

# Comparison of Pulmonary Function Tests in Asthmatic and Normal Children

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## Research Article

**Abstract: Objective:** To compare pulmonary function tests with the help of spirometry asthmatic children with normal children. **Methodology:** two groups of children more than 6 years of age were made one group of children previously diagnosed asthma and another of normal children according to ATS standards spirometry was performed and those children who were able to perform acceptable and repeatable spirometry were included and the PFTS results between two groups were compared. **Outcome measures** with respect to following parameters percent predicted values for FVC and FEV<sub>1</sub>, FEV<sub>1</sub>/FVC in percentage and bronchodilator reversibility. **Study design** Hospital based, case control study. **Conclusion** In asthmatic children when compared with normal children, there was no significant difference in both study and control group in percent predicted values of FVC, but percent predicted values of FEV<sub>1</sub> and FEV<sub>1</sub>/FVC ratio in percent were decreased significantly in asthmatic children as compared with healthy children. And in asthmatic children good bronchodilator reversibility was present as compared with normal children. So this study concludes that asthmatic children have abnormal PFTs as compared with normal children typical obstructive pattern is seen in them.

**Key Words:** FVC, FEV<sub>1</sub> and FEV<sub>1</sub>/FVC ratio.

## Introduction

Spirometry (meaning the measuring of breath) is the most common of the pulmonary function tests (PFTs), measuring lung function, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled. Spirometry is an important tool used for generating pneumotachographs which are helpful in assessing conditions such as asthma. Spirometry needs subject's co operation and hence can be performed in children 6 years and above.(1) Pulmonary function tests (PFTs) are used to determine asthma severity, along with clinical symptoms and medication requirements. Normal lung function is one of the goals of asthma management in international guidelines(2). Furthermore, long-term cohort studies have established that PFT results in children with asthma are correlated with asthma severity and with pulmonary function impairment in adulthood (3). Many studies concluded that failure to perform spirometry in children with asthma results in under diagnosis of airflow obstruction. Over the last several

decades much research has been undertaken to determine the normal values for lung volumes and lung capacities. Thus, by having tables of normal values; it is then easy to compare the severity of airway obstruction in children with hyper reactive airway disease. So my study aims at comparison of spirometric parameters in asthmatic children with normal children.

## Materials and Methods

In present study we compared pulmonary function tests of asthmatic children 6 years and above with healthy children with the help of following parameters percent predicted FVC and FEV<sub>1</sub>, FEV<sub>1</sub>/FVC % and bronchodilator reversibility. All children attending the pediatric outpatient department of a tertiary level hospital and asthma specialty clinic during the period of October 2009 to October 2011 and Two groups were made as study group and control group. Children who met the inclusion criteria in both the groups were subjected to spirometry. The study group included children more than 6 years of age who had symptoms suggestive of asthma were diagnosed as asthmatics based on definition and guidelines given by National Asthma Education And Prevention Program and control group included Age sex weight and height matched healthy children. Case record form was filled for every child in both the groups, patient information sheet was given to every subject in their mother tongue and informed consent form was taken. In the study 104 asthmatic children who were diagnosed previously and who were 6 years and above were subjected to ATS standardized spirometer out of 104 asthmatic children 76 asthmatic children were able to perform acceptable and repeatable spirometry(4) with respect to ATS standards so the study group comprised of 76 asthmatic children. I performed spirometry 106 healthy children above 6 years of age out of which 80 healthy children were able to perform acceptable and repeatable spirometry with respect to ATS standards so my control group consisted of 80 normal

children. The spirometric data obtained for both study and control group was analyzed with the non-parametric Wilcoxon on rank sum test, to determine the statistical

significance of difference of these variables before and after bronchodilator.

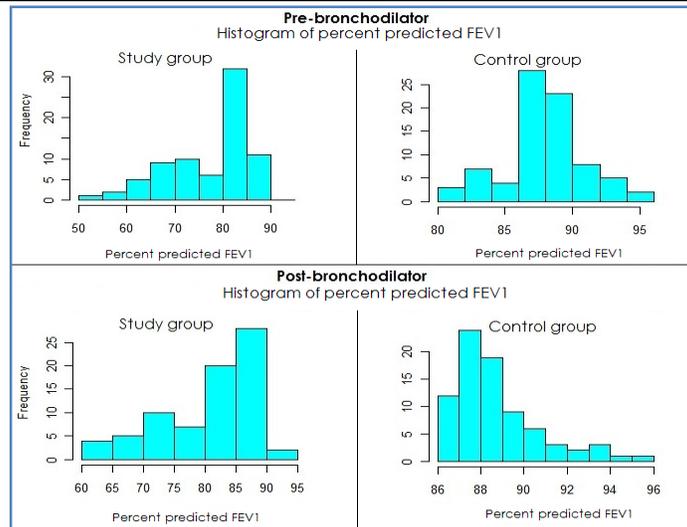
**Results**

**Table 1:** Significance of difference of percent predicted FVC between two groups for pre bronchodilator status

State	Percent predicted FVC (Mean ± SD)		p-value
	Study group	Control group	
Pre-bronchodilator	95 ± 2.75	95.7 ± 3.09	0.1102

**Table 2:** Significance of difference of percent predicted FEV1 between two groups for pre and post-bronchodilator states as well as between pre and post bronchodilator states for each group

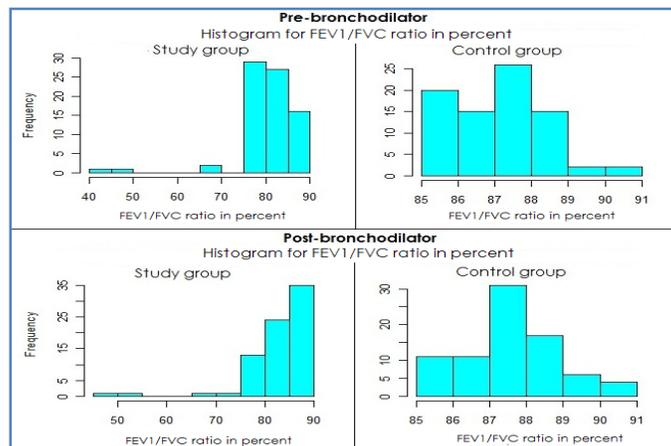
State	Percent predicted FEV1 (Mean ± SD)		p-value
	Study group	Control group	
Pre-bronchodilator	78 ± 8.39	88 ± 2.94	2.20E-16
Post-bronchodilator	81 ± 7.87	89 ± 2.06	1.12E-15
p-value	0.00133	0.1316	



**Figure 1:** Frequency distribution for percent predicted FEV1 for pre and post-bronchodilator states in two groups

**Table 3:** Significance of difference of FEV1/FVC% between two groups for pre and post-bronchodilator states as well as between pre and post bronchodilator states for each group

State	FEV1/FVC ratio (Mean ± SD)		p-value
	Study group	Control group	
Pre-bronchodilator	80 ± 7.14	88 ± 1.23	2.20E-16
Post-bronchodilator	83 ± 6.71	88 ± 1.22	7.81E-12
p-value	0.000099	0.2445	



**Figure 2:** Frequency distribution for FEV1/FVC% for pre and post-bronchodilator states in two groups

## Discussion

### A) Comparison of Percent Predicted Values of FVC in Asthmatic Children and Normal Children in Prebronchodilator States

Forced vital capacity is the determination of the vital capacity from a maximally forced expiratory effort. Pre bronchodilator percent predicted value of FVC in study and control groups is shown in table 1. (>80 percent predicted value of FVC is supposed to normal) In this study group mean SD of percent predicted values of FVC is  $95 \pm 2.75$ , we found that there was no significant difference in both study and control group in percent predicted values of FVC. **Shrivastava A 1995** (5) studied PFTs in children with respiratory disorders and in normal children. He found that FVC was normal in asthmatic children, decreased in restrictive diseases as in pneumonia and empyema. FVC remains normal in mild and moderate obstruction. It may be decreased in severe obstruction and in restrictive lung diseases it is reduced (6) as FVC represents lung parenchyma and asthma is disease of airways(7) so in asthma FVC remains normal except in severe asthma where FVC may be decreased due to worsening of air trapping. And in restrictive lung conditions there is loss of lung tissue so FVC is decreased.

### B) Comparison of Percent Predicted Values of FEV1 in Asthmatic and Normal Children in Prebronchodilator States

Table 2 and figure 1 showing distribution of percent predicted FEV1 in study and control groups in pre and post bronchodilator states. FEV1 is volume that has been exhaled at the end of the first second of forced expiration The percent predicted value of FEV1 is considered normal when it is more than 80 The mean SD of percent predicted value of FEV1 before bronchodilator in asthmatic children is  $78 \pm 8.39$  and that of in healthy children is  $88 \pm 2.94$  when predicted values of FEV1 values of study and control group is compared in pre bronchodilator states, the p value is  $2.20 \times 10^{-16}$  which is less than 0.0001 indicating that there is significant difference between the two and the percent predicted value of FEV1 before bronchodilator in asthmatic children is reduced significantly. Two studies in adults who had asthma by **Peat et al. 1987**(8) & **Lange et al. 1998**(9) concluded that the average decline in FEV1 was significantly greater in those who had asthma than those who did not have asthma. In studies by **Bacharier et al. 2004**(7); **Paull et al. 2005**(10); in asthmatic children between 5-18 years of age found normal FEV1 values (many over 90 percent predicted) in a majority of the children, but study by **Strunk et al. 2006**(11) had a study with objective of effect of mild to moderate childhood asthma on lung growth found that FEV1 was

lower for boys with asthma than for boys without asthma. In asthma diffuse narrowing of the airways results in profound physiologic consequences. This narrowing has been thought to occur disproportionately in the small bronchi,(12,13) although recent studies suggest a prominent role for large and medium airways.(12,14)As a result, lung function tests are abnormal, with an increase in airway resistance and a decline in maximal expiratory flow. (12). In obstructive lung conditions the airways are narrowed, usually causing an increase in time it takes to empty the lungs. So FEV1 is reduced in asthma.

### C) FEV1/FVC Ratio in Asthmatics and in Healthy Children

The 2007 edition of the National Heart, Lung and Blood's Expert Panel Report 3 (3) recently added FEV1/FVC as lung function parameter in monitoring asthma in children FEV1/FVC ratio more than 85 is considered normal (6). With reference to figure 2 and table 3 mean SD of the ratio in asthmatic children is  $80 \pm 7$  in pre bronchodilator states and that of in normal children is  $88 \pm 1.23$  and difference between the two is significant as p value is  $2.20 \times 10^{-16}$  which is less than 0.0001, in study by **Bacharier et al. 2004** (7) FEV1/FVC ratios at age 10 years, in asthmatics, 79% (mean with a range 76–83%) compared with 87% (mean with a range 85–89%) for the control subjects. The FEV1/FVC ratio represents exaggeration of dysanapsis that occurs in asthma. Dysanapsis was first described by Green and colleagues(15) and Mead as variability of maximal expiratory flow–volume curves among healthy adults (16). Dysanapsis in the lung is a normal phenomenon caused by disproportionate growth of airways and lung parenchyma. This effect is exaggerated in asthma with airways (represented by FEV1) smaller than the lung parenchyma (represented by FVC)(17). The extent of dysanapsis in asthma (as represented by abnormal FEV1/FVC) is highly correlated with the degree of airway hyperresponsiveness (7,18)

### D) Reversibility in Asthmatic Children and in Normal Children

Reversibility is improvement in FEV1 of more than 12% and 200ml after bronchodilator treatment indicates reversible airflow obstruction and is important factor in diagnosing asthma. In table 2 in study group mean SD percent predicted value of FEV1 in pre bronchodilator and post bronchodilator states are  $78 \pm 8.39$  and  $81 \pm 7.87$  respectively. Difference between the two is statistically significant as p value is 0.00133 as it is less than 0.05 and in control group difference between predicted value of FEV1 in pre bronchodilator and post bronchodilator states is statistically insignificant. As defined above when there was good bronchodilator

reversibility (Improvement in FEV1 of more than 12% and 200ml after bronchodilator treatment) in asthmatic children and no reversibility in control group. **Bussamra, M.H. et al 2005**, (19) had a study in children and adolescents with asthma for evaluation of the magnitude of the bronchodilator response, their conclusion was in asthmatic children cut off values established for assessment of bronchodilator response agree with those in literature. There was good bronchodilator response in asthmatics. In asthmatic children when compared with normal children, there was no significant difference in both study and control group in percent predicted values of FVC, but percent predicted values of FEV1 and FEV1/FVC ratio in percent were decreased significantly in asthmatic children as compared with healthy children. And in asthmatic children good bronchodilator reversibility was present as compared with normal children. So this study concludes that asthmatic children have abnormal PFTs as compared with normal children typical obstructive pattern is seen in them.

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