Ventilatory Functions of Indian Adults: A Comparative Study with the European Predictions

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ABSTRACT

Objective
The aim of this cross sectional study was to study Pulmonary Function Test (PFT) parameters in Indian adults between age group 20 to 40 years, and to compare with the prediction equations issued by European Community for steel and Coal (ECSC).

Method
PFT parameters Forced Vital capacity (FVC), Residual volume (RV), Total Lung Capacity (TLC), Maximal Expiratory Pressure (MEP), Maximal Inspiratory Pressure (MIP), and Airway Resistance (Raw) were determined in 381 healthy non smokers of either sex between the age group 20 to 40 years residing in Marathwada region. The parameters were recorded using Medgraphics Body Plethysmograph, Elite DX Model No - 830001-005.

Results
For males, the differences in means of our and predicted values in liters for FVC, RV, TLC, MEP, MIP and Raw are 4.52 and 4.54, 2.00 and 1.69, 6.09 and 6.53, 157.09 and 196.22, -108.68 and –124.77, 1.19 and 2.24 respectively. For Females, the differences in means of our and predicted values in liters for FVC, RV, TLC, MEP, MIP and Raw are 2.59 and 3.49, 2.16 and 1.34, 4.68 and 4.86, 45.69 and 160.29, -65.16 and –91.76, 1.03 and 1.79 respectively.

Conclusion
Healthy Indians had consistently lower values of FVC, TLC, MEP, MIP and Raw, but higher values of RV than the ECSC recommendations in either sex. The ECSC recommended prediction equations may not be used for the Indian population. Population specific prediction equation should be derived for the Indian population after a large scale study.

Key words: India, Pulmonary Function Test, prediction equation, Spirometry.
the results can be diminished and the measurement accuracy can be improved, the range of normal values for populations can be narrowed and abnormalities more easily detected. Study by American Thoracic Society (ATS) has postulated the difference in PFT amongst different ethnic groups is due mainly to differences in respiratory muscle strength, fat-free mass and chest dimensions. Indians have generally lower maximal respiratory pressures as compared with others namely Caucasians and Chinese.

The primary objective of this study was to measure Respiratory pressures (MIP & MEP), FVC, TLC, Raw and RV in a group of healthy men and women residing in central Indian region with an age range of 20 to 40 yr, in order to compare them with the machine generated (western) predicted values.

METHODS

The present cross sectional study was conducted at Department of Physiology, Govt. Medical College, Aurangabad, a tertiary care teaching institute in Maharashtra region of India from August 2009 to December 2010.

The sample size estimated were 400 subjects between the age group of 20 to 40 years of either sex residing in Marathwada region. Only Healthy, asymptomatic, life long non smoking subjects were included for the test as per the guidelines of American Thoracic Society.

A Total of 408 randomly selected subjects from the society were explained the background of the study out of which 397 turned out to enroll themselves for the study. Detailed explanation of the purpose and methodology of the test was given to all subjects. 16 subjects were excluded, 10 were smokers, 2 had history of intense athletic activity and 4 had family history of cardiopulmonary disease. Total 381 subjects were selected as participants. Informed written consents were obtained form these participants. Appointments were given to five subjects per day.

Pulmonary function test were recorded using Medgraphics Body Plethysmograph, Elite DX Model No-830001-005 by Medical Graphics Corporation, St. Paul, Minnesota, USA after volume calibration at 3 liters and temperature calibration at room temperature to give values at BTPS. Subjects were encouraged persistently for maximum efforts. Three readings were taken and the best of three readings were recorded for analysis. The European Respiratory Society’s prediction equations, which represent those of the European Community for Steel and Coal, were used. Following parameters were measured and their values, (actual values) were compared with predicted values.

- Maximum expiratory pressure (MEP)
- Maximum inspiratory pressure (MIP)
- Forced vital capacity (FVC)
- Total lung capacity (TLC)
- Residual volume (RV)
- Airway resistance (RAW)

Statistical method

The subjects were divided according to their gender. Mean, standard deviation, of the study sample (observed value) was calculated and compared with the predicted value using independent sample't' test. Statistical significance of the difference was seen by calculating two-tailed significance.

The data was analyzed using SPSS for windows software, release 9.0.0. Independent sample't' test was applied for comparison of each parameter with its predicted.

RESULTS

Total of 381 normal subjects of either sex, ranging from age group of 20 to 40 were studied. The mean age, height and weight of the subjects in the study group was as shown in the table 1.

The difference in actual and predicted values for the studied parameters in males was as shown in table 2. The differences found were statistically highly significant (p value<0.001) except FVC in which the difference was statistically not significant (p value>0.05).

For females the difference was as shown in table 3. The differences found were statistically highly significant (p value<0.001) except TLC in...
Table 1: Physical characteristics of the study group

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Males (n = 216)</th>
<th>Females (n = 165)</th>
<th>All N = 381</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>32.29 ± 3.50</td>
<td>31.06 ± 2.98</td>
<td>31.675</td>
</tr>
<tr>
<td>Height (cms)</td>
<td>170.78 ± 6.45</td>
<td>156.62 ± 7.45</td>
<td>163.7</td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>67.39 ± 11.57</td>
<td>51.83 ± 4.77</td>
<td>59.61</td>
</tr>
</tbody>
</table>

Table 2: Comparison of Lung function tests in males with their predicted values derived from the European equations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Actual Mean±SD</th>
<th>Predicted Mean±SD</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (lits)</td>
<td>4.52±0.45</td>
<td>4.54±0.65</td>
<td>0.692</td>
</tr>
<tr>
<td>RV (lits)</td>
<td>2.00±0.12</td>
<td>1.69±0.10</td>
<td>0.00</td>
</tr>
<tr>
<td>TLC (lits)</td>
<td>6.09±0.53</td>
<td>6.53±0.53</td>
<td>0.00</td>
</tr>
<tr>
<td>MEP (cms/H₂o)</td>
<td>157.09±5.87</td>
<td>196.22±33.04</td>
<td>0.00</td>
</tr>
<tr>
<td>MIP (cms/H₂o)</td>
<td>-108.68±3.61</td>
<td>-124.77±0.63</td>
<td>0.00</td>
</tr>
<tr>
<td>Raw (cms/H₂o/sec)</td>
<td>1.19±0.11</td>
<td>2.24±0.01</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 3: Comparison of Lung function tests in females with their predicted values derived from the European equations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Actual Mean±SD</th>
<th>Predicted Mean±SD</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC (lits)</td>
<td>2.59±0.28</td>
<td>3.49±0.90</td>
<td>0.00</td>
</tr>
<tr>
<td>RV (lits)</td>
<td>2.16±0.24</td>
<td>1.34±0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>TLC (lits)</td>
<td>4.68±0.48</td>
<td>4.86±0.63</td>
<td>0.005</td>
</tr>
<tr>
<td>MEP (cms/H₂o)</td>
<td>45.69±4.61</td>
<td>160.29±30.50</td>
<td>0.00</td>
</tr>
<tr>
<td>MIP (cms/H₂o)</td>
<td>-65.16±0.63</td>
<td>-91.76±15.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Raw (cms/H₂o/sec)</td>
<td>1.03±0.008</td>
<td>1.79±0.14</td>
<td>0.00</td>
</tr>
</tbody>
</table>

which the difference was statistically significant (p value <0.05).

All the pulmonary functions in the native population, except RV showed a decline when compared with their predicted. Comparatively RV volume was higher than the predicted values. These differences were statistically highly significant. (P value<0.001)

**DISCUSSION**

Respiratory muscle pressures i.e. MEP & MIP are an indicator of respiratory muscle strength\(^8-10\). Our study indicates that Indians had lesser muscular strength than the subjects in the computer generated modules. Similar results were reported in studies by John A et al.,\(^7\).

The study sample also had higher Residual Volumes than the predicted values. This could be the effect of poor muscular strength resulting in inability to expire to the maximum during normal breathing as compared to predicted values, and therefore resulting in higher residual volumes. Study by Kreitzer SM et al indicates that RV is normal or increased especially in expiratory muscle weakness\(^11\).
The observed values for the FVC, TLC were lower than the predicted values for the study sample and the difference is highly significant (p<0.001). In a study by Donnelly PM et al which tried to explain the racial difference in lung volumes, it was observed that Caucasians (western population) have physically large chest cavities and increased number of alveoli than the Indians which accounted for the increased lung volumes. The observation made by Yap WS et al explains the ethnic difference in lung volumes by measuring the upper body segment length and thoracic size. In their study, 1250 subjects between 20-90 yrs were studied. They found out the ratio of sitting height to standing height. Their findings showed a significant difference of ratios, Chinese - 0.539, Malays – 0.529, Indians – 0.518. This paralleled the ethnic difference in lung volumes. Mengesha et al reported that Indians have the poorest pulmonary functions among all races studied. Caucasians had the best pulmonary function followed by the Africans, Chinese and Indians. Similar observations were made by Giri B R et al in which the muscularity effect on various ventilatory parameters was observed.

The lower ventilatory functions of our study subjects could be explained on the basis of their poor muscle strength as is evident from their MEP and MIP. However Johan A et al in their study refutes that the ethnic difference in respiratory muscle strength can explain the difference in lung volumes.

In the Indian population, airway resistance was observed to be less than the values predicted. Generally the airway resistance is dependent inversely on the lung volume i.e. airway resistance is high at low lung volumes and decreases sharply as the lung volumes increase.

Our observation was contrary to the above studies. Amongst the parameters studied by us while all the observations were in line with the observation made by earlier studies, the observed decreased airway resistance amongst the Indian population was unexpected and needs to be explored on a large scale study. The decreased airway resistance could be a result of process of adaptation whereby airway resistance would compensate for the other wise poor pulmonary functions in the study group. This partly explains the relative healthy conditions of the study subjects in spite of lower lung functions as compared to the predicted values derived from the prediction equations of the European population.

CONCLUSION

The pulmonary function test values in the population from the Indian region were much lower compared to the predicted value of the European population. Therefore we suggest that reference equations, derived after a large scale study from the native population, should be used instead of using the European prediction equation.

REFERENCES

6 American Thoracic Society. Lung function


