Spirometric Standards for Healthy Children Aged 6-15 Years in a School of Dhaka City, Bangladesh

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Abstract

Background: Prevalence of Asthma in children is about 7% in Bangladesh but Spirometric value of children is not available.

Objective: The study was conducted to find out the spirometric value of normal school going children and to compare the values with those of other countries.

Methodology: Sprirometric evaluation of normal school going children was done by computerized spirometer (Ponygraphic of COSMED srl-Italy) in a school of Dhaka city during the period of February 2002 to July 2002. Nine hundred twenty seven healthy children aged 6-15 years were selected for the study. Outcome variable were the forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), peak expiratory flow (PEF), the ratio of FEV_1 to FVC and forced expiratory flow (FEF) between 25% & 75% of vital capacity ($FEF_{25\% \& 75\%}$). The pulmonary function data was separated by sex and categorized on the basis of height, weight, age and body surface area. The mean and standard deviation were calculated for every such variable. The results (FVC) of present study was compared with those of other countries (India, Nigeria, British and America).

Results: The lung function variables showed a linear positive correlation with height, weight, age and body surface area (independent variables). Strong correlation was found between lung function values and independent variables. Height showed the maximum correlation in comparison with other variable. Forced vital capacity (FVC) and FEV_1 showed a spurt after the height of 150 cm. Regression equations for lung function values were determined for boys and girls considering height as independent variable. Boys showed higher values for lung functions than those of girls. Lung function values of these studied children are nearly similar to Indian children and significantly lower than Nigerian, British (UK) and American (USA) peers.

Conclusion: Spirometric values of our children are very much comparable with those of regional children (India) but values are lower than those of African (Nigeria), European (British) and American (USA) children.

Recommendation: Further study should be done with larger sample size to have our own national data and to fill up the standard spirometric values for the children of our country.

Key words: Spirometric standards, healthy children.

Introduction

Asthma is the most common chronic inflammatory disease in children and is a major global health problem[1-3]. Prevalence of asthma in children is 7% in Bangladesh and is increasing day by day in our country and also globally[1,4-9]. Pulmonary function test of various types are utilized clinically and epidemiologically to measure the functional status of lungs in order to assess the disease[10,11]. Though they do not provide a specific diagnosis, but we can understand the physiology, course and progress of the respiratory diseases, assess the severity and help in the management of number of respiratory diseases[11]. Spirometry is the method of choice for evaluation of pulmonary function. It is indicated in all the children with clinical diagnosis of asthma, chronic/recurrent cough or wheeze, exercise induced cough

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or breathlessness and with recurrent respiratory manifestations. Spirometry evaluates forced vital capacity (FVC), forced expiratory volume in first second (FEV$_1$), the ratio of FEV$_1$ to FVC, peak expiratory flow rate (PEFR) and forced expiratory flow between 25% and 75% of vital capacity (FEF $_{25\% \& 75\%}$). The base line spirometry, bronchodilator reversibility and histamine challenge are diagnostic of hyper-reactive airway with 98% sensitivity[12]. Spirometer is a computerized and self calibrating instrument that can asses respiratory functional parameters of a person in detail both in disease and normal status. To compare the lung function values of a diseased children, some reference values or nomogram is essential. Nomograms and regression equation for predicting lung function values in relation to height, weight, age and sex are present in different countries. We use the nomogram of lung function values of western and other countries. Recently, peak expiratory flow rate (PEFR) value of Bangladeshi children was determined by peak flow meter[13]. So far we know, there is no spirometric data of lung function values of Bangladeshi normal children. But it is proved by different studies that normal values of lung function tests differ from population to population in relation to race, socio-economic status and ethnic background. So for diagnosis, management, follow up and research on respiratory disorder it is important to have lung function values of normal children.

Materials and Methods

It was a cross sectional study conducted during February 2002 to July 2002. One school of Dhaka city was selected purposively for the study. Nine hundred twenty seven healthy children (M-463, F- 464) of class one to class ten were selected following the inclusion criteria (Boys and girls, 6-15 years of age, having no history of obvious chronic lung diseases, chronic cough, atopic diseases (asthma, eczema, rhino conjunctivitis), chest deformity, heart diseases or smoking habit). Proper clinical examination and information were recorded in a questionnaire by one of the authors. Age was calculated from the date of birth given by parents. Height was measured by stadiometer and weight was recorded by bathroom scale in children with school uniform and putting off shoes.

A computerized spirometer (Ponygraphic of COSMED srl-Italy) was used in this study. Before testing, the procedure was explained and demonstrated to each child. Each subject was allowed to practice at least three times and after being satisfied about the subject's ability to perform the test, three recordings were obtained and the best of the three was chosen for analysis.

All measurements were made in standing posture. FVC, FEV$_1$, FEV$_1$ /FVC%, PEF and FEF $_{(25\%-75\%)}$ were measured while the subject performed a forced vital capacity maneuver. Pulmonary function data were categorized on the basis of height, weight, age and body surface area but results have been produced on the basis of height as height showed maximum correlation in comparison with other variables as shown in different studies[14-17].

Data analysis was done through SPSS win program. For significance chi-square and 't' test was done according to variables. The result (FVC) of present study was compared with results of other countries (India, Nigeria, British and America)

Results

The mean and standard deviation of the variables (FVC, FEV$_1$, FEV$_1$ /FVC%, PEF and FEF$_{(25\%-75\%)}$) were calculated at 10 cm interval against height 110-180 cm in male and 110-170 cm in female (Table-I and II). In figure 1 and 2 the mean values of FVC and FEV$_1$ are plotted against height. In both sexes the graph showed a fairly constant increase in FVC and FEV$_1$ and sharper increase from height 150 cm. Graphs of the other spirometric measurements follow approximately the same pattern but FVC and FEV$_1$ is only shown in this article. Regression equation for prediction of lung function values (FVC, FEV$_1$, FEV$_1$ /FVC%, PEF and FEF $_{(25\%-75\%)}$) from independent variable (height) for boys and girls were performed (Table-III). In this study nomogram of FVC and FEV$_1$ for boys and girls were constructed on the basis of regression equation (Table-III and Fig. 3 to 6), where height was considered as independent variable. The mean FVC value at two height levels (120 cm and 160 cm) of present study was compared with predicted mean from other study of different countries (India, Nigeria, America and Britain). The results of Nigeria, America and Britain were significantly higher than the mean FVC values of present study but the FVC of present result was almost similar to Indian study result (Table-IV).

Table-I
FVC, FEV1, FEV1/FVC, PEF, FEF 25%-75% for studied male

Ht.(cm)	FVC(L)	FEV$_1$(L)	PEV$_1$/FVC%	PEF	FEF 25%-75%
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
110-120	0.99±0.12	0.99±0.11	99.82±0.17	2.97±0.49	2.04±0.49
120-130	1.26±0.19	1.23±0.20	98.21±0.48	3.30±0.61	2.13±0.50
130-140	1.59±0.25	1.56±0.22	98.61±0.27	3.76±0.70	2.60±0.51
140-150	1.99±0.32	1.92±0.94	96.59±0.49	4.33±0.84	2.90±0.56
150-160	2.64±0.32	2.51±0.32	95.25±0.51	5.04±1.12	3.43±0.69
160-170	3.09±0.35	3.00±0.34	97.17±0.39	6.00±1.34	4.33±0.89
170-180	3.53±0.37	3.44±0.39	97.54±0.95	6.93±1.26	4.97±0.89

Table-II
FVC, FEV1, FEV1/FVC, PEF, FEF 25%-75% for female

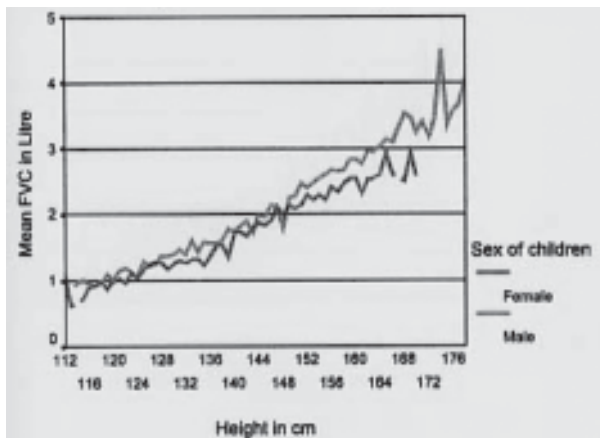| Ht.(cm)	FVC(L)	FEV$_1$(L)	PEV$_1$/FVC%	PEF	FEF 25%-75%
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
110-120	0.94±0.15	0.93±0.15	99.78±0.11	2.61±0.58	1.96±0.45
120-130	1.17±0.19	1.15±0.19	99.38±0.21	2.99±0.61	2.19±0.48
130-140	1.40±0.27	1.39±0.26	99.35±0.23	3.50±0.83	2.53±0.58
140-150	1.93±0.32	1.87±0.30	97.55±0.31	3.67±0.96	2.85±0.67
150-160	2.33±0.24	2.28±0.23	97.67±0.34	4.31±1.11	3.42±0.77
160-170	2.59±0.23	2.54±0.18	98.09±0.91	5.06±1.17	3.92±0.66

Fig-1: *Mean FVC (L) in relation to height and sex*
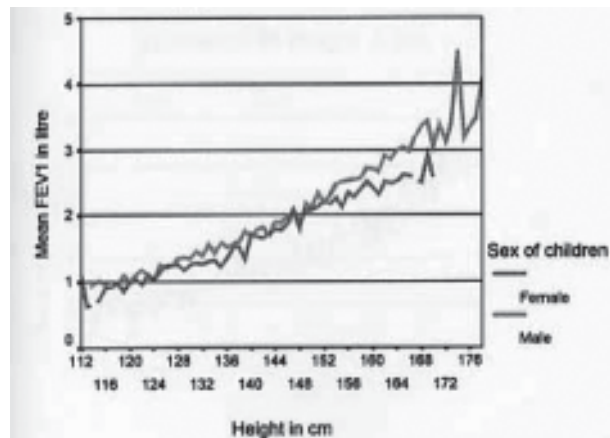

Fig-2: *Mean FEV$_1$ (L) in relation to height and sex*

Table-III
Regression equation for prediction of lung function values independent variable (height)

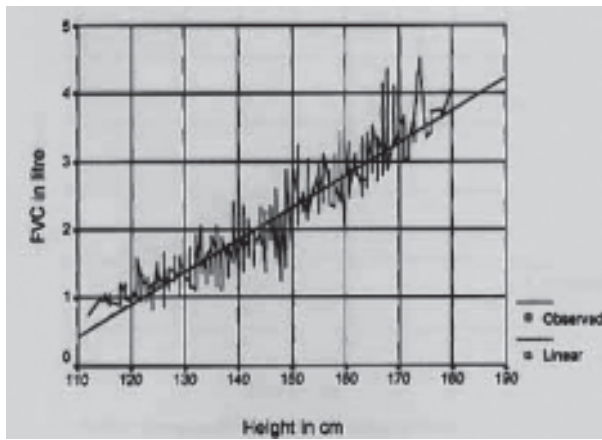| Sex	Variables		Regression equation
	Dependent	Independent	
Boys	FVC (L)	Height in cm	0.047 x Ht.- 4.77
Girls	FVC (L)	Height in cm	0.038 x Ht.- 3.73
Boys	FEV1 (L)	Height in cm	0.045 x Ht.- 4.55
Girls	FEV1 (L)	Height in cm	0.037 x Ht.- 3.55
Boys	FEV1 /FVC%	Height in cm	0.050 x Ht.+104.78
Girls	FEV1 /FVC%	Height in cm	0.057 x Ht.+106.56
Boys	PEF (L/sec)	Height in cm	0.067 x Ht.- 5.38
Girls	PEF (L/sec)	Height in cm	0.045 x Ht.- 2.77
Boys	FEF 25%-75%(L/sec)	Height in cm	0.052 x Ht.- 4.60
Girls	FEF 25%-75%(L/sec)	Height in cm	0.040 x Ht.- 2.96

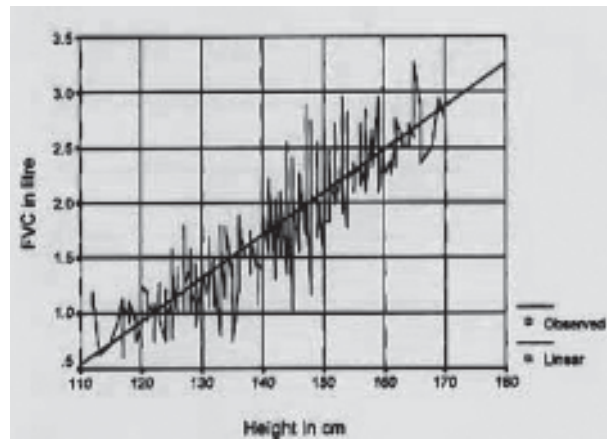**Fig-3:** *Nomogram of FVC (L) in boys in relation to Height*

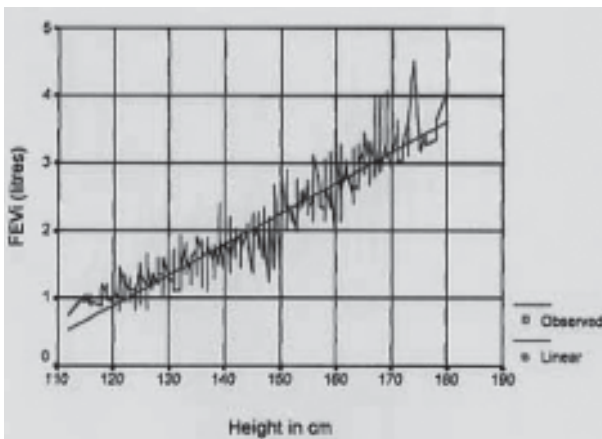**Fig-4:** *Nomogram of FVC (L) in girls in relation to Height*

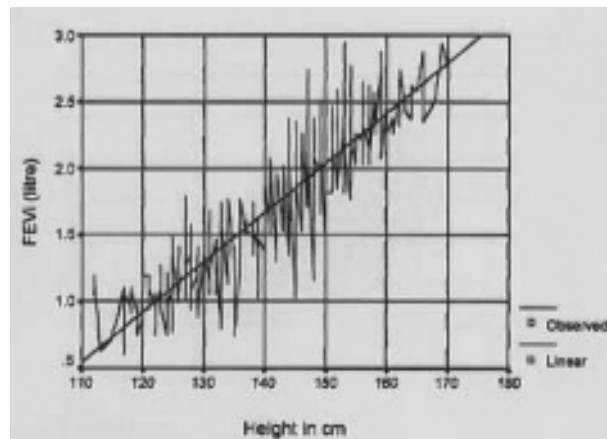**Fig-5:** *Nomogram of FEV$_1$ (L) in boys in relation to Height*

Fig-6: *Nomogram of FEV$_1$ (L) in girls in relation to Height*

Table-IV
Comparison of present result with other countries

Country	FVC (L) at Ht. of 120 cm.				FVC (L) at Ht. of 160 cm			
	Male	P value	Female	P value	Male	P value	Female	P value
Bangladesh	1.26		1.17		3.09		2.59	
India	1.42	<0.001	1.22	>0.05	2.63	<0.001	2.64	>0.05
Nigeria	1.66	<0.001	1.59	<0.001	3.27	<0.001	3.35	<0.001
America (USA)	1.52	<0.001	1.40	<0.01	3.54	<0.001	3.24	<0.001
British (UK)	1.49	<0.001	1.46	<0.001	3.89	<0.001	3.42	<0.001

Discussion

This study determines the normal values of lung function and prediction formula in children. For the first time normal values and regression equation for healthy Bangladeshi children have been calculated. The positive correlation of lung function value with age, height, weight and body surface area observed in both sexes but most significant correlation observed with height, which was observed by other studies[14-17]. This study found the difference of mean values of lung function indices between boys and girls, which is significant in all height groups except 110-120 cm and 140-150 cm. The lower values in girls were due to physiological reason and better performance of the boys. This may be due to anthropometric difference as well as factors such as difference in muscle strength and size and shape of the thoracic case between the sexes[14]. In this study we found rapid increase in pulmonary indices at approximately 150 cm onward which is comparable to other works[18]. FVC of present study result was compared with Indian, Nigerian, British and American results. The result (FVC) of present study is lower than Nigerian, British and American children. The difference with Indian results was not significant for girls but the results for boys was found significantly lower at Ht. of 120 cm and higher at Ht. of 160 cm[14-18].

Lower values of FVC of present study correlates with a previous study of Bangladeshi adult male[19]. They found that lung capacities and volumes of our population were lower than those of Europeans by about 20%. This study correlated with other study where they found difference in lung function in different ethnic groups[20]. In this study the nomogram was constructed from height based regression equation.

This small study in an urban school does not reflect the whole country status. So, we need to do large study.

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