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# LUNG FUNCTION NORMS IN HEALTHY WORKING WOMEN

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**Abstract :** Two hundred seventy four healthy working women subjects representing different states were subjected to pulmonary function testing to establish linear multiple regression model. Lung functions were considered as dependent variables while age, height and weight as independent variables. Highly significant negative correlation of all lung function parameters with age and positive correlations with height and weight were observed. Females showed a decline of 0.203, 0.199 and 0.210 litres per decade in FVC, FEV0.75 and FEV1.0 parameters respectively. An increase in FVC, FEV0.75 and FEV1.0 values was found to be 0.0217, 0.0132 and 0.0178 litres respectively per unit centimeter increase in height.

**Key words :** lung function norms women

## INTRODUCTION

In spite of tremendous upsurge in the use of pulmonary function tests in the diagnosis, prognosis and management of various respiratory disorders, proper physiological norms of pulmonary function tests for healthy women of different age groups are lacking in our country. Previous studies (1–10), which attempted to establish normal standards of lung function in the female population, lacked homogeniety. A close look at the different studies shows that the differences originated because of the type of population, the size of the studied sample, different methodologies and pulmonary equipment used and the respiratory parameters studied (3–8). In India there are vide variations in socio-economic, geographical, climatic, environmental and nutritional conditions and it is, therefore, not easy to establish national ventilatory norms for healthy Indian women until a well planned cross sectional study comprising of proper spirometric tests in various age groups is undertaken.

The present study deals to establish physiological norms on a group of healthy women of different age groups representing various parts of India.

## METHODS

The study subjects consisted of 274 asymptomatic females employed in electronic and heavy industries from Bangalore, Bhopal, Hyderabad, Ghaziabad, Trivendrum, Lucknow and nursing staff of

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a local hospital. These subjects were actually a part of the population studied during earlier health surveys carried out by this centre (11–13). Although all the subjects were studied but only asymptomatic women were taken out to establish physiological norms. The normalcy of the subjects was decided by accurate respiratory history and through clinical and radiological examinations. Each subject underwent a detailed physical examination and chest X-ray (postero-anterior view) was taken and only those subjects who were found clinically and radiologically normal were included in this study. A normal subject was defined as one who did not have persistent cough or phlegm in the morning and did not report haemoptysis, dyspnoea, wheezing or nasal catarrh at the time of the interview, a history of heart disease or any respiratory disorder such as bronchitis, pneumonia, pleurisy, tuberculosis, asthma or bronchiectasis etc during the previous three years and at the time of the study.

The age in years and anthropometric data including standing height (in centimeters) and body weight (in kilograms) were recorded for each subject prior to lung function recording. The body surface area and Quintex Index for assessing nutritional status of the study subjects were calculated for each woman.

Spirometric lung functions were recorded in standing posture using precalibrated bellow type dry spirometer (Vitalograph, Model–S) with nose clip on. The vitalograph was daily calibrated for volume by syringe method prior to recording of lung functions. The spirometry was performed in the morning hours. All spirograms were recorded by one investigator to minimise inter-observer variations.

After recording the vital capacity (VC), the standard protocol for spirometry as recommended by American Thoracic Society (ATS) (14) was followed. Expiratory FVC manoeuvres were obtained for each case. The forced expiratory manoeuvres were performed at least three times for each subject and the best of the three attempts was selected for data computation. All the lung function values were corrected to conditions of body temperature and pressure saturated with water vapour (BTPS 37°C).

A multiple regression model was fitted using lung functions as dependent variables and age, height, weight and body surface area with lung functions were calculated and their significance was tested by Students 't' test. The constant, partial regression coefficients of age, height and weight were calculated by the method of least square. The multiple correlation coefficient ($R^2$) and residual standard deviation (RSD) were calculated as per Draper and Smith (15).

## RESULTS

The physical and nutritional parameters of the female population and lung functions in different regions are shown in Table I and II respectively. Mean lung functions in different age groups are shown in Table III. The mean values of lung functions showed a significant declining trend ($P < 0.001$) with the increasing age. The lung functions of women in organised and unorganised industries are shown in Table IV. No significant differences were observed in any of the lung functions between the two groups. Hence data were found to be homogeneous with respect to different regions and types of industry.

The correlation co-efficient of physical parameters with FVC, FEV1.0, FEV 0.75 and IMBC are given in Table V. Significant

TABLE I : General physical characteristics of surveyed women hailing from different parts of India.

| *Physical Characteristics* | *North (60) Mean±SD* | *Central (110) Mean±SD* | *South (104) Mean±SD* |
|---|---|---|---|
| Age (yrs) | 28.9±6.5 | 31.3±5.1 | 34.8±4.5 |
| Height(cms) | 152.2±6.4 | 153.5±6.0 | 153.3±5.2 |
| Weight(kg) | 46.6±9.3 | 50.2±9.1 | 56.7±8.9 |
| BSA | 1.48±0.15 | 1.46±0.14 | 1.55±0.13 |
| Quintex Index | 2.01±0.37 | 2.13±0.37 | 2.41±0.38 |

TABLE II : Lung function values of females hailing from different parts of the country.

| *Lung functions* | *North (60) Mean ± SD* | *Central (110) Mean ± SD* | *South (104) Mean ± SD* |
|---|---|---|---|
| FVC (lit/min) | 2.36 ± 0.51 | 2.40 ± 0.50 | 2.40 ± 0.31 |
| FEV1 (lit/min) | 2.07 ± 0.49 | 2.05 ± 0.46 | 2.06 ± 0.30 |
| FEV. 75(lit/min) | 1.81 ± 0.34 | 1.83 ± 0.45 | 1.90 ± 0.49 |
| FEV/FVC (%) | 87.5 ± 6.00 | 84.7 ± 8.70 | 85.46 ± 6.69 |
| IMBC | 76.0 ± 19.7 | 73.1 ± 17.9 | 72.46 ± 13.5 |

TABLE III : Lung function values of women of different age groups.

| *Age groups* | *FVC Mean ± SD* | *FEV 0.75 Mean ± SD* | *FEV 1.0 Mean ± SD* | *FEV1/FVC Mean ± SD* | *IMBC Mean ± SD* |
|---|---|---|---|---|---|
| 21–25 | 2.58 ± 0.51 | 2.05 ± 0.45 | 2.23 ± 0.46 | 86.7 ± 7.1 | 81.9 ± 18.0 |
| 26–30 | 2.45 ± 0.45 | 1.88 ± 0.48 | 2.11 ± 0.47 | 85.8 ± 0.5 | 74.8 ± 19.4 |
| 31–35 | 2.38 ± 0.40 | 1.80 ± 0.40 | 2.04 ± 0.38 | 85.1 ± 7.5 | 72.2 ± 15.4 |
| 36–40 | 2.27 ± 0.39 | 1.76 ± 0.37 | 1.95 ± 0.35 | 86.1 ± 7.6 | 70.3 ± 14.7 |
| 41–45 | 2.26 ± 0.39 | 1.71 ± 0.30 | 1.89 ± 0.31 | 83.7 ± 6.4 | 68.2 ± 12.1 |

TABLE IV : Lung function values of women in organised and unorganised industries.

| *Lung functions* | *Organised (203) Mean±SD* | *Unorganised (71) Mean±SD* |
|---|---|---|
| FVC (lit/min) | 2.41 ± 0.39 | 2.36 ± 0.54 |
| $FEV_1$ (lit/min) | 2.06 ± 0.38 | 2.02 ± 0.49 |
| FEV 0.75 (lit/min) | 1.83 ± 0.40 | 1.85 ± 0.48 |
| $FEV_1$/FVC (%) | 85.6 ± 7.57 | 85.5 ± 7.30 |
| IMBC | 73.3 ± 15.9 | 74.1 ± 19.2 |

TABLE V : Correlation coefficient of lung function parameters with age, height, weight and body surface area.

| *Lung function* | *Age* | *Height* | *Weight* | *BSA* |
|---|---|---|---|---|
| FVC | −0.23 | 0.39 | 0.26 | 0.33 |
| FEV1.0 | −0.22 | 0.29 | 0.24 | 0.28 |
| FEV 0.75 | −0.22 | 0.29 | 0.24 | 0.23 |
| IMBC | −0.22 | 0.28 | 0.23 | 0.28 |

TABLE VI : Regression relationships for age, height and weight for predicting lung function parameters for age group 20 to 45 years in healthy women.

| *Measure-ments* | *Intercept* | *Regression* | | | | | | *Coefficients* | |
|---|---|---|---|---|---|---|---|---|---|
| | | *Age* | | *Height* | | *Weight* | | *Multiple* | *$R^2$ RSD* |
| | | *Coeff.* | *SE* | *Coeff.* | *SE* | *Coeff.* | *SE* | | |
| FVC | −0.828 | −0.0203 | 0.0043 | +0.0217 | 0.0042 | +0.0106 | 0.0026 | 0.240 | 0.146 |
| FEV0.75 | −0.0966 | −0.0199 | 0.0043 | +0.0132 | 0.0043 | +0.0107 | 0.0026 | 0.173 | 0.149 |
| FEV1 | −0.5716 | −0.0210 | 0.0040 | +0.0178 | 0.0040 | +0.0109 | 0.0024 | 0.233 | 0.131 |
| IMBC | −4.2332 | −0.7851 | 0.1732 | +0.5318 | 0.1706 | +0.4142 | 0.1045 | 0.169 | 238.1 |

negative correlation of all lung funtion parameters with age was observed whereas correlation co-efficients with height and weight were significantly positive. The analysis showed better correlation of lung functions with height than age, weight and body surface area although the level of significance of correlation co-efficient from zero was the same ($P < 0.001$) for all the physical parameters.

Table VI shows regression coefficients of determination ($R^2$) and residual standard deviation (RSD) for pulmonary function parameters. The normal decline of FVC, FEV1.0 and FEV0.75 with respect to age was of the same order i.e. 0.203, 0.210 and 0.199 litre/decade respectively. The respective regression co-efficients of FVC, FEV1.0 and FEV0.75 to height were 0.022, 0.018 and 0.013 litres/centimeter. The co-efficients with respect to weight were also of the same order (0.0106 litre/kg for FVC, 0,0109 litre/kg for FEV1.0 and 0.0107 litre/kg for FEV0.75).

The total explained variation ($R^2$) for all the lung function parameters ranged between 17 and 24 per cent leaving a substantial amount to be accounted for either by factors not included in the model or by random variation. RSD's were also of the same order and hence had similar predictive capacity to determine FVC, FEV1.0 and FEV0.75 parameters.

## DISCUSSION

The purpose of this study was to evaluate ventilatory function in a cross section of women population in different age groups derived from different zones of India and to lay down ventilatory norms. In fact, in India, no such study of the female population has been done previously for assessing the respiratory norms.

The determination of ventilatory tests in different groups revealed that all lung function variables attained maximum peak in the 21–25 years age group and thereafter steadily declined. Since all the dynamic ventilatory functions depend upon the compliance of the thorax-lung system, airway resistance and muscular strength rather than the absolute anatomical lung volumes, the deterioration in the lung function with advancing age, is mainly caused by change in these factors (16). The age-related loss in pulmonary function is due to decrease in lung compliance, increase in airway resistance and reduction in the strength of respiratory muscles associated with changes in the elastic recoil of the lung and increase in the stiffness of the thoracic cage (17).

The lung function data for Indian women population in the present study have been compared with the data already available from India (1,3,7,21–24). Our values of FVC and other respiratory parameters are higher than those reported by some of the previous investigators (18–20). The difference can be explained by different physical characteristics and racial factors. Jakhanwal et al (7) obtained low lung function values and offered a similar explanation. The possible reasons for the differences in pulmonary function values could also be due to the method of selection of samples for the study, the type of population and the techniques and instruments employed in measuring the lung functions. Previous investigators (6–8, 18–20) have mainly used water spirometers which have greater inertia and resistance than the dry spirometers used in the present study. Besides this the nutritional standards (18–21), health status and the physical fitness of the population vary in different area of our climatically heterogenous country. However, the mean lung function values reported in female population from Delhi (1, 2) are better than those observed in our study, due to relatively better economic conditions when compared with the population in other parts of India. With much better nutritional standards and active outdoor habits, there is better growth of musculo-skeletal system of the thoracic cage and lung tissue, resulting in better lung function in Delhi population. It had also been suggested that the domestic pollution caused by burning of biomass fuels impaired the pulmonary function status in Indian women (25–27).

The lung function values recorded in the female population in the present study are comparable with the findings of Kasliwal et al (22), Kamat et al (28), Bhattacharya and Banerjee (21) and Rao et al (18).

Thus, the present study deals with the assessment of various lung functions in a cross section of Indian female population in different age groups, drawn from various parts of the country. The study did not reveal ethnic variation in lung function parameters in north and south Indian female population, though the nutritional status of the subjects were not the same in different parts of India.

## CONCLUSION

Multiple linear regression analysis of the lung functions showed that the total variation explained by the variable ranged between 21 per cent and 24 per cent leaving a substantial amount to be accounted for either by factors not included in the model or by random variation. This has led to study of the role of socio-economic factors as one of the explanatory variables. Explained variation can be increased by including this factors also, as one of the explanatory variables in the regression model. The models will be helpful in classifying female subjects with respect to various lung function abnormalities and also in comparing different populations for lung functions after standardizing for age, height and weight.

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