Short Communication

Predicted equations for pulmonary function in normal adolescent south indian population

R. Sitalakshmi1*, P. Ravi Shankar2, R. Padmavathi3, A. S. Subhashini3 and M. Vijayalakshmi Thanasekaran4

Department of 1Physiology, Sree Balaji Medical College and Hospital, Chennai – 600 044, Tamil Nadu
Departments of 2Community Medicine, 3Physiology, 4Chest Medicine, Sri Ramachandra University, Chennai, Tamil Nadu. India

Abstract

Pulmonary functions are affected by variables like age, sex, height, weight, and geographic location. Our study aims to establish predicted equations for pulmonary functions in normal South Indian adolescent population. 400 subjects were grouped into pre & peripubertal (10-14 years) and pubertal (15 to 18 years) age categories. Anthropometric data collected, PFT assessed using portable data logging Spirometer MIR II. Mean FVC and FEV1 values were 2.80 L, 2.49 L in boys and 2.34 L, 2.12 L in girls respectively. Predicted equations for both adolescent age groups were generated by using linear regression analysis. PFT were significantly different in both age categories in boys and girls. PFT increased with increasing age and significantly correlated with the anthropometric parameters. Region specific and age specific predicted equations for PFT are generated from this study.

Introduction

Adolescent population account for 25% of the world population, of which 85% are in the developing countries. In India the adolescent population is 243 million, 16% of whom are in Chennai city (1). Adolescents are often healthier than older children and their health problems are taken for granted & adolescent studies are very limited. Lung functions are affected by known variables such as age, stature, gender, physical activity and environmental conditions. Lung function increases linearly with age and height during the adolescent growth spurt at 10-12 yrs in females and 16-19 yrs in males. The vital capacity increases in boys and girls rapidly and almost linearly till about 18 years (2).

Reference values play an important role in establishing whether, in an individual, measured volumes fall within a range to be expected for a healthy person of the same sex, similar stature, age, and other characteristics. The most common respiratory disorder in children is bronchial asthma 4-5% and its prevalence is increasing worldwide (3),
test. Pearson’s correlation analysis was used to assess the association of pulmonary functions with BMI. Linear regression analysis was performed for generation of prediction equations. The level of significance was taken at 5% level.

Results

Out of the 554 study population, 400 were selected, rest excluded based on exclusion criteria. The study sample included 226 boys, 174 girls. They were divided into two categories:

Pre & peripubertal age group: 10 -14 years. Pubertal age group: 15-18 years. Anthropometric parameters were significantly different among both age categories in both boys and girls as shown in Table I. FEV1, FVC were significantly different in both age categories in both boys and girls. Pulmonary functions were higher in boys than girls both categories. BMI correlated significantly with pulmonary functions as shown in Table II. Prediction equations for FVC and FEV1 were generated separately for boys and girls using linear regression analysis using age, height and weight.

GENERATION OF PREDICTED EQUATIONS (Using Linear Regression analysis)

Pre & Peri Pubertal Boys : 10-14 years

\[ FVC \text{ (Lit)} : 0.040* \text{ age (yrs)} + 0.0215* \text{ height (cms)} + 0.0018* \text{ weight (kg)} - 1.52. \]

\[ FEV₁ \text{ (Lit/sec)} : 0.002* \text{ age (yrs)} + 0.021* \text{ height (cms)} + 0.014 * \text{ weight (kg)} - 1.730. \]

Materials and Methods

The present cross-sectional study was carried out among 400 healthy adolescents (226 boys and 174 girls) from a total of 554 subjects. The study was approved by the SRMC Institutional Ethics committee. Written permission from the principals of schools and colleges were obtained. Informed consent was obtained from the participants. Personal history (name, age, gender,), followed by clinical, general and respiratory system examination was done. Subjects were excluded based on the exclusion criteria such as H/O acute illness three weeks prior; congenital cardiac disorders, surgeries in the recent past (three months), wheeze, repeated respiratory infections & smoking. Anthropometrical indices such as standing height, weight were measured and BMI calculated. Pulmonary function parameters FVC and FEV₁ were measured using portable data logging Spirometer- MIR II (A 23 model which performs as per the specifications of The American Thoracic Society (ATS) (7). The best values of three attempts were taken after sufficient training.

Statistical analysis

Data is represented as Mean±SD. Analysis done by one-way ANOVA and post-hoc by Tuky-Krammer test. Pearson’s correlation analysis was used to assess the association of pulmonary functions with BMI. Linear regression analysis was performed for generation of prediction equations. The level of significance was taken at 5% level.

### Results

Out of the 554 study population, 400 were selected, rest excluded based on exclusion criteria. The study sample included 226 boys, 174 girls. They were divided into two categories:

Pre & peripubertal age group: 10 -14 years. Pubertal age group: 15-18 years. Anthropometric parameters were significantly different among both age categories in both boys and girls as shown in Table I. FEV1, FVC were significantly different in both age categories in both boys and girls. Pulmonary functions were higher in boys than girls both categories. BMI correlated significantly with pulmonary functions as shown in Table II. Prediction equations for FVC and FEV1 were generated separately for boys and girls using linear regression analysis using age, height and weight.

### Generation of Predicted Equations (Using Linear Regression analysis)

Pre & Peri Pubertal Boys: 10-14 years

\[ FVC \text{ (Lit)} : 0.040* \text{ age (yrs)} + 0.0215* \text{ height (cms)} + 0.0018* \text{ weight (kg)} - 1.52. \]

\[ FEV₁ \text{ (Lit/sec)} : 0.002* \text{ age (yrs)} + 0.021* \text{ height (cms)} + 0.014 * \text{ weight (kg)} - 1.730. \]
Pre & Peri Pubertal Girls: 10 -14 years

FVC (L): 0.031* age (yrs) + 0.017* height (cms) + 0.080* weight (kg) – 1.088.

FEV₁ (Lit/sec): 0.039* age (yrs) + 0.015* height (cms) + 0.011* weight (kg) – 1.269.

Pre & Peri Pubertal Boys: 15 -18 years

FVC (Lit): 0.311* age (yrs) + 0.027* height (cms) + 0.015* weight (kg) – 6.850.

FEV₁ (Lit/sec): 0.230* age (yrs) + 0.023* height (cms) + 0.011* weight (kg) – 5.110.

Pubertal Boys: 15 -18 years

FVC (Lit): 0.018* age (yrs) + 0.006* height (cms) + 0.008* weight (kg) – 1.834.

FEV₁ (Lit/sec): 0.127* age (yrs) + 0.006* height (cms) + 0.009* weight (kg) – 1.031.

Pubertal Girls: 15 -18 years

FVC (Lit): 0.018* age (yrs) + 0.006* height (cms) + 0.008* weight (kg) – 1.834.

FEV₁ (Lit/sec): 0.127* age (yrs) + 0.006* height (cms) + 0.009* weight (kg) – 1.031.

Discussion

This study has generated baseline pulmonary functions in healthy adolescents. Results indicate a significant increase in pulmonary functions with increasing age and anthropometric parameters. Similar results have been observed in studies from India and other countries (8, 9, and 10). The values of FVC and FEV₁ show an increase with age in both boys and girls. The reason being, age related increase in muscle power attributed to the pubertal changes and probable increase in the size of the alveoli. There are gender differences in the anthropometric and pulmonary function data. The difference between pre and pubertal categories is less in girls compared to boys probably due to earlier onset (2-5 years) of puberty in girls (11, 12).

In our study, pulmonary functions correlated with all the anthropometric indices significantly as reported by other studies (13, 14, and 15). The vital capacity increases in boys and girls rapidly and linearly till 18 years due to morphological changes in the respiratory system during puberty. FVC and FEV₁ in the present study are slightly higher than that of other studies from Chennai (10). PFT of the present study were lower than Punjabi study (16) and few western countries (14, 17, 18, and 19) due to differences in geographic location, dietary habits, environmental factors, socioeconomic status. Pulmonary function values are similar to the predicted values generated by Vijayan et al (3). The predicted equations can be used in large epidemiological studies for predicting lung function where use of spirometer would be time consuming. The results of tests cannot be interpreted appropriately without reference to predicted values. The predicted equations generated from this study can also be fed into the spirometer and can be considered as referral standards.

References