressed as Mean ± SD. The data underwent Student's *t*-test for large ($n > 30$) paired samples to test the significance of difference. The computed *t* was compared with the critical *t* scores for different levels of significance to accept or reject Ho. Statistical significance was set at $P \leq 0.05$.

Result

The physical and physiological responses of the participants before and after practicing yoga are presented in Table 2. There was no significant difference observed in body weight before and after yogic practices. FVC and FEV_1 did not show any significant change, though a trend of improvement was observed. Tiffeneau index also registered a non-significant trend of increase after yogic training. MVV increased significantly ($P < 0.01$) after three months of yogic practice.

Table-2: Comparison of body weight and pulmonary function before and after the yoga training

Parameters	**Pre-training** (n=60)	**Post-training** (n=60)
Body weight (kg)	69.6 ± 7.17	67.4 ± 6.41
Forced Vital Capacity (L)	4.4 ± 0.42	4.5 ± 0.41
FEV_1 (L)	3.7 ± 0.42	3.8 ± 0.42
Maximum Voluntary Ventilation (L/min)	154.2 ± 31.22	170.5 ± 27.50 *
Tiffeneau index [(FEV_1/FVC)*100]	84.1 ± 5.84	84.4 ± 7.84
Values are expressed as Mean ± SD. * = $P < 0.01$.		

Discussion

In the present study, a significant increase in MVV was observed as a result of three months yogic practice alongwith a non-significant trend of increase in FVC, FEV_1 and Tiffeneau index. Respiratory system uses many muscles and other interlocking movements. Regular yogic practices can help in the improvement of total pulmonary function by increasing efficiency and performance of these muscles and movements [2-3]. Yogic breathing maneuvers inflate lung near to total lung capacity that help in release of lung surfactant and prostaglandins into alveolar spaces which increase lung compliance and decrease bronchial smooth muscle tone, respectively [2,8-9]. Appropriate yogic breathing maneuvers can improve pulmonary muscular strength and efficiency [10], which can ultimately help in the improvement of lung volumes and capacities [11]. Yogic cleansing processes (shuddhi kriyas) help in the removal of infective nasal secretions from respiratory tract thereby increase total lung capacities and volumes [2].

It has been established that regular practice of yogic asanas and pranayamas, as a non-pharmacological approach to treat a diseased person, could improve overall pulmonary performance [12-14]. Significant increase in MVV, observed in our study, might be due to increased strength and/or endurance of respiratory muscles [6], more specifically VM – the diaphragm and the intercostals. MVV was improved by the likely integrated interaction of various components of the respiratory system like respiratory muscles, chest wall, alveoli and airways – probably mediated by increased lung compliance; which in turn, could be a result of enhanced release of lung surfactants and prostaglandins [8-9].

Performing various yogic stretching and yogic balancing acts could improve strength and flexibility of respiratory muscles [15]. Moreover yogic breathing maneuvers intends to change the breathing pattern from chest breathing, which involves intercostals muscles and other accessory muscles, to abdominal breathing pattern, which uses the diaphragm in addition to the formers [16]. Reduction in ventilatory muscle strength and / or endurance due to hypobaric hypoxia affects exercise capacity and thereby human performance [17]. Thus by improving the strength and endurance of VM through yoga, onset of VM fatigue could be delayed, which could then led to improvement of physical performance. VM fatigue could be a cardinal limitation for human performance in sports, mountaineering and vigilance in high altitude areas. Prior training of VM, with the help of yoga, might improve performance in those areas or prevent further deterioration.

It might thus be concluded from the study that, regular yogic practice for three months resulted in the improvement of MVV. This increased ventilatory endurance, in turn, might be beneficial in augmentation of human performance where strength and endurance of ventilatory muscles could play a pivotal role; which might partly also be attributed to by the non-significant increase in FVC, FEV_1 and Tiffeneau index.

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