A Comparative Evaluation Of Pulmonary Functions In Athletes, Yogis And Sedentary Individuals

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Abstract: Background: Lung function parameters tend to have a relationship with lifestyle such as regular exercise and non-exercise. Hence the present study was undertaken to assess the effects of exercise in athletes and yogis on respiratory system and compared with sedentary group. Aim & Objective: To compare the differences in pulmonary function among the athletes, yogis and sedentary group. Method: A total of 300 subjects comprising athletes, yogis and sedentary were assessed for pulmonary function test. The parameters used as determinants of lung function were predicted percent of means of FVC, FEV1, FEV3, PEFR, FEF 25-75%, FVC/FVC ratio and MVV recorded as per standard procedure using RMS Medspiror. Result: Pulmonary Function Profile was analyzed and compared among the study groups. In our study the athletic group was having higher predicted percentage of mean value of FVC, FEV1, FEV3,PEFR,and MVV as compared to yogis and sedentary group. Yogis were having higher lung function values as compared to sedentary group and higher values of FEF25-75% and FVC/FVC ratio than athletic group. Conclusion: All pulmonary function parameters were higher in athletes and yogis than in the normal sedentary control individuals. This study suggests that regular exercise has an important role in determining and improving lung functions.

Key Words: Athletes, Pulmonary Function, Sedentary, yogis

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Introduction: Now-a-days, more persons are interested in physical fitness than any time before. Bufferal0 health study concluded that pulmonary function is a long-term predictor for overall survival rates in both genders and could be used as a tool in general health assessment. Hence it becomes essential to achieve more efficient lung function as a preventive measure. Sedentary lifestyles could be associated with less efficient pulmonary function. Involvement in certain physical activities or sports could help in respiratory muscle strengthening and improvement in pulmonary function. It is claimed that yoga practices improve general health and fitness. Yoga is a science practiced in India over thousands of years. In recent times medical fraternity is much attracted towards yoga. Yoga practice mainly consist of Asana (posture- a particular position of the body which contributes to steadiness of body and mind), Pranayama (to control the breathing in a superior and extra-ordinary way to get maximum benefits) and meditation. It produces consistent physiological changes and have a sound scientific basis. Yogic exercises have been found to be beneficial for better maintenance of bodily functions, even in normal healthy subjects. In this study we have compared pulmonary function of people with sedentary life styles, athletes and yogis to see if athletes and yogis have better pulmonary function than people with sedentary life styles; and if so, how they differ amongst themselves with respect to various spirometric parameters.

Materials and Method: This study carried out in year 2009-12 with the approval of PG Board for non clinical sciences, PGIMS, Rohtak in the department of physiology, MAMC, Agroha, Hisar. Spirometry was conducted on athletes from defence personals of Indian army; yogis from Patanjali sewa samiti, Hisar and sedentary life style subjects were selected from the medical staff at MAMC, Agroha. Spirometry was conducted on 300 randomly selected subjects from those fulfilling the inclusion criteria in each category. Those failing to perform the test successfully were rejected and replaced by another randomly selected subject. The readings were taken in standing position using RMS MEDSPIROR based on ATS recommendations. Time of testing was 4.00 pm to 6.00 pm; mean temperature was 35°C. Subjects in the study were aged 26 to 35 years. Definitions: Sedentary lifestyle was defined as per center for disease control and prevention,
as no leisure-time physical activity, or activities
done for less than 20 minutes or fewer than 3
times per week. Athletes were defined as
marathon runners running at least 2 km daily
since last 6 months. Yogis were defined as
subjects practicing asanas and pranayama for at
least 1 hour daily since 6 months. Asanas and
sukshmyayam (Surya namaskar, Vajrasana,
Mandookasana,Vakrasana,Bhujangasana,marka
tasana,Naukasana, Shavasana etc.) for 15
minutes and Pranayama was done for about 45
minutes in early morning, sitting on the floor, in
Padmasana and included steps namely
Bhastrika, Kapalbhati, Anulomvilom,
Bahypranayam, Bhramri, Ujjai , Udhgeeth
pranayam and Pranav dhyan. “Smoker” was
defined as per center for disease control and
prevention as those who have smoked more
than 100 cigarettes in their lifetime and
currently smoke.2

Inclusion criteria :
1. Non obese individuals, as in non-obese men
there is no much effect
of
body weight on FVC
values.3
2 . Consent to participate in the study
Exclusion criteria :
1. Smokers
2. American Thoracic Society (ATS)
questionnaire suggestive of any active
respiratory disorder.4

Statistical analysis: Statistical analysis was
done using SPSS version 16. Parameters
analyzed were in the form of percentage of the
predicted for the age, sex, height and weight –
Forced Expiratory Volume in 1 second (FEV1),
Forced Vital Capacity ( FVC), Peak Expiratory
Flow Rate (PEFR), FEV1/FVC and Forced mid
Expiratory Flow rate (FEF 25–75%). One way
analysis of variance was used to see if the
groups differ in any of the parameters. Post
Hoc test for equality of variance were used to
assess normality and Post-hoc Dunnett T3 test
was used for between groups comparison.

Result: Comparison of lung function parameters
across activities is shown in Fig. 1. The groups
differed significantly in FVC (P=.001), FEV1
(P=0.001), FEV3 (P=.001), PEFR (P=.001),
FEV1/FVC (P=.001) and MVV (P=.001). The
highest mean FVC (101.22%), FEV1 (106.67%),
FEV3 (104.44%), PEFR (95.28%) and MVV
(95.34%) were observed in athletes. Highest FEF
25-75% (93.11%) and FEV1/FVC (109.08%) were
found in yogis. Lowest values were observed
amongst sedentary individuals respectively.

Comparison of athletes with sedentary workers
revealed significantly higher FVC (P=.001,95%
CI;6.8;16.7), FEV1 (P=0.001, 95% CI; 13.03;
24.46), PEFR (P=.001,95% CI;23.10;38.93),
FEV1/FVC (P=.042, 95% CI; .15; 11.38) and
MVV (P=.001,95% CI;3.48;17.75) parameters
amongst the athletes. Comparison of yogis with
sedentary workers revealed significantly higher
FEV1 (P=0.039, 95% CI;.23;12.32) and PEFR
(P=0.001, 95% CI: 5.43;21.20) amongst yogis.
Lung functions of athletes were significantly
higher than yogis except for FEF 25-75%
insignificantly and FEV1/FVC which was
significantly higher amongst yogis.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sedentary n=100</th>
<th>Athlete n=100</th>
<th>Yogi n=100</th>
<th>F-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>30.26±2.90</td>
<td>30.30±2.61</td>
<td>29.86±2.98</td>
<td>.735</td>
<td>NS</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.07±8.06</td>
<td>171.16±4.46</td>
<td>169.11±8.44</td>
<td>2.022</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.96±11.24</td>
<td>67.12±4.99</td>
<td>63.90±12.28</td>
<td>3.271</td>
<td>NS</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.09±3.16</td>
<td>22.89±1.57</td>
<td>22.62±3.67</td>
<td>2.182</td>
<td>NS</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.77±.17</td>
<td>1.79±.08</td>
<td>1.73±.19</td>
<td>3.69</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS= not significant; <.05  *= significant
Table 2: Predicted percent of means of Lung function parameters in athletes, yogis and sedentary individuals (mean± SD)

<table>
<thead>
<tr>
<th>Parameter (predicted %)</th>
<th>Sedentary n=100</th>
<th>Athlete n=100</th>
<th>Yogi n=100</th>
<th>F-value</th>
<th>p-value</th>
<th>Between group comparison (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A-S</td>
</tr>
<tr>
<td>FVC</td>
<td>89.38±15.55</td>
<td>101.22±13.43</td>
<td>86.80±16.08</td>
<td>26.062</td>
<td>.001**</td>
<td>.001**</td>
</tr>
<tr>
<td>FEV1</td>
<td>87.92±20.67</td>
<td>106.67±11.58</td>
<td>94.20±14.25</td>
<td>35.75</td>
<td>.001**</td>
<td>.001**</td>
</tr>
<tr>
<td>FEV3</td>
<td>90.70±15.82</td>
<td>104.44±13.26</td>
<td>89.53±16.44</td>
<td>29.601</td>
<td>.001**</td>
<td>.001**</td>
</tr>
<tr>
<td>PEFR</td>
<td>64.26±27.86</td>
<td>95.28±17.34</td>
<td>77.58±17.10</td>
<td>53.046</td>
<td>.001**</td>
<td>.001**</td>
</tr>
<tr>
<td>FEF25-75%</td>
<td>87.06±35.75</td>
<td>92.84±23.14</td>
<td>93.11±19.73</td>
<td>1.591</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>99.42±21.58</td>
<td>105.19±8.62</td>
<td>109.08±9.69</td>
<td>11.18</td>
<td>.011**</td>
<td>.042*</td>
</tr>
<tr>
<td>MVV</td>
<td>84.72±20.03</td>
<td>95.34±21.82</td>
<td>83.22±16.19</td>
<td>11.492</td>
<td>.001**</td>
<td>.001**</td>
</tr>
</tbody>
</table>

A= athlete; S= Sedentary; Y= Yogi; SD= standard deviation; NS= not significant; ≤.05 * = significant; ≤.001 **= highly significant

![Fig 1: Lung function parameters in athletes, yogis and sedentary individuals](image)

**Discussion:** Physical inactivity and low cardiorespiratory fitness are recognized as important causes of morbidity and mortality. It is generally accepted that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardiorespiratory fitness. Buffaloalo health study revealed FEV1 as an independent predictor of overall long term survival rates and could be used as a tool in general health assessment.1 Pursuing a physical activity or sport which could help in achieving efficient lung function especially FEV1 is an essential preventive strategy in this busy age when prevalence of sedentary life style is increasing and so are the associated lifestyle disorders. The results of the present study showed that those performing yoga and athletic activity regularly had higher lung function parameters as compared to those with sedentary life styles. Significantly higher values were observed for FEV1 and PEFR. Significantly higher MVV in athletes which is advantageous for physical work capacity.5 Robinson and Kjeldgaard also have reported increased MVV with running training.6 The results discussed above clearly indicate that athlete had higher values of lung functions compared of the controls, thereby confirming that regular exercise has a facilitating effect on the lungs. Similar results have been obtained by other workers in this field. The possible explanation for this could be that regular forceful inspiration and expiration for prolonged periods during running, leads to the strengthening of the respiratory muscles, both voluntary and involuntary. This helps the lungs
to inflate and deflate maximally. This maximum inflation and deflation is an important physiological stimulus for the release of lung surfactant and prostaglandin into the alveolar spaces thereby increasing the lung compliance and decreasing the bronchial smooth muscle tone respectively.\textsuperscript{7,8,9} Ringqvist suggested that changes in airway resistance serves as a major stimulus for respiratory muscle hypertrophy. Since airway resistance is related inversely and curvilinearly to lung volumes, then airway resistance will be reduced when subjects breathe at high lung volumes.\textsuperscript{10} Pyorala et al pointed out that endurance athlete maintain lower and deeper rhythms of breathing, both at rest and at exercise than compared to normals.\textsuperscript{11}

It has been shown in previous studies that beneficial effects of yoga become established between 6 to 12 weeks.\textsuperscript{12} The subjects in our study were yoga practitioners with more than 24 weeks of daily yoga practice. Pranayam, a yogic practice has beneficial effects on respiratory efficiency. It includes various exercises like bhastrika, kapalbhati etc. which involve forceful inspiration to Total Lung Capacity (TLC) and forceful exhalation to residual volume, and all maneuvers are done through nostrils, which offer resistance by means of decreased cross sectional area and turbulence. Breathing through one nostril in Anulomvilom pranayama further increases the resistance. The effects of resistance training on skeletal muscle are well documented.\textsuperscript{13} Higher peak expiratory flow rates and FEV1 could be explained due to better strengthening of respiratory muscles in yogis. Skeletal muscle control many crucial elements of aerobic conditioning including lung ventilation. Repeated inspirations to TLC and breath holdings as done during pranayam can lead to increase in the maximal shortening of the inspiratory muscles which has been shown to improve the lung function parameters.\textsuperscript{14} The findings of the present study can also be explained on the basis of better functions of respiratory muscle strength, improved thoracic mobility and the balance between lung and chest elasticity which the athletes and yogis may have gained from regular exercise. Hence regular physical activity causes many desirable physiological, psychological and physical changes in the individual.

**Conclusion:** Both athletes and yogis had significantly better lung functions as compared to sedentary workers. People with sedentary lifestyles had lowest pulmonary function parameters. Sedentary life style is also associated with higher incidence of obesity, and development of restrictive lung function and cardiovascular morbidity. In this busy age people should try to be involved in such physical activities or sports with better health yield for the time spent. We recommend that sedentary workers should adopt yogic exercises for improving their health. Apart from the preventive value of yoga there is emerging realization of its benefit as a complementary therapy in therapeutic and rehabilitative medicine.\textsuperscript{15,16}

**Acknowledgement:** Sincere thanks to the athletes, yogis and sedentary individuals for extending cooperation for this study. Authors also thank to Sh. Sanjay Tanwar for statistical analysis of the data.

**References:**


Source Of Financial Support-Nil
Conflict Of Interest-None