CHAPTER 3

Materials and Methods
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Seven occupational groups were selected for respiratory function study. A total number of 679 subjects including 163 control subjects were investigated. They were grouped as:

1. Cotton mill workers - 105 (male)
2. Wood workers - 75 (male)
3. Bakery workers - 59 males
4. Insecticide plant workers - 46 males
5. Tailors - 30 females
6. Sedentary workers - 77 males and 35 females
7. Press workers - 57 males and 32 females

Healthy, age and height-matched non-smokers free from exposure to any pollutants with no previous history of respiratory or other illness were selected as controls.

Pulmonary function tests were carried out with portable PC-based spirometer with printer (Vitalograph Compact II, Buckingham) in the morning hours. The spirometer was calibrated immediately before the start of each session. Calibration was done for more than one occasion during the session. Before the recordings, all the subjects were well motivated thus ensuring recording at optimum levels. The technique was explained to each and every individual and this was followed by the demonstration of its performance. Three tests (VC, IVC, FVC) were carried out in a comfortable standing position. Three trials were made for each test of which the best was selected automatically by the machine and was taken for analysis. The values were
recorded at BTPS. The standing height was measured to the nearest centimetre. The test printout consists of actual values, predicted values and predicted percentage. Only the actual values were considered for analysis.

Variables like sex, age, smoking status, types of occupation, period of exposure to occupation, respiratory symptoms etc. were also recorded using a questionnaire.

There were substantial evidences that smoking interferes with respiratory functions and the workplace exposure has cumulative effect on lung functions. Because of the difficulty in separating the effect of cigarette smoking and workplace exposure in smokers, smokers were excluded from the study and non-smoking workers were selected as subjects. Males and females were considered separately.

The parameters studied were:

<table>
<thead>
<tr>
<th>A. <strong>Lung volumes</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital capacity</td>
<td>(VC)</td>
</tr>
<tr>
<td>Inspiratory vital capacity</td>
<td>(IVC)</td>
</tr>
<tr>
<td>Forced vital capacity</td>
<td>(FVC)</td>
</tr>
<tr>
<td>Forced expiratory volume at 1 sec.</td>
<td>(FEV1)</td>
</tr>
<tr>
<td>Forced expiratory volume at 0.5 sec.</td>
<td>(FEV0.5)</td>
</tr>
<tr>
<td>Ratios between forced expiratory volume in second to vital capacity, to forced vital capacity in percentage</td>
<td>(FEV1/VC%, FEV1/IVC%, FEV1/FVC%, FEV0.5/FVC%)</td>
</tr>
<tr>
<td>Maximal voluntary ventilation (indirect)</td>
<td>(MVVind)</td>
</tr>
</tbody>
</table>
### B. Flow rates

- **Peak expiratory flow rate** (PEF)
- Forced expiratory flow between the first 200 ml and 1200 ml of exhaled volume (FEF
  20-1200)
- Forced mid expiratory flow (FEF
  75-85)
- Forced late expiratory flow rate (FEF
  90-100)
- Forced expiratory flow rates at 25%, 50% and 75% of FVC (FEF
  25, FEF
  50, and FEF
  75)
- Peak inspiratory flow rate (PIF)
- Forced inspiratory flow rates at 25%, 50% and 75% of FIF
  25, FIF
  50, and FIF
  75
- Forced mid expiratory flow time (FMFT)

### Statistical Analysis

Statistical analysis was carried out using unpaired students 't'-test. Males and females were analysed separately. For each occupation, the subjects were classified into three age groups: <35 years (G₁), 35-45 years (G₂) and >45 years (G₃), and the parameters of lung volumes and flow rates were compared with age-matched control group to find the significance, if any. The workers were classified into three exposure groups: <10 years of exposure (E₁), 10-20 years of exposure (E₂), and >20 years of exposure (E₃). An attempt has been made to correlate the duration of exposure and lung parameters using coefficient of correlation. ANOVA was carried out to test the significance among different occupations at different age group and exposure. However, the ANOVA gave only the information whether the means are significantly different or not, but not any information about the pairs which are significantly different. For this, the least significant difference test (LSD) was carried out.
1. **Unpaired \( t \)-test**

The test is used to compare two samples with same variance.

\[
1 = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}
\]

\( n_1 + n_2 - 2 \) = degrees of freedom

\( n_1 \) = size of first sample

\( n_2 \) = size of second sample

\( \bar{x}_1 \) = mean of first sample

\( \bar{x}_2 \) = mean of second sample

\( s_1^2 \) = variance of first sample

\( s_2^2 \) = variance of second sample

2. **Correlation analysis**

To find out the association between two quantitatively measured or continuous variables, coefficient of correlation is used.

\[
\frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}
\]

where \( x_i \) and \( y_i \) are the observations of \( x \) and \( y \) on \( i \)th individual, \( i \) ranges from 1 to \( n \) and \( \bar{x} \) and \( \bar{y} \) are the means of respective variables.

3. **Analysis of Variance (ANOVA)**

The Analysis of Variance table is given below:

<table>
<thead>
<tr>
<th>Due to</th>
<th>df</th>
<th>Sum of squares</th>
<th>Mean sum of squares</th>
<th>( F )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between samples</td>
<td>( k-1 )</td>
<td>( \frac{S_{Sx}^2}{E} )</td>
<td>( \frac{S_{Sx}^2}{k-1} )</td>
<td>( \frac{S_{Sx}^2 / S_{Sx}}{S_{Sx} / S_{Sx}} )</td>
</tr>
<tr>
<td>Within samples</td>
<td>( n-k )</td>
<td>( \frac{\sum_{i=1}^{k} \sum_{j=1}^{n_i} (x_{ij} - \bar{x_i})^2}{n-k} )</td>
<td>( \frac{\sum_{i=1}^{k} \sum_{j=1}^{n_i} (x_{ij} - \bar{x_i})^2}{n-k} )</td>
<td>( \frac{E_{Sx} / n-k}{S_{Sx} / n-k} )</td>
</tr>
<tr>
<td>Total</td>
<td>( n-1 )</td>
<td>( \sum_{i=1}^{k} \sum_{j=1}^{n_i} (x_{ij} - \bar{x})^2 )</td>
<td>( \sum_{i=1}^{k} \sum_{j=1}^{n_i} (x_{ij} - \bar{x})^2 )</td>
<td>( \frac{1}{n-1} )</td>
</tr>
</tbody>
</table>
where \( C = \frac{\sum \sum X_{i}}{n} \).

The calculated value of \( F \) is compared with the table value of \( F \) with \((k-1, n-k)\) degrees of freedom.

4. **LSD test**

The least significant difference (LSD) at \( \alpha \% \) level of significance is given by:

\[
\text{LSD} = \text{Student's Error} \times t_{\alpha/2} \times S_{s} \frac{\sqrt{\frac{1}{n} + \frac{1}{n}}}{\sqrt{\frac{1}{u} + \frac{1}{v}}} 
\]

where \( S_{s} = \sigma \sqrt{\frac{1}{u} + \frac{1}{v}} \)  \( \text{(Rao, 1996)} \)