# Rural-Urban Variation of Pulmonary Function in Relation to Age, Sex and Anthropometric Variables among the Bengalee Population

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## ABSTRACT

Pulmonary function variables depend on height, age and gender. There is evidence of considerable variations in pulmonary functions in different ethnic groups and across generations. The aim of the present study was to assess pulmonary efficiency parameters of adult Bengalee population and their variations in relation to age, sex and anthropometric variables. Effort was also made to assess the variation of pulmonary functions of the people living in rural and urban areas. A total of 319 subjects were selected for the study having the age range 20-85 years. Among them 171 was male and 148 were female. All the subjects were classified into rural and urban groups. Height and weight were measured with standardized techniques. Pulmonary function test (PFT) was performed with the help of a portable micro spirometer (Model: DATOSPIR MICROC). BMI and COPD were computed by standardized techniques. There was a significant difference ($p<0.001$) in height and weight between males and female subjects but no such significant difference was observed in case of BMI. It was observed from the results that in urban population height, weight and BMI values were higher than that of the rural population for both sexes ($p<0.05$ or lesser). The PFT parameters were significantly higher in male than in females ($p<0.001$). The results showed that the PFT values were higher in urban areas than that in rural areas for both sexes ($p<0.001$). There was a significant difference ($p<0.05$, or lesser) in PFT parameters among three age groups for male subjects. There was a significant correlation ($p<0.05$ or lesser) between PFT parameters and height, weight and BMI for both sexes. GOLD Spirometric Criteria for COPD Severity was taken for the present study and it was found that most of the subjects of the selected population were belonged to mild COPD for both sexes. It was concluded that there was a clear cut rural urban difference in pulmonary function efficiency parameters. PFT parameters were significantly correlated with height, weight, and BMI parameters.

**Key words :** PFT, Urban-Rural difference, COPD

## INTRODUCTION

Life expectancy has risen sharply during the past century and is expected to continue to rise in virtually all populations throughout the World (1). Nearly 20% of the adult population has reduced $FEV_1$ values, indicating impaired lung function (2). The majority of these individuals with reduced $FEV_1$ have COPD, asthma, or fibrotic lung disease (2). Spirometric investigation is seen as a gold standard for diagnosing airway obstruction. Therefore, spirometry is increasingly seen as a quality standard in general practice (3, 4). Spirometry is the most frequently performed pulmonary function test. Pulmonary function variables depend on height, age and gender. There is evidence of considerable variations in pulmonary function in different ethnic groups and across generations (5).

Pulmonary function tests check how well our lungs work. The tests determine how much air our lungs can hold, how quickly we can move air in and out of our lungs and how well our lungs put oxygen into and remove carbon dioxide from our blood.

Pulmonary function tests provide an assessment of respiratory system in terms of its functions. These are quantitative measures of various aspects of Broncho pulmonary functions which help us to define the normal functions and to determine the nature and extent of Broncho pulmonary dysfunctions (6). Pulmonary function declines slowly throughout adult life, even in healthy persons. Cross-sectional analyses have suggested that the decline may accelerate after age 70 (7). Lung function tests have been increasingly applied for evaluation and clinical management of respiratory disarray and have developed into an integral part of assessment of pulmonary disease. Pulmonary function values are influenced by environmental and genetic, geographic condition and ethnic and racial origin and technical parameters (8).

Factors such as obesity (9, 10, 11), body fat distribution (11, 12), alcohol consumption (13), dietary composition (14, 15, 16), physical activity and several other cardiovascular risk factors (11) have been associated with pulmonary function in some studies, although investigations of these factors, particularly within a single study, have been relatively infrequent.

The aim of the present study was to assess pulmonary efficiency parameters of adult Bengali population and their variations in relation to age and sex. Efforts were also made to assess the variation of pulmonary functions of the people living in rural and urban areas.

## METHODS AND MATERIALS

**Selection of site:**

The study was carried out in different rural and urban areas of Purba and Paschim Midnapore districts, West Bengal.

**Selection of subject:**

About 319 subjects were selected for the study having the age range 20-85 yrs. All the subjects volunteered for the study. The subjects were divided into male and female groups. Each group was again subdivided into three age groups: Younger adult (20 -40 years), older adults (41 – 60 years) and elderly groups (61-85 years). All the subjects were classified into rural and urban groups.

**Measurement of height:**

Height was taken with the help of an anthropometry with an accuracy of 0.1 cm. At first the subject was asked to stand straight on the floor and then the vertical distance from floor to vertex (maximum bulge portion of the head) was measured.

**Measurement of weight:**

Weight of the subject was taken by a portable weighing machine (Libra). Subject was asked to stand straight on the weighing machine in minimum clothing and reading was taken from the scale of the machine with an accuracy of 0.5 kg.

**Measurement of BMI:**

The body mass index (BMI) was calculated from the collected height (mt) and weight (kg) data.

$$\textbf{BMI=Weight (kg) / Height}^2\textbf{ (mt)}$$

**Pulmonary function test:**

Pulmonary function test (PFT) was performed with the help of a portable Micro spirometer (Model: DATOSPIR MICROC). In this experiment the subject at first asked to take a maximum breath as much as possible through a disposable mouth peace attach to the spirometer and then to exhale forcefully through the mouth piece while the nose was closed with nose clip. The following parameters were measured –Forced vital capacity (FVC), Forced expiratory volume in one second (FEV1), Peak expiratory flow (PEF).

**Assessment of Chronic Obstructive Pulmonary Disease (COPD):**

To assess the severity of COPD, lung function value was predicted from the standard prediction equation of normal male subjects (17). Following is the equation for predicted $FEV_1$.

For male subject: **Predicted $FEV_1$=-0.028** XA **+ 0.047** X**H - 3.737**

For Female subject: **Predicted $FEV_1$=- 0.027** X **A + 0.021** X **H - 0.254**

A-Age in years,

H- Height in Centimeters

The criteria followed for categorization of the severity of COPD were based upon the GOLD spirometric criteria for COPD severity as given in following table (18):

| **Classification of Severity of Airflow Limitation in COPD (Based on Post-Bronchodilator FEV1)** | | |
|---|---|---|
| In subjects with $FEV_1/FVC < 0.70$ | | |
| GOLD 1: | Mild | $FEV_1 \geq 80\%$ predicted |
| GOLD 2: | Moderate | $50\% \leq FEV_1 < 80\%$ predicted |
| GOLD 3: | Severe | $30\% \leq FEV_1 < 50\%$ predicted |
| GOLD 4: | Very Severe | $FEV_1 < 30\%$ predicted |

**Statistical analysis:**

Data were summarized into mean and standard deviation values using Microsoft Excel. For performing t-tests and one way ANOVA different software packages were used. Correlation coefficient between height, weight, BMI and PFT parameters were determined by employing product moment correlation coefficient through MS Excel.

## RESULTS AND DISCUSSION

The physical profile of the subjects, viz., height, weight and BMI has been presented in Table 1a.The results, which showed the comparison of height, weight, and BMI between male and female subjects, indicated that there was a significant difference ($p<0.001$) of height and weight between male and female subjects. In case of BMI no significant difference was noted between male and female subjects.

**Table1a:** Comparison of height, weight &BMI Between male and female subjects

| Gender | Height (cm) | Weight (Kg) | BMI (Kg/ $m^2$) |
|---|---|---|---|
| **MALE (n=171)** | 160.6 ±6.88 | 59.3 ±53.09 | 23.0 ±21.12 |
| **FEMALE (n=148)** | 150.6 ±6.14 | 48.1 ±11.85 | 21.1 ±4.67 |
| **t value** | **13.726**** | **5.731**** | **0.638 NS** |

**p<0.001 NS=Not Significant

**Table 1b:** Comparison of height, weight and BMI between urban and rural subjects

| Gender | Rural / urban | Height (cm) | Weight (Kg) | BMI (Kg/ $m^2$) |
|---|---|---|---|---|
| **Male** | **Urban (n=113)** | 162.3 ±5.86 | 60.3 ±9.16 | 22.9 ±3.08 |
| | **Rural (n=58)** | 158.1 ±7.70 | 45.8 ±8.72 | 18.3 ±2.84 |
| | **T value** | **4.037**** | **9.997**** | **9.475**** |
| **Female** | **Urban (n=85)** | 152.0 ±5.8 | 54.0 ±10.2 | 23.4 ±4.23 |
| | **Rural (n=63)** | 148.7 ±6.36 | 40.0 ±8.79 | 18.0 ±3.20 |
| | **Tvalue** | **3.183*** | **8.667**** | **8.391**** |

*p<0.05 **p<0.001

The comparison of height, weight, and BMI between rural and urban areas indicated that there was a significant difference ($p<0.001$) of all the parameters between subjects of urban and rural areas (Table 1b).It was observed from the results that in urban areas height, weight and BMI values were higher than that of rural areas for the respondents of both sexes. The finding of the present study was not in conformity with some previous studies which reported that the above mentioned parameters were higher in rural areas than in urban areas (19, 20). The comparison of height, weight, BMI among different age groups has been presented in Table 1c.The results of ANOVA revealed that there was a significant difference ($p<0.001$) in height, weight and BMI among different age groups. It was noticed that the values of the anthropometric variables were decreased with the increasing age. The reason for decline in stature in advanced age could be due to thinning of intervertebral discs as well as flabbiness of muscles, which changed the posture. The decline in stature appears to be a common phenomenon and was also reported by Brahmam (21), Tyagi and kapoor (22), Kapoor and Tyagi (23), Bhardwaj and Kapoor (24). Aiken (25) also reported that a loss of collagen between spinal vertebrae causes the spine to bow and the height to shrink. With advancing age the cartilage disc between vertebrae degenerates causing the vertebrae to come close together thus resulting in decrease in stature.

**Table 1c:** Comparison of height, weight and BMI among different age groups

| Age groups | Gender | PFT Parameters | | |
|---|---|---|---|---|
| | | Height (cm) | Weight (Kg) | BMI (Kg/ $m^2$) |
| 20-40 years (n=99) | Male | 161.9 ±6.82 | 56.8 ±10.83 | 21.6 ±3.57 |
| 41-60 years (n=47) | | 160.6 ±7.02 | 56.5±11.25 | 21.8 ±3.56 |
| 61-85 years (n=25) | | 157.8 ±5.5 | 47.2 ±10.7 | 18.9 ±3.8 |
| F value | | 3.869* | 8.018** | 6.195* |
| 20-40 years (n=94) | Female | 151.9 ±5.4 | 50.0 ±11.0 | 21.6 ±4.3 |
| 41-60 years (n=31) | | 149.8 ±8.28 | 39.4 ±11.09 | 17.4 ±3.78 |
| 61-85 years (n=23) | | 146.1 ±4.12 | 37.5 ±4.93 | 17.6 ±2.25 |
| F value | | 6.371* | 15.130** | 13.591** |

*$p<0.05$ **$p<0.001$

The body weight was found to decrease with advancement of the age. A larger change was noted the upper age group (61 -85 years) than that of other age groups. However, it was opined that the body weight was increased with age till the age of 49 years and decreased after 50 years (26). Increase in body weight till middle age shows the accumulation of fat with age. It can be due to more appetite among the subjects in younger age groups leading to increased energy intake, fat rich diet and relatively less energy expenditure due to lesser involvement in physical activity. The decline in body weight in more advanced age may be attributed to the decrease in muscle mass in response to reduced amount of protein intake as well as decline in number and size of muscle fibers due to degenerative diseases associated with the advancing age. It may partly be due to bones becoming lighter because of gradual mineral mass loss (26). The Increase in body weight and BMI with age and declining in advanced age has also been reported by Tyagi and kapoor (22), Kapoor and Tyagi (23) and Tandon (27). This study was not in conformity with the study of Chung et al (28).

Table 2a showed the comparison of different pulmonary function test (PFT) parameters between male and female subjects and it was observed from the results that the PFT parameters were significantly higher ($p<0.001$) in males than that in females. Budhiraj et al (8) also reported lower pulmonary function values in female than the male subjects in similar age group. The sex difference in lung function may be attributed to various factors including of sex hormone, sex hormone receptor, or intracellular signaling pathway in addition to physiological and anatomical differences in respiratory system of male and female (29, 30). This study also supports the hypothesis of the study of Choudhuri and Choudhuri (31).

**Table 2a:** Comparison of Different parameters of Pulmonary Function Test (PFT) between male and female healthy population

| PFT Parameters | Male (n=171) | Female (n=148) | t value |
|---|---|---|---|
| **FVC (Lit)** | 2.57±0.74 | 1.93±0.81 | **7.633**** |
| **FEV1 (Lit)** | 2.21±0.61 | 1.68±0.58 | **8.310**** |
| **PEF (Lit/Sec)** | 3.78±1.74 | 2.96±1.41 | **4.811**** |

**p<0.001

It was observed from table 2b that there were a significant differences (p<0.001) of PFT parameters between rural and urban subjects. The results showed that the PFT values were higher in the subjects of urban areas than that in rural areas. But no significant difference was observed in case of FVC for both sexes. The finding of the present study was in agreement with the study of Malik and Jindal in the 1985 (32).

**Table 2b:** Comparison of different parameters of Pulmonary Function Test (PFT) between rural and urban subjects among the selected population

| PFT Parameters | Male | | Female | | t value | |
|---|---|---|---|---|---|---|
| | Urban (n=113) | Rural (n=58) | Urban (n=85) | Rural (n=63) | Male | Female |
| **FVC (Lit)** | 2.62±0.58 | 2.46±1.00 | 1.93±0.74 | 1.86±0.90 | 1.370NS | 0.560 NS |
| **$FEV_1$ (Lit)** | 2.31±0.58 | 2.00±0.63 | 1.74±0.61 | 1.53±0.49 | 3.230** | 2.217 NS |
| **PEF (Lit/Sec)** | 4.18±1.88 | 2.93±1.06 | 3.30±1.47 | 2.38±0.98 | 4.689** | 4.269** |

*p<0.05 **p<0.001 NS=Not Significant

Different PFT parameters showed significant difference (p<0.001) among different age groups and it was observed from the results that the values were decreasing with the increasing age for both sexes (Table 2c). However in case of females the FVC and $FEV_1$ had no significant difference among the age groups but PEF showed significant difference (p<0.001) among age groups.. The relationship of pulmonary function test with age has been also observed by other studies which supports the findings of the present study. Lung function increases linearly with age until the adolescent growth spurt at age 10 yrs in females and 12 yrs in males (33). Lowering PEF may also be due to narrowing of small airways in the lungs (34). The probable cause for the findings may be because of the airflow at low lung volume mainly depends on elastic recoil, resistance of the lung and resistance of small airways. Deposition of suspended particulate matters in the lungs and airways gradually decrease the diameter of airway and conversely increase resistance in lungs and airways. As a result elastic recoil pressure of the lung decreases. Narrowing and resultant increase in small airway resistance and/or decrease in elastic recoil pressure of the older subject may cause decreased flow at these low lung volumes (35).

**Table 2c:** Comparison of Different parameters of Pulmonary Function Test (PFT) between different age groups of the selected population

| Age groups | Gender | PFT Parameters | | |
|---|---|---|---|---|
| | | FVC (Lit) | $FEV_1$ (Lit) | PEF (Lit/Sec) |
| **20-40 years(n=99)** | **Male** | 2.74±0.78 | 2.43±0.55 | 4.30±1.89 |
| **41-60 years(n=47)** | | 2.53±0.52 | 2.06±0.51 | 3.13±1.27 |
| **61-85 years(n=25)** | | 2.01±0.79 | 1.71±0.72 | 2.78±0.98 |
| **F value** | | **10.414**** | **18.357**** | **13.374**** |
| **20-40 years(n=94)** | **Female** | 2.00±0.72 | 1.78±0.54 | 3.24±1.51 |
| **41-60 years(n=31)** | | 2.00±1.17 | 1.62±0.58 | 2.44±0.87 |
| **61-85 years(n=23)** | | 1.69±0.82 | 1.35±0.51 | 2.10±0.85 |
| **F value** | | **0.923 NS** | **4.239 NS** | **6.420*** |

*p<0.05 **p<0.001 NS=Not Significant

**Table 3**: Comparison of FVC and $FEV_1$ between the present study (male subjects) and other study

| Parameters | Present study (N=172) | Wood workers † (n=17) | Office workers† (n=41) |
|---|---|---|---|
| **FVC (lit)** | 2.57±0.74 | 3.89 ± 0.64* | 4.99 ± 0.57* |
| **$FEV_1$ (lit)** | 2.21±0.61 | 3.45 ± 0.54* | 4.07 ± 0.51* |

† Milanowski et al (39) * p< 0.05

Table 3 showed the comparison of FVC and FEV1 among the present study and the other studies. It was observed from the results that the values were significantly (p<0.05) lower in case of present study than that of the other studied population. It was noted that there was a significant difference in both PFT parameters between the present study and the study of Milanowski et al (36). The wood workers and office workers had higher values of FVC and FEV1 than that of the subjects of the present study.

Table 4 showed the correlation between anthropometric parameters (height, weight, BMI) and PFT parameters of the selected population. The results showed that there was a significant correlation between PFT parameters and height, weight, BMI for both sexes (p<0.05or less). Lung volumes are related to body size, and standing height is the most important correlating variable. In children and adolescents, lung growth appears to lag behind the increase in standing height during the growth spurt, and there is a shift in the relationship between lung volume and height during adolescence (37, 38).

**Table 4:** Correlation between height, weight and BMI and PFT parameters of the selected population (male=172, female=148)

| | FVC | | $FEV_1$ | | PEF | |
|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** |
| **Height (cm)** | 0.35** | 0.15 NS | 0.34** | 0.30 ** | 0.28** | 0.33 ** |
| **Weight (kg)** | 0.18* | 0.12 NS | 0.29** | 0.24 ** | 0.27** | 0.32 ** |
| **BMI** | 0.05 NS | 0.07 Ns | 0.18* | 0.15 NS | 0.18* | 0.24 * |

*p<0.05 **p<0.001 NS=Not Significant

**Table 5:** COPD severity of the selected population (male=172, female=148)

| Severity of COPD | Male (n=171) | | Female (n=148) | |
|---|---|---|---|---|
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| **I. Mild COPD** | 165 | 96.5 | 129 | 87.2 |
| **II. Moderate COPD** | 5 | 2.92 | 15 | 10.1 |
| **III. Severe COPD** | 1 | 0.58 | 4 | 2.7 |
| **IV. Very Severe COPD** | 0 | 0.00 | 0 | 0.00 |

GOLD Spirometric Criteria for COPD severity was done for the present study and it was found that most of the subjects of the selected population were belongs to mild COPD for both sexes. It was observed from Table 5 that 96.5% of male and 87.2% of female subjects showed mild COPD whereas 2.92% of male and 10.1% of female subjects shoed moderate COPD.

## CONCLUSION

From the findings of the study it can be concluded that there was a significant difference of height and weight between male and female subjects in urban areas. The values of height, weight and BMI of the urban population were higher than that of rural areas for both sexes. The results also revealed that the height, weight and BMI values were decreases with increasing age.

PFT parameters were significantly higher in males than that in females. The results also revealed that the PFT values were higher in urban areas than that in rural areas. PFT values were decreasing with the advancement of age for both sexes. PFT parameters were significantly correlated with height, weight and BMI parameters. Most of the subjects of the studied population had mild COPD for both sexes.

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