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Effect of duration of yoga training on pulmonary function tests and respiratory pressures in sedentary healthy adult population of Nagpur

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Abstract: *Objective:* The aim of the current study was to study the minimum duration of yoga training required to induce favorable changes in pulmonary functions in normal healthy sedentary adults. *Background:* Effect of Yoga training on Pulmonary Function Tests (PFTs) is well established. It is matter of interest at what point beneficial effects of Yoga starts. *Method:* It was prospective observational study. 60 healthy, sedentary adults (32 males and 28 females) in the age group of 20 to 45 years were selected. They were given yoga training for 45 minutes, five days a week for 8 weeks. The PFTs i.e. Forced Expiratory Volume (FEV), Forced Expiratory Volume at the end of one second (FEV1), Peak Expiratory Flow Rate (PEFR), Respiratory Pressures i.e. Maximum Inspiratory Pressure (MIP) and Maximum Expiratory Pressure (MEP) were measured at zero week, at 4th week and at 8th week. The data was statistically analyzed by One-way Repeated measure ANOVA test. *Result:* Our study showed marginal improvement in above parameters at the end of 4 weeks but at the end of 8 weeks the improvement was statistically significant. *Conclusion:* Yoga training of 8 weeks is required for significant improvement in PFTs and respiratory pressures healthy sedentary adults.
Keywords: Yoga, PFT, MEP, MIP

Introduction

The modality of exercise that is most economic and beneficial for population has now become the topic of research [1]. Yoga training is not a mere physical training. It includes postural asana, controlled breathing (pranayama) and proper relaxation. Thus, it is an integrated training. Now a days yoga is getting lot of popularity. Many people are inclined towards practice of yoga for health promotion. It is imperative to do continuous research work on yoga training to provide scientific and updated information to society for its benefit. The pulmonary functions have been identified as a long-term predictor for overall survival rates as well as a tool in general health assessment [2]. Many studies are available showing the favorable effect of yoga on PFTs and respiratory pressures [3-16].

These studies were done for variable duration of time. None of studies showed at what point the significant beneficial effects on pulmonary functions started. For obvious reasons benefits of yoga depend on duration of yoga training/practice. Long term practice of yoga gives more health benefits. The current study was planned to test the effect of duration of yoga training on pulmonary functions and respiratory pressures in normal healthy and sedentary adults of Nagpur and to determine after what duration of yoga practice the beneficial effects on PFT's become significant.

Material and Methods

Study set up: It was prospective observational study. The study was conducted in Department of Physiology in co-ordination with Yoga Centre of City.

Study group: Healthy males and females with normal physical examination and with sedentary occupations between 20 and 45 years of age were included in the study. The employees from offices of Two Government medical colleges of city were motivated to participate in the study by explaining plan of the study to them. The recruitment was purely on the voluntary basis. After screening and fulfillments of inclusion and exclusion

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criteria, volunteers were recruited in the study. Study group consisted of 60 subjects out of whom 32 were males and 28 females. Volunteers had not been engaged in yoga practice nor were they doing any physical exercise at least during 3 years preceding the study as assessed by enquiring in detail. subjects who were in non-sedentary occupations, Smokers, alcoholics, post operative patients and subjects suffering from any hernia, pregnant females, subjects with history of any cardiovascular disorder, any active respiratory disorder were excluded by thorough history and clinical examination.

Ethics: After explaining the purpose and design of study written consent was taken from the subjects. The protocol of project was submitted to institutional ethics committee and the project was started after approval.

Study protocol: Sixty volunteers were divided into cohorts of 15 subjects each. At the outset of study baseline parameters i.e. height in cm & weight in kg and PFTs were measured in a single day for one cohort. The subjects of that cohort were motivated for the yoga training and they were given yoga training at yoga center of the city for eight weeks. After fourth and eighth weeks of yoga by all fifteen subjects in that cohort, all the PFT parameters were again studied. After baseline parameters were recorded for one cohort and the training started for that cohort, the next cohort was subjected to same treatment.

Subjects were instructed not to practice any yogic techniques or any form of exercise during study other than the prescribed ones. Participants were allowed to do their routine activities during the study period. Subjects were motivated regularly for training for compliance needed till the end of the study. All the subjects were instructed about the steps of integrated yoga training which was of 45 minutes duration from 6 am to 6:45 am in yoga center from Monday to Friday for eight weeks. Integrated Yoga Module as prescribed by Swami Vivekananda Yoga Anussandhana Sansthan (SVYASA) Bangalore was followed [17].

It was done under supervision. Module included following practices,

Breathing practice	5 min
Instant Relaxation technique	1 min
Loosening exercises	5 min
Quick relaxation technique	2 min
Asana	15 min
Preparation for Pranayam i.e. Sectional breathing	2 min
Kapalbhati	30 sec to 1min
Pranayam (Nadi-shuddhi)	(6 rounds) 4 min
Deep Relaxation technique	10 min

Yogasanas practiced were chakrasana, padmasana, tadasana, pashchimottanasana konasana, utkatasana, sarvangasana, dhanurasana, halasana, makarasana, vajrasana, virasana. There was no drop out of subject from any cohort during study. Recording of pulmonary function tests i.e. FEV, FEV1 and PEFR, respiratory pressures i.e. MIP and MEP was done at zero weeks, at end of 4^{th} week and at the end 8^{th} week. These recordings were done on days of rest (no yoga done on that day) in the morning about 2 h after a light breakfast by single investigator.

Recording of Respiratory pressures: MEP and MIP were measured by using instrument MedGraphics Breezesuite ultima pfx (M/s Biotronics Equipment Pvt. Ltd, 401, Bangashree Tower, Daji Ramchandra Road, Charai, Thane, Maharashtra 400601). Procedure was explained and demonstrated to subjects. They were made familiar with instrument and procedure for performing the test. Procedure was done with the subject in sitting position and breathing was done through mouthpiece connected to machine.

Maximum inspiratory pressure (MIP) was recorded by asking the subject to breathe in voluntarily with maximal efforts from the end of maximal and forceful expiration against a mouthpiece valve system that was occluded at residual volume. Maximum expiratory pressure (MEP) was recorded by asking subject to breath out voluntarily with maximal efforts from the end of maximal and complete inspiration (i.e. total lung capacity) against a

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mouthpiece valve system that was occluded at total lung capacity. Values of MIP and MEP were recorded in mmHg. The procedure was done in three attempts and the best of three attempts was selected. Enough recuperation was provided between attempts to avoid short term fatigability of the respiratory muscle.

Recording of Pulmonary function tests: Pulmonary function tests were recorded by same instrument with proper demonstration. The tests were performed in sitting position. The subject was asked to take full inspiration which was followed by as much rapid and forceful expiration as possible in the mouthpiece with the nostrils closed. Three consecutive readings were taken and the best reading among three was selected and noted. One single expiratory effort gives readings about many parameters. Out of these FEV, FEV1, PEFR were selected.

Statistical analysis: All the data was collected and subjected to statistical analysis. Demographic, PFTs and Respiratory Pressures were presented as Mean $\pm$ S.D. One-way Repeated measure ANOVA test was performed to compare the differences at different time points. Pair wise comparison was performed to compare difference between any two time points. $P< 0.05$ was considered as statistically significant. Statistical software STATA version10.0 and SPSS version 16.0 were used for statistical analysis.

Results

Table-1: Demographic characteristics of study subjects

Variable	Mean	SD$\pm$	Range
Age in years	33.45	8.05	20-45
Height in cm	165.31	7.66	152-190
Weight in kg	60.1	9.42	44-83
BMI	21.9	2.36	17.1-26.1

Table-1 depicts the demographic characteristics of study population. Table 2 shows the Effect of Duration of Yoga Training program on PFTs and Respiratory pressures along with comparison at different follow up. Values of FVC, FEV1, PEFR, MEP and MIP at zero week, 4 week and 8 week were found to be statistically highly significant by One-way Repeated measure ANOVA test (respective F values are, FVC=284.05, FEV1=235.04, PEFR=252.40, MEP=259.73 and MIP235.01). All the PFT respiratory pressure values were marginally increased at the end of 4 weeks of training but significantly increased at the end of eight weeks of training.

Table-2: Effect of Duration of Yoga Training program on PFTs and Respiratory pressures along with comparison at different follow up

Parameter	Before $\pm$ SD	4 week	8 week	Comparison Before vs. 4 week (Mean Difference and p value)	Comparison Before vs. 8 week (Mean Difference and p value)
Mean FVC(l)	3.43 $\pm$ 0.52	3.46 $\pm$ 0.52	3.78 $\pm$0.49	-0.021 P value=0.108	-0.345 P value <0.001
FEV1 (%)	81.11 $\pm$ 2.92	81.5 $\pm$3.03	86.8 $\pm$ 3.17	-0.383 P value=0.075	-5.683 P value<0.001
PEFR (l/min)	426.91 $\pm$ 43.51	429.18 $\pm$ 43.72	461.5 $\pm$ 40.97	-2.067 P value= 0.062	-34.58 P value<0.001
MEP cm of H2O	106.38 $\pm$17.09	106.77 $\pm$ 17.25	115.55 $\pm$ 18.58	-0.383 P value=0.273	-9.167 P value<0.001
MIP cm of H2O	80.8 $\pm$ 10.77	81.06 $\pm$10.70	88.35 $\pm$ 11.4	-0.267 P value=0.609	-7.550 P value<0.001

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Discussion

Better pulmonary functions in subjects performing yoga are documented [3-16]. However, significant improvements in FVC, FEV1 and PEFR and respiratory pressures have been reported following yoga training by some authors in their studies [9, 18-19]. Some studies were done for minimum of three weeks and some to six months [9, 18]. In these studies PFT parameters were recorded at the outset of study and then at the end of study. No where during the course of study PFT parameters were recorded. Hence it becomes very difficult to determine at what moment the beneficial effect of yoga started significantly.

The present study was undertaken to determine after what duration yoga shows significant beneficial effects on PFTs. In our study, All the PFT parameters and Respiratory pressures were improved significantly at the end of 8 weeks as compared to 4 weeks of yoga training. Loosening exercises warm up the body, enabling blood to flow to all parts of body and preparing the body for subsequent main part of training. Since, Lung ventilation is controlled by skeletal muscles; MEP and MIP depend on the strength of expiratory muscles and strength of all inspiratory muscles respectively. During pranayama, filling of lungs to maximum (Total lung capacity) caused by deep inspirations and breath holdings as done can lead to increase in the maximal shortening of the inspiratory muscles. Frequent practice leads to improved strength of inspiratory muscles which has been shown to improve the lung function parameters [20].

Yoga postures involve isometric contraction which is known to increase skeletal muscle strength [15]. Yogis have significantly higher peak expiratory flow rates presumably due to respiratory muscle conditioning [11]. Kapalbhati produces short powerful strokes of exhalation in quick succession with contraction of abdominal and diaphragm muscles which trains the subject to make full use of diaphragm and abdominal muscles in breathing [14]. Thus yoga training improves the strength of expiratory as well as inspiratory muscles which in turn Increase in MEP and MIP. In addition to improved respiratory muscle performance, increased FEV1 in yogic practitioners may be because of improved patency of airways [16, 21].

During pranayama all the maneuvers i.e. deep inspiration up to TLC and prolonged expiration up to residual volume, are done through nostrils which offer resistance by means of decreased cross sectional area and turbulence. Breathing through one nostril in Anulom-vilom (Nadi shuddhi) pranayama further increases the resistance. Higher peak expiratory flow rates and FEV1 could be explained due to better strengthening of respiratory muscles in yogis. By yoga practice respiratory apparatus is emptied and filled more completely and efficiently which is recorded in terms of increased forced vital capacity (FVC) [12-13]. Increased and controlled movement of diaphragm during pranayama improves its strength which also explains the improvement in vital capacity. In yogasanas undue tension from the skeletal muscles is removed which helps the thorax to relax better than before. All these practices seem to increase expiratory reserve volume (ERV) thereby increasing the vital capacity [14].

Lung inflation near to total lung capacity is a major physiological stimulus for the release of lung surfactant and prostaglandins into alveolar space, which increases lung compliance and decreases bronchiolar smooth muscle tone, respectively [16,20,22]. Yoga with its calming effect on the mind can reduce and release emotional stresses, hereby withdrawing the broncho-constrictor effect [12, 14, 22]. By practicing pranayama, the various reflex mechanisms that control respiratory center in bulbopontine area may be altered or modified by producing a strong cortical force thereby increasing the breath holding time or decreasing the resting respiratory rate [21, 23]. We conclude, by regular practice of integrated yoga training significant improvement in Pulmonary Functions and Respiratory pressures were reported after minimum of eight weeks in healthy and sedentary adult population of Nagpur.

The strength of the study is that it gives idea about the minimum duration for practice of yoga to induce significant favorable changes in pulmonary functions. This will be of definite help to the patients who are advised

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Integrated Yoga Therapy. Limitation of this study is, it was done in small geographical area and Pulmonary functions are influenced by variety of factors outside the small geographic area, hence further studies with bigger sample size, covering large geographical area be carried out to know the minimum duration of yoga practice.

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