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TO STUDY AND EVALUATE THE PULMONARY FUNCTION TESTs IN INDIAN CLASSICAL SINGERS AND COMPARE THEM WITH THAT OF NON-SINGERS

[*1]Dr. Shivali Barwal, [2]Dr. Yuvraj Gharu, [3]Dr. Minoo Sharma and [4]Dr. Luxmi Gharu

[1]Department of Tele-Medicine, I.G.M.C., Shimla.
[2]Professor, Department of Physiology, I.G.M.C., Shimla.
[3]Associate Professor, Department of Physiology, I.G.M.C., Shimla.
[4]Associate Professor, Department of Music (Vocal), R.K.M.V., Shimla.

***Corresponding Author: Dr. Shivali Barwal**

Department of Tele-Medicine, I.G.M.C., Shimla.

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ABSTRACT

An Observational Retrospective Cohort Study titled "To study the effects of Indian Classical Singing on cardiac and pulmonary parameters" was conducted in the department of Physiology, IGMC, Shimla. Singing has been associated with physiological effects, including changes in both the cardiovascular and pulmonary systems. The pulmonary parameters evaluated in this study are the PFTs, mainly FVC, FEV1, FVC%, FEV1%. Studies of classical singers have shown that they tend to begin phrases at high lung volumes and end at low lung volumes.[1] Singing requires increased initiation volumes, closer to 70% to 100% VC, than either speaking (60% VC) or breathing at rest (40% VC).[2] The increasing strength of expiratory muscles is a probable reason for the increasing vital capacity in the singers group. Aim of current study was to study and evaluate the PFTs in Indian classical singers and compare them with that of non-singers. **Material and Method:** For the study group 45 trained Indian classical singers were selected from the degree colleges, private musical academies of Shimla and Himachal Pradesh University, Shimla. In the control group 45 age and sex matched subjects were included from amongst healthy volunteers (from IGMC or Degree colleges). PFTs were measured by using an electronic portable PC based spirometer with printer (MODEL-VITALOGRAPH COMPACT-II, BUCKINGHAM, ENGLAND) spirometer. The data was evaluated statistically. **Results:** Significant improvement in the PFTs is seen after regular practice of singing especially the Indian classical singing as hypothesised in the present study. **Conclusions:** In the light of the results in the current study, it appears reasonable to conclude that the professional singers who have an increased potential for singing, the pulmonary and cardiovascular parameters are influenced to a great extent. There is growing interest in Singing for Lung Health (SLH), an approach where patients with respiratory disease take part in singing groups, intended to improve their condition.[3]

KEYWORDS: PFTs, FVC, FEV1, FVC%, FEV1%.

INTRODUCTION

Pulmonary function tests fulfil a pivotal role in respiratory medicine. They are used to diagnose airways obstruction, assess its severity and prognosis, delineate risk factors (e.g. preoperative assessment), detect early lung disease, and monitor for normal lung growth and lung function decline.

Unlike the majority of biological indices in medicine, such as plasma concentrations of chemical analytes or hormones, pulmonary function varies with age, standing height, sex and ethnicity. Therefore, test results should be compared to predicted values, and lower and upper limits of normal (LLN and ULN respectively) that are appropriate for the individual being tested.[4]

Singing requires a wider range of lung volumes than either speaking or other phonatory tasks and therefore requires increased muscle activity to control the pressures that result. Thus exercises that strengthen the respiratory muscles also affect the lung volumes.

We hypothesized that the PFTs of Indian classical singers would be markedly better than that of the normal subjects and also, more the duration of singing, the better the PFTs.

Hence we aimed to study and evaluate the PFTs in Indian classical singers and compare them with that of non-singers. We also tried to correlate the duration of singing with various PFT variables in study group of singers.

METHODS

The present study is an observational retrospective cohort study, conducted in the Department of

Physiology, Indira Gandhi Medical College of Shimla and in the Degree Colleges of Shimla.

In the present study pulmonary function tests of 45 students of Indian Classical Music were performed and then compared with 45 age and sex matched controls from various Colleges in Shimla.

The subjects were selected after following the inclusion criteria and proper history taking was done.

SELECTION OF SUBJECTS

Inclusion Criteria

1. Willingness to participate in the study.
2. Healthy students who had been learning Indian classical music and were singing regularly for atleast 2 years.
3. Age between 18 years to 35 years.
4. Performing Indian classical singing for 4to 6 hours daily.

EXCLUSION CRITERIA

1. Age less than 18 and more than 35 years old.
2. Singing as religious songs of any religion.
3. Smokers.

Selection of Controls

INCLUSION CRITERIA

1. Willingness to participate in the study.
2. Those who do not perform activities like singing, yoga or gym class which use vigorous respiration training for minimum 2years.
3. Age between 18years to 35years.

EXCLUSION CRITERIA

1. Age less than 18 and more than 35 years old.
2. Those with the historic or clinical evidence of any neuromuscular illness likely to affect the performance of spirometric PFT's (e.g. limited joint mobility etc.).
3. Those who could not perform acceptable and repeatable spirometry.

SPIROMETRY

The subjects were instructed and demonstrated on how to perform the tests. The subject was made to sit and relax for approximately fifteen minutes prior to recording.

1. The subject was asked to perform the test in standing upright posture. First time they were instructed to take maximum inspiration and blow into the instrument rapidly and forcefully.

Second time they were asked to take maximal inspiration and make a prolonged forceful expiration followed by re-inspiration from the mouth piece. A close watch was kept to ensure that a tight seal is maintained between the lips and the mouthpiece of the device. The spirometric parameters were recorded.

2. At least three readings were taken and the highest reading at any testing session was used in trend analysis. All values were corrected for body temperature, air pressure and water saturation (BTPS).
3. Spirometric data was recorded as.

a) Absolute measures.

b) Percent of those predicted for age, sex and height

-Predicted values were calculated from the regression equation.

4. The indices which were measured in the study include.

- Forced vital capacity(FVC)
- Forced expiratory volume in one second (FEV1)
- FEV1/FVC ratio
- Peak expiratory flow rate (PEFR)
- Forced mid expiratory flow ($FEF_{25-75\%}$)

STATISTICAL ANALYSIS

Sample size was calculated by using the parameter FVC in liters, mean difference of 0.18 (Bandopadhyay et al)[5] considering confidence interval (two-sided) 95%, power 80%, ratio of two groups 1:1.Sample size was found to be 45 in each group i.e. total sample of 90.

The data collected was compiled on excel spreadsheet of Microsoft office 2010 and was statistically analysed by using SPSS software v. 23.

Spirometric PFT results of the subjects and controls were compared using student's "t" test and the p value computed against the degree of freedom. p value <0.05 is taken as statistically significant.

Pearson's correlation coefficient (r) was used to find the correlation between a parameter and the duration of singing.

The sociodemographic data was collected for each subject and recorded on the proforma.

Table 1: Sociodemographic Profile Of Cases And Controls.

Sr. No.	Parameters		Cases Mean(±SD) N	Controls Mean (±SD) N
1.	Number of subjects		45	45
2.	Age (years)		22.47 (±3.94)	19.64 (±2.72)
3	Gender	Males n (%)	20 (44.4%)	20(44.4%)
		Females n (%)	25(55.5%)	25(55.5%)
4.	Education		Literate	Literate

5.	Height (cm)	160.09 (± 9.27)	163.40 (± 7.51)
6.	Weight (kg)	54.34 (±10.85)	55.38 (±8.93)
7.	BMI	21.15 (±3.66)	20.69 (± 2.69)
8.	Residence	Urban	Urban

According to the duration of singing four subgroups were formed as shown in table 2. As the duration of singing increases, the measured values of the PFTs also increase.

Table 2: Subgroups of singers formed on the basis of duration of Singing.

Subgroup	Duration of Singing (in years)	Number of Participants
Group 1	(> 5yrs)	9
Group 2	(> 4yrs)	9
Group 3	(> 3yrs)	11
Group 4	(1-2yrs)	16

Maximum singers were in Group 4 and minimum in Group 2

RESULTS AND DISCUSSION

A healthy voice depends upon a healthy respiration.[6] Singing is a complex physical activity dependent on the use of the lungs for air supply to regulate airflow and create large lung volumes. Previous studies about the effects of singing as an intervention in certain diseases affecting body function showed different results. In singing, exhalation is active and requires active diaphragm contraction and good posture. Singing is an activity with potential to improve health outcomes in people with COPD, a progressive, chronic lung disease characterised by airflow obstruction.

RESULTS

The effect of regular practise of Indian Classical Singing on the cardiopulmonary health was observed by recording the pulmonary function tests of the singers and the non singers. The data were compiled on a masterchart and analysed statistically.

Table 3: Comparison of the Spirometric Pulmonary Functions between Singers and Non-singers.

Sr. No.	Parameters	Singers Mean(±SD)	Controls Mean(±SD)	p-Value
1.	FVC (litres)	3.19 (±.83)	2.98 (±.78)	.217
2.	FEV1(litres)	2.54(±.63)	2.58 (±.57)	.737
3.	FEV1/FVC(%)	79.63 (±8.50)	90.53(±9.88)	.000
4.	PEFR(litres/min)	298.91 (±53.25)	303.04 (±68.68)	.754
5.	FEF 25-75%	2.88(±.53)	3.52(±1.05)	.001

Table 4: The means of 'percentage of predicted values' of the PFTs of the two groups.

Sr.No.	Parameters	Singers Mean(±SD)	Non-singers Mean(±SD)	p-value
1.	FVC%	84.26(±11.67)	74.13(±10.17)	.000
2.	FEV1%	77.49(±10.79)	74.40(±10.34)	.17
3.	PEFR%	65.54(±6.47)	63(±13.19)	.26
4.	FEF 25-75%	67.5(±11.44)	83.6(±24.38)	.000

The mean value of FVC in the singer group was 3.19 (±.83) and in the control group was 2.98 (±.78) litres. On comparing the value of FVC in the two groups, it was higher in the singer group as compared to the control group.

The mean value of FVC% in the singer group was 84.26 % and in the control group was 74.13%. The difference in the means was statistically significant, p value was .000.

The singers achieved better percentage of predicted values in the case of FVC as they had achieved better ventilatory capacity due to regular breathing exercises.

The correlation was calculated between the duration of singing and the FVC. The correlation coefficient "r" was +1. Hence a positive correlation was found to exist between the duration of singing and the FVC. As the duration of singing increases, the FVC also increases.

The mean value of FEV1 in the singer group was 2.54(±.63) and in the control group was 2.58 (±.57)

litres. On comparing the value of FEV1 in the two groups, it was lower in the singer group as compared to the control group. The mean value of FEV1% in the singer group was 77.49(±10.79) and in the control group was 74.40(±10.34). The difference in the means was statistically significant, p value was .000.

The singers achieved better percentage of predicted values as PFTs were improved due to singing. The mean height of the singers was less than that of the controls. Predicted volumes were achieved better by the singers in respect of FVC and FEV1. Similarly PEFR measured values were lower due to lower height of the singers, however PEFR% was higher due to better achievement of predicted values.

Another parameter of importance is FEV1/FVC ratio. A diagnosis of obstructive lung disease is made when the ratio of the Forced Expiratory Volume in 1 sec (FEV1) to Forced Vital Capacity (FVC) is less than 70%.[9] The mean measured value of FEV1/FVC in the singers and the non-singers was more than 70% which rules out any obstructive changes in these two groups.

DISCUSSION

In the present study the PFT values of singers mainly FVC, FVC% predicted and FEV1% predicted are higher than that of the non singers. Singing causes muscle remodelling in the form of increase in muscle mass and extensibility, which ultimately builds strength and flexibility in respiratory muscles of professional singers resulting in improved breathing capacity. Thus increase in strength of expiratory muscles is one of the reasons for increased vital capacity in the singers group.

During singing exercises, repeated stimulus happens to respiratory muscles causing physiological changes in neuromuscular junction. The length and complexity of nerve terminal branching increases, followed by the increase in number of presynaptic vesicles which increase the amount of acetylcholine. This increases muscle core strength and provides better breath co-ordination during singing and so is of tremendous benefit to the singers.

Similar increase in FVC was also observed by Bandopadhyay et al in a study done on female singers of Kolkata. Carroll et al also reported increase in the values of PFTs in singers of USA as observed in the present study.[7] Gould et al also supported this opinion and suggested that it could be due to the fact that singers had a reduced residual volume and total lung capacity ratio (RV/TLC).[8] That is the reason behind their expanded vital capacity at the expense of their residual volume. This might be another reason for the increase in the vital capacity.

However, FEV1/FVC provides little information on distal airways and investigators have tried to establish other markers of distal airways impairment using spirometry and/or body plethysmography. The small airways may play an important role in the clinical manifestations of asthma. Forced expiratory flow between 25% and 75% ($FEF_{25\%–75\%}$) has been proposed as an approximate measure of the caliber of distal airways.[10]

In the light of the results in the current study, it appears reasonable to conclude that the professional singers who have a marked potential for singing, the cardiopulmonary parameters are influenced.

With increasing duration of singing the status of pulmonary functions gets improved due to increase in strength and flexibility of respiratory muscles.

Hence we conclude that singing especially the Indian classical as in the present study can cause significant improvements in ventilatory capacity and can lead to improved cardiovascular fitness comparable to yoga and exercise. So singing should be promoted in the modern lifestyle.

Future studies can be planned to assess cardiopulmonary fitness of singers by using Heart Rate Variability. The limitations of the present study can be covered up by increasing the sample size and including more number of participants with longer duration of singing.

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