Pulmonary function test in healthy school children of 8 to 14 years age in south Gujarat region, India

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**ABSTRACT**

**Objective:** To obtain reference values for FEV\(_1\), FVC, FEV\(_1\)% and PEFR among children aged 8-14 years in south Gujarat region of India. **Materials and Methods:** This cross-sectional study was conducted among 655 normal healthy school children (408 boys and 247 girls) of Surat city aged 8 to 14 years studying in V to VII standard during November 2007 to April 2008. Height, weight, body surface area were measured. All included children were tested in a sitting position with the head straight after taking written consent from parents. Spirometry was done using the spirometer “Spirolab II” MIR 010. Spirometer used in the study facilitates the total valuation of lung function including forced vital capacity (FVC), forced expiratory volume in one second (FEV\(_1\)), forced expiratory volume ratio in one second (FEV\(_1\)%), and peak expiratory flow rate (PEFR). **Results:** FVC, FEV\(_1\), and PEFR were found to be statistically significant in the study groups. For FVC and FEV\(_1\), highest correlation was found with age in girls and height in boys. For FEV\(_1\)% significant negative correlation was found with age and height in both sexes, but positive correlation was found with surface area. Similarly, PEFR showed highest correlation with surface area in boys and girls. **Conclusion:** Variables such as FVC, FEV\(_1\), and PEFR show good positive correlation with height, age, and body surface area in both sexes. There is a need to have regional values for the prediction of normal spirometric parameters in a country like India with considerable diversity.

**KEY WORDS:** Age, body surface area, forced vital capacity, healthy children, height, peak expiratory flow rate

**INTRODUCTION**

Among the various investigation modalities available, pulmonary function test (PFT) is an invaluable tool for the assessment of lung function. PFT for lungs can be comparable to the ECG for heart.\(^{[1]}\) PFT is used to identify the underlying cause of respiratory symptoms in children and adolescents and to monitor the status of those with chronic lung diseases. In clinical practice, spirometry is the investigation of choice for the overall assessment of pulmonary function and is equated with the PFT in day to day practice. The application of PFT in diagnosis and management of respiratory diseases is not yet a routine in our country. Predictive normal values are essential for meaningful clinical interpretation of these tests. Studies carried out in children had projected the equations for predicting different lung functions using height, age and weight as independent variables in India\(^{[2-5]}\) and in other countries\(^{[6-9]}\) and also showed differences in India and other countries as well as regional differences for spirometric parameters. From these studies, it is obvious that there are differences in spirometric parameters between Indian and western world as well as regional differences. As far as our research is concerned, no regional reference data for south Gujarati children are available. So, the present study was conducted with a purpose to obtain reference values for forced vital capacity (FVC), forced expiratory volume in one second (FEV\(_1\)), forced expiratory volume ratio in one second (FEV\(_1\)%), and peak expiratory flow rate (PEFR) among children aged 8-14 years in south Gujarat region of India.

**MATERIALS AND METHODS**

The present study was conducted among normal healthy school children of 8-14 years in Surat, south Gujarat region. The study was approved by ethical committee of Government Medical College, Surat and as per the Helsinki
Correlation

### RESULTS

The present study was conducted among 655 normal healthy school children (408 boys and 247 girls) 8 to 14 years old in Surat. Table 1 shows anthropometric and lung function variables of normal healthy school children as per their mean ± SD (standard deviation). Among different variables, FVC, FEV1, and PEFR were found to be statistically significant in study groups.

Co-efficient of correlation between various anthropometric and lung function variables in normal healthy school children is shown in Table 2. Various anthropometric variables such as age, sex, height, weight and surface area are independent variables. For multiple regression analysis, the following equation was used: $Y = \beta + a (height) + b (weight) + c (age) + d (surface area) + e (gender)$, where $Y$ is the dependent variable and $\beta$ is intercept.

### Table 1: Anthropometric and lung function variables of study group as per mean ± SD

| Variable         | Boys (n=408) | Girls (n=247) | $P$ value* |
|------------------|--------------|---------------|------------|
| Age (years)      | 10.68 ± 1.34 | 10.63 ± 1.33  | 0.528      |
| Height (cm)      | 142.34 ± 9.67| 141.72 ± 9.56 | 0.425      |
| Weight (Kg)      | 35.73 ± 8.83 | 35.0 ± 8.91   | 0.309      |
| Surface area ($m^2$) | 1.18 ± 0.17 | 1.17 ± 0.18   | 0.327      |
| FVC (L)          | 2.0 ± 0.46   | 1.91 ± 0.47   | 0.009      |
| FEV1 (L)         | 1.76 ± 0.38  | 1.69 ± 0.40   | 0.025      |
| FEV1%            | 88.11 ± 4.30 | 88.56 ± 4.47  | 0.190      |
| PEFR (L/s)       | 4.74 ± 0.96  | 4.47 ± 1.15   | 0.000      |

* $P < 0.05$ is significant

### Table 2: Correlation between various anthropometric and lung function variables in study group

| Variable                   | Correlation co-efficient | Significance* (2 tailed) |
|-----------------------------|--------------------------|--------------------------|
| Forced vital capacity (FVC) |                          |                          |
| Age                         | 0.046                    | 0.000                    |
| Height                      | 0.442                    | 0.000                    |
| Weight                      | 0.110                    | 0.030                    |
| Surface area                | 0.138                    | 0.000                    |
| Forced expiratory volume in one second (FEV1) |                     |                          |
| Age                         | -0.218                   | 0.000                    |
| Height                      | -0.137                   | 0.000                    |
| Weight                      | -0.046                   | 0.000                    |
| Surface area                | 0.368                    | 0.000                    |
| Peak expiratory flow rate   |                          |                          |
| Age                         | 0.269                    | 0.000                    |
| Height                      | 0.249                    | 0.000                    |
| Weight                      | 0.024                    | 0.000                    |
| Surface area                | 0.655                    | 0.000                    |

* $P < 0.001$, $r =$ coefficient of correlation without taking gender in consideration
age, height, weight and surface area were compared against lung function parameters such as FVC, FEV1, FEV1% and PEFR. For FVC and FEV1, highest correlation was found with age in girls and height in boys. For FEV1%, significant negative correlation was found with age and height in both sexes but positive correlation was found with surface area. Similarly, PEFR shows highest correlation with surface area in boys and girls.

Multiple regression analysis was done for lung function variables in normal healthy children of the study group [Table 3]. The FVC, FEV1 and PEFR have shown significant association with anthropometric variables. Table 4 shows sex wise comparison of FVC, FEV1 and PEFR between present study and various other studies.

**DISCUSSION**

The purpose of the present study was to derive predictive equations for lung function from healthy children of south Gujarat. Reference value describes the level of an index for a group of healthy persons that is the reference population in terms of defining variable, known as reference variable. Commonly used reference variables include ethnic group, age, gender and one or more indices of body size. Thus, the reference values are generated from an equation and the result of an individual subject is obtained by inserting values of his/her features into equation. Number of variables in the reference equation depends on the index. For example, it is more for primary indices such as FEV1 and FVC to which both body size and age contribute than to their ratio FEV1%. The lung function reported from India and other parts of south Asia exhibit considerable diversity. Contributory factors are racial differences, use of a wide variety of equipments and numerous environmental influences including nutrition, climate, terrain and prevalence of diseases.

In India, several studies were carried out on school children to predict the lung function using anthropometric variables. The studies conducted on children at Chandigarh,[2] Bombay,[3] Delhi[4] and Hyderabad[10] have projected different types of regression equations for lung functions in Indian children. Some of them had used age, height and weight,[14] age and height,[10] age and body surface area[10] or height alone[10] as independent variables for prediction of lung functions. The present study done on Gujarati children has used age, height, weight, body surface area and gender as independent variables for the prediction equations of FVC, FEV1, FEV1% and PEFR.

**Table 3: Multiple regression analysis for lung function variables in study group**

| Dependent variable | Intercept | Coefficient |
|--------------------|-----------|-------------|
|                    | Height (cm) | Weight (Kg) | Age (years) | Gender (M/F) | Surface area (MF) |
| FVC                | −2.8065    | 0.020       | 0.005      | 0.113       | 0.059               |
| FEV1               | −2.4188    | 0.017       | 0.004      | 0.088       | 0.030               |
| FEV1%              | 95.873     | −0.099      | 0.016      | −0.582      | −0.821              |
| PEFR               | −4.8491    | 0.023       | 0.001      | 0.106       | 0.081               |

**Table 4: Comparison of FVC, FEV1 and PEFR among boys and girls with other studies**

| Author          | No. of cases | PEFR | FVC | FEV1 |
|-----------------|--------------|------|-----|------|
| For boys        |              |      |     |      |
| Mallik SK et al | 441          | 2.1±0.7 | 1.9±0.6 |
| Sharma PP et al | 222          | 4.2±0.76 | 2.1±0.5 |
| For girls       |              |      |     |      |
| Harikumaran NR  | 109          | 1.7±0.21 | 1.59±0.19 |
| Malik SK et al  | 322          | 1.9±0.4 | 1.7±0.8 |
| Present study   | 408          | 4.7±0.96 | 2.01±0.46 |
| Present study   | 247          | 4.47±1.15 | 1.91±0.47 |

The present study has shown significant correlation for FVC with age (r=0.404, P<0.001) in girls and height in boys. Similarly, for FEV1, significant correlation (r=0.412, P<0.001) was found with age in girls and height in boys which was also reported by various authors.[3,10,11] Shamssain et al,[12] in their study in Libyan children showed that FVC (r=0.442, P<0.001) and FEV1 (r=0.479, P<0.001) were significantly less in girls than boys. Vijayan et al,[13] in a study on south Indian children, showed that correlations of FVC and FEV1 were highest with height followed by weight and age. Height influences the prediction equations in males to a greater extent whereas age and weight had greater influences in girls. Wang et al,[14] concluded that for the same height boys, have greater lung function values than girls.

FEV1% has shown negative correlation with height and age while statistically significant positive correlations with surface area, similar to Shamssain study.[7] In contrast to the present study, Chatterjee et al,[15] reported that FVC, FEV1, and PEFR values increased progressively with age from 9 to 16 years and showed significantly high correlation coefficient with weight and negative correlation of FEV1% with surface area.

The present study reported that FEV1% and PEFR have shown significant correlation with body surface area. Similar findings were reported by some authors.[16,17] Various studies[5,11] have shown that the prediction equation based on age and height and those based on age and body surface area did not show significant difference when used to calculate lung function values.
Connett et al.\(^6\) suggested that there were important differences in lung function between races. It was lower in Indian children than Chinese children, which is attributed to short chest length, a racial characteristic, in Indians. Vijayan et al.\(^{[13]}\) reported that pulmonary function measurements in south Indian children were similar to those of western India and lower than Caucasians, while Rajkappor et al.\(^{[18]}\) from Rohtak city in India derived values of lung function well comparable to other north Indian and western reports but higher than south Indian children. Chatterjee et al.\(^{[15]}\) observed that boys of his study were much closer to boys of Delhi in FVC, but higher than south Indian boys in FEV\(_1\); north and south Indian boys in PEFR.

**CONCLUSION**

Variables such as FVC, FEV\(_1\) and PEFR show good positive correlation with height, age and body surface area in both sexes. Applicability of Caucasian equations for Indian population is not appropriate and there is a need for reference equations in Indian subcontinent.\(^{[19]}\) Also there is a need to have regional values for the prediction of normal spirometric parameters in a country like India with considerable diversity.

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**REFERENCES**

1. Vijayasekaran D, Subramanyam L, Balachandran A, Shivbalan S. Spirometry in clinical practice. Indian Pediatr 2003;40:626-32.
2. Mallik SK, Jindal SK. Pulmonary function tests in healthy children. Indian Pediatr 1985;22:677-81.
3. Chowgule RV, Shetye VM, Parmar JR. Lung function tests in normal Indian children. Indian Pediatr 1995;32:185-91.
4. Sharma PP, Gupta P, Deshpande R, Gupta P. Lung function values in healthy children (10-15 years). Indian J Pediatr 1997;64:85-91.
5. Nair RH, Kesavachandran C, Sanil R, Sreekumar R, Shashidhar S. Prediction equation for lung functions in south Indian children. Indian J Physiol Pharmacol 1997;41:390-6.
6. Connett GJ, Quak SH, Wong ML, Teo J, Lee BW. Lung function reference values in Singaporean children aged 6-18 years. Thorax 1994;49:901-5.
7. Shamssain MH. Forcend expiratory indices in normal black southern African children aged 6-19 years. Thorax 1991;46:175-9.
8. Mosteller RD. Simplified calculation of body-surface area. N Engl J Med 1987;317:1098.
9. Miller MR, Hankinson J, Busasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J 2005;26:319-38.
10. Raju PS, Prasad KV, Ramana YV, Ahmed SK, Murthy KY. Study on lung function tests and prediction equations in Indian male children. Indian Pediatr 2003;40:705-11.
11. Deshpande JN, Dahat HB, Shirole CD, Pande AH. Pulmonary functions and their correlation with anthropometric parameters in rural children. Indian J Pediatr 1983;50:375-8.
12. Shamssain MH, Thompson J, Ogston SA. Forced expiratory indices in normal Libyan children aged 6-19 years. Thorax 1988;43:467-70.
13. Vijayan VK, Reetha AM, Kuppurao KV, Venkatesan P, Thilakavathy S. Pulmonary function in normal south Indian children aged 7 to 19 years. Indian J Chest Dis Allied Sci 2000;42:147-56.
14. Wang X, Dockery DW, Wypij D, Fay ME, Ferris BG Jr. Pulmonary function between 6 and 18 years of age. Pediatr Pulmonol 1993;15:75-88.
15. Chatterjee S, Mandal A. Pulmonary function studies in healthy school boys of West Bengal. Jpn J Physiol 1991;41:797-808.
16. Taksande A, Jain M, Vilhekar K, Chaturvedi P. Peak expiratory flow rate of rural school children from Wardha district, Maharashtra in India. World J Pediatr 2008;4:211-4.
17. Debray P, Shreevatsa BM, MG RB, Sen TK, Roy S, Sah S. A comparative study of the peak expiratory flow rate of Indian and Nepalese young adults in a teaching institute. JNMA J Nepal Med Assoc 2008;47:7-11.
18. Rajkappor, Mahajan KK, Mahajan A. Ventilatory lung function tests in school children of 6-13 years. Indian J Chest Dis Allied Sci 1997;39:97-105.
19. Aggarwal AN, Gupta D, Behera D, Jindal SK. Applicability of commonly used Caucasian prediction equations for spirometry interpretation in India. Indian J Med Res 2005;122:153-64.

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