RESEARCH ARTICLE

Assessment of pulmonary function test and its variability among different socio-demographic status of healthy school children of age group 9–17 years

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ABSTRACT

Background: Pulmonary function test (PFT) is used to diagnose the underlying cause of respiratory symptoms in children and adolescents. It is also used 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 assessment of lung function.

Aim and Objective: The aim of the study was to determine pulmonary function (as measured by FEV1 and FEV6) among school going children of age group 9–17 years and its variability with age, sex, height, and regional difference.

Materials and Methods: This cross-sectional study was conducted among 703 normal healthy school children (335 boys and 368 girls) of Thiruvananthapuram city aged 9–17 years during 2015–2016. The study group included both South Indian and North Indian children. Height, weight, and BMI 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 instrument “Vitalograph-COPD 6.” It displays FEV1 and FEV6. The FEV6 is used as a surrogate marker of FVC. Results: FEV1 and FEV6 were found to be statistically significant in the study group. Both FEV1 and FEV6 were higher in boys than girls. In both boys and girls, FEV1 and FEV6 values showed strong positive correlation with age, and height which was found to be statistically significant (\( P < 0.001 \)). North Indian children have got higher FEV1 and FEV6 values than South Indian children. This was also found to be statistically significant (\( P < 0.001 \)). Conclusion: Variables such as FEV1 and FEV6 values showed strong positive correlation with age and height in both sexes. By regression analysis, it was found that age, gender, and height were the significant predictors for both FEV1 and FEV6.

KEY WORDS: FEV1; FEV6; Vitalograph; Pulmonary Function Test

INTRODUCTION

In many pulmonary disorders, pulmonary function test (PFT) is a vital instrument for assessing lung function.\(^1\) PFT can be used to diagnose the fundamental cause of pulmonary manifestations in children as well as adults and to observe the condition of those suffering from chronic lung diseases. In the hospital set up, spirometry is the best option to investigate the overall evaluation of respiratory function which is equal to PFT in routine practice. The implementation of PFT in diagnosis and treatment of pulmonary diseases are still not done routinely in India.\(^2\) Globally millions of people suffer from respiratory diseases and four million people die prematurely due to it each year.\(^3\) Various equations to anticipate lung functions have been predicted in a few countries including ours using data such as age, weight, and height as independent variables based on a few studies.
conducted in children.[45] From the above-mentioned studies, it is clear that there are variations in lung function parameters between Indian and western countries besides regional variations. This study is being conducted with a purpose to assess the pulmonary function using FEV1 and FEV6 and its variability among different socio-demographic status such as age, gender, height, and regional difference among school going children of age group 9–17 years in Thiruvananthapuram.

MATERIALS AND METHODS

This study was carried out in normal and healthy school children of 9–17 years in Thiruvananthapuram, Kerala. This study was done with the approval of the human ethics committee of Thiruvananthapuram, Government Medical College. The written consent from the parents of these students within the study group was obtained after taking permission from school authorities. This study was done among girls and boys studying in Class IV to XII whose age ranged between 9 and 17 years during 2015–2016. All children having symptoms associated with the upper respiratory tract infection in the previous 2 weeks, children with acute or chronic pulmonary diseases, H/o regular usage of any bronchodilator, and children with chest or spine deformity or muscle weaknesses were excluded from this study.

The aim and objective of the present study was described to the school authorities and parents of the study group. The parents were asked to fill up a structured questionnaire; also a detailed clinical assessment of each child was done to eliminate any relevant issues as per the exclusion criteria. From the study set up, 750 children were examined among whom 703 children (335-boys and 368-girls) were incorporated in the study whereas 47 children were eliminated based on exclusion criteria. BMI was measured using the recorded height and weight. To find out the chest expansion, chest circumference was recorded at the nipples’ level at the end of full exhalation and full inhalation. PFT was done using the instrument “Vitalograph - COPD 6.”

All children under inclusion criteria were evaluated in a sitting posture with the head at the erect position. Before the test, for achieving a full familiarity, the procedure was described and illustrated to each and every child. Vitalograph was the instrument used in the study to measure the pulmonary function of the participants. It is a mini mobile electronic equipment that measures around 11.3 cm height, 6.3 cm width, and of thickness 4.5 cm which weighs 55 g, charged by batteries. It displays FEV1 and FEV6. The FEV6 is used as a surrogate marker of FVC. It has a display and a suitable design which permits it to be handled with ease by the participant. It is incorporated by a flowmeter that detects errors such as finishing of the procedure or coughing by showing an exclamation mark on the display and producing a very lengthy beep. The instrument has already been validated in the Thiruvananthapuram scenario in school children in a previous study and Cronbach’s alpha value was found to be 0.81 and 0.75 for the parameters FEV1 and FEV6 when compared to a full spirometer. After setting age, height, and gender in the instrument, participants are asked to inhale deeply. Then a mouthpiece with the device is inserted into their mouth and then the students were asked to exhale continuously and vigorously for exactly 6 s. When that time is attained (6 s), the instrument emits a beep sound to suggest that the participant can end the procedure. Values are noted from the instrument. Each student used a new disposable mouthpiece. Minimum of three values was taken and best of the three values was selected for scrutiny, depending on standardization of spirometry study which is based on ATS/ERS task force series[6] and many other studies.[7]

All data were typed into Microsoft Excel sheet which was analyzed using Statistical Package for the Social Sciences version 16 software. The categorical variables have been summarized using frequencies and proportions, quantitative variables as mean ± standard deviation (SD) for the normally distributed data and median and interquartile range for skewed data. The quantitative variables between the two groups were compared and were found out by using unpaired t-test. Comparison of quantitative variables among more than 2 groups was done by ANOVA with post hoc analysis of multiple comparisons. Pearson correlation was used to analyze the relationships between quantitative variables. All hypotheses were tested at a significance level of 95% and power of 80%.

RESULTS

Table 1 shows age and pulmonary function variables of normal and healthy school children according to their mean ± SD. It showed that with increase in age, there was an increase in both FEV1 and FEV6 values which is statistically significant (P < 0.001). Table 2 shows age and pulmonary function variables of normal and healthy school children according to their mean ± SD. It showed that all values except FEV1/FEV6 were higher in males than females which was found to be statistically significant. Table 3 shows association of pulmonary function variables with different anthropometric variables in healthy school children. Both FEV1 and FEV6 values showed statistically significant strong positive correlation with height. Relation of regional difference with lung function parameters is summarized in Table 4. Both FEV1 and FEV6 were higher in North Indians (P < 0.001). FEV1 and FEV6 in boys and girls in comparison with other studies are depicted in Table 5.
DISCUSSION

This study is an effort to assess FEV1 and FEV6 (FVC) in school children in relation to the variables such as age, gender, height, and regional difference in Thiruvananthapuram. In this study, FEV1 value was found to be increased statistically with increasing age which was significant ($P < 0.001$) and FEV6 values with increase in age up to 15 years ($P < 0.001$). Lung parameters FEV1 and FEV6 were lower in girls than boys ($P < 0.001$). In both boys and girls, FEV1 and FEV6 values have shown positive association with age ($P < 0.001$). We also found a statistically significant correlation of FEV1 and FEV6 found with height ($P < 0.001$). Among all the anthropometric variables, height has shown the maximum coefficient of correlation (for FEV1, $r = 0.83$ and for FEV6, $r = 0.8$). Lung function parameters FEV1 and FEV6 were increased in North Indians compared to South Indians ($P = 0.001$).

In India using anthropometric variables, several studies were conducted in school children to predict the pulmonary function. Studies carried out by Vijayan et al., Arnall et al.,[10] and Doctor et al.,[2] etc., showed that there is positive correlation of age with FEV1 and FVC, which coincides with our study. The respiratory system undergoes various anatomical and physiological changes with age. The cause of this increase with age most probably relates to rapid increase in the volume of the thoracic cage as shown by increase in FEV6. The increase in FEV1 could be due to increase in power of accessory muscles of respiration.

Choudhuri and Choudhuri et al.,[11] Behera et al.,[12] and Aggarwal et al.[13] found a significant gender variation in pulmonary function parameters, similar to our study. Gender variation in pulmonary function may be due to varying factors such as anatomical and physiological differences in pulmonary system of female and male, effect of sex hormone, their receptor, or intracellular signaling pathways. Positive correlation of FEV1 and FEV6 could be due to boys having larger lungs, increased number and surface area of alveoli compared to girls for a given age. Development of the respiratory system of female and male, effect of sex hormone, their receptor, and Doctor et al., etc., showed that there is positive correlation of age with lung function parameters ($P < 0.001$).

Rajkappor et al.[14] and Chowgule et al.[15] found a positive association of pulmonary function with height, which

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Age</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;10 (n=71)</td>
<td>10-11 (n=103)</td>
</tr>
<tr>
<td>FEV1</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>FEV6</td>
<td>Mean</td>
<td>SD</td>
</tr>
</tbody>
</table>

**Table 2: Correlation of gender with lung function parameters ($n=703$)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Gender</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>FEV1</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>FEV6</td>
<td>Mean</td>
<td>SD</td>
</tr>
</tbody>
</table>

*Statistical significance $P < 0.05$

**Table 3: Association of height with lung function parameters**

<table>
<thead>
<tr>
<th>Correlation between height and other lung parameters</th>
<th>Pearson correlation</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1</td>
<td>0.830**</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>FEV6</td>
<td>0.800**</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Statistical significance $P < 0.05$**

**Table 4: Relation of regional difference with lung function parameters ($n=703$)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Regional Difference</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South Indian (n=556)</td>
<td>North Indian (n=147)</td>
</tr>
<tr>
<td>FEV1</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>FEV6</td>
<td>Mean</td>
<td>SD</td>
</tr>
</tbody>
</table>

**Table 5: FEV1 and FEV6 in boys and girls in comparison with other studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>FEV1 (L)</th>
<th>FEV6 (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Present study</td>
<td>2.23</td>
<td>2.48</td>
</tr>
<tr>
<td>Rosenthal et al.</td>
<td>2.36</td>
<td>2.82</td>
</tr>
<tr>
<td>Shamssain</td>
<td>1.82</td>
<td>2.29</td>
</tr>
<tr>
<td>Chowgule et al.</td>
<td>2.26</td>
<td>2.54</td>
</tr>
<tr>
<td>Vijayan et al.</td>
<td>2.24</td>
<td>2.59</td>
</tr>
<tr>
<td>Rajkappor et al.</td>
<td>1.49</td>
<td>1.63</td>
</tr>
<tr>
<td>Budhiraja et al.</td>
<td>1.95</td>
<td>2.16</td>
</tr>
<tr>
<td>Sharm et al.</td>
<td>2.05</td>
<td>2.13</td>
</tr>
<tr>
<td>Malik et al.</td>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Doctor et al.</td>
<td>1.76</td>
<td>2.01</td>
</tr>
</tbody>
</table>
coincides with our study. The cause of this increase with height relates to rapid increase in the volume of the thoracic cage as shown by increase in FEV6. The increase in FEV1 could be due to increase in power of the accessory muscles of respiration and size of airways.

Study was done by Duong et al. in 2015 interpreted that pulmonary function differs substantially in different parts of the world. Our study also showed significant regional difference. These differences might be due to the contribution of genetic, environmental, and socioeconomic factors.

Strength of the Study
Since it is a non-invasive procedure and the instrument used for the study is portable, we can use it in a non-clinical set up.

Limitation of the Study
Mouthpiece used for this study was a standard sized one. Therefore, it was very difficult for the younger children to carry out the procedure. Hence, it took some more time to conduct the procedure than with the older children.

CONCLUSION
Variables such as FEV1 and FEV6 values showed strong association with age and height in both sexes. By regression analysis, it was found that age, height, and gender were the significant determinants for both FEV1 and FEV6.

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REFERENCES

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