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Evaluation of Lung Function by Spirometry in 12-14 yrs Adolescents in schools of Raipur city Chhattisgarh

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ORIGINAL RESEARCH

ABSTRACT

Aim

The study was carried out in normal school children in Raipur city to determine pulmonary functions in the age group 12-14 years.

Background

Spirometry is a important tool to assessment of lung function by evaluating forced vital capacity (FVC), forced expiratory volume in first second (FEV1), the ratio of FEV1 to FVC, peak expiratory flow rate (PEFR). Indian norms for spirometric test values are different from Western and other norms. Even within the country the test values differ between different regional and ethnic groups.

Material Methods

This is Cross sectional analytical observational study. 267 subjects were evaluated through pulmonary function test by Spirometry. Results were expressed as Mean ± SEM (Standard error of mean). Pearson's correlation coefficient(r) is calculated between dependent and independent variables. Prediction equations were developed using the multiple linear regression procedure.

Results

In our study spirometric parameters for boys were higher than girls. All Spirometric values were found to increase in relation to increase in height in both girls and boys except for the FEV1 %. All Spirometric values were found to increase in relation to increase in Age (12 to 14 years) in both girls and boys except for the FEV1 %.

Conclusion

This study shows, all the independent variables (age, weight, height and BSA) have linear positive correlation with lung function parameters, both for boys and girls. Height is the most important and reliable single independent variable. Regression equations for spirometry variables for region have been developed.

Key Words

Forced Vital Capacity (FVC), Forced Expiratory Volume in First Second (FEV1), Peak Expiratory Flow Rate (PEFR)

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INTRODUCTION

Studies shows Indian norms for spirometric test values [1,2,3,4] are different from Western and other norms since the lung functions are affected by known variables such as age, stature, gender, ethnic group, and environmental conditions therefore correct interpretation of pulmonary function data requires use of locally developed prediction equations. The reference values of pulmonary function tests and regression equations are available for Caucasian, Negroid, Aboriginal and Chinese children[5,6].

No study till date was reported from Chhattisgarh region, hence we carried out a study to find out basic norms of pulmonary function tests in the healthy school children of Raipur city Chhattisgarh in the age group of 12 to 14 years and to find its correlation with regards to age, sex, height and weight and to develop regression equations for spirometry.

MATERIAL AND METHOD

This Cross sectional analytical observational study was conducted in the Schools of Raipur city during year July 2012 to July 2013. The study was approved by the

Institutional Ethics Committee. Objectives & method of study was fully explained & informed consent was taken from subjects parents prior to start of the study. The subjects were evaluated through pulmonary function test by Spirometry method using schiller spirovit sp-1 Switzerland spirometer. A total of 267 subjects aged between 12-14 years were included in the study. Age in years, gender, weight, standing height, Body surface area (BSA) were recorded using standard method at the time of the testing.

Sample size Calculated by using WHO sample size determination in health studies. The estimated sample size was 267 with 95% Confidence level and 0.50 anticipated population proportions with 0.06 of absolute precision. Subjects having past history of chronic disease viz. pulmonary T.B. or having respiratory tract infection at the time of study, structural deformity of thoracic cage, Students < 12 yrs & >14 yrs were excluded from study.

Statistical Analysis

Results were expressed as Mean ± SEM (Standard error of mean). Pearson's correlation coefficient(r) is calculated between dependent and independent variables. Two tailed p-values were used throughout and p-values < 0.05 were judged statistically significant. Statistical analysis was carried out using statistical package for the social sciences (SPSS) 19.0 and Graph Pad Prism 6 software's. Analysis was carried out separately in boys and girls.

In the present study, the dependent variables were FVC, FEV1, and PEFR. Prediction equations were developed using the multiple linear regression procedure. Linear and nonlinear models were developed and the former was selected based on criteria of simplicity and ease of clinical application, high predictive capability (R^2) and yield of smallest residuals. The independent variables were height, age and weight & BSA. Regression equation was derived for spirometric variable FVC, FEV1 & PEFR for girls and boys separately.

RESULT

Total numbers of subjects in our study were 267. Boys were 109(40.82%) and Girls were 158(59.18%). In 12 years age group total subjects were 73 (27.34%), in 13 years 102 (38.2%) and in 14 years 92 (34.46%).

Table 1 shows in study group mean age was 13.07 years with SEM 0.048 and 95% CI was 12.98 - 13.17. Mean weight was 41.49 kg with SEM 0.41 and 95% CI 40.68 – 42.30. Mean Height was 149.64 cm SEM 0.55 and 95% CI was 148.55 – 150.73. Mean BSA was 1.31 with SE 0.008 and 95% CI was 1.29 – 1.33. Mean Age ±SEM for Boys were 13.14±0.07 and for Girls were 13.03±0.06 with Z-value of 1.17 and P value of 0.24. Mean Weight ±SEM for Boys were 42.93±0.67 and for Girls were 40.50±0.51 with Z-value of 2.91 and P value of 0.004. Mean Height ±SEM for Boys were 152.09±0.85 and for Girls were 147.95±0.69 with Z-value of 3.76 and P value of <0.001. Mean BSA ±SEM for Boys were 1.34±0.013 and for Girls were 1.29± 0.01 with Z-value of 3.31 and P value of <0.001.

Table 1 shows In study group mean FVC was 2.4 L with SEM 0.025 and 95% CI was 2.35 – 2.45. Mean FEV1 was 2.67L with SEM 0.025 and 95% CI 2.62 – 2.72. Mean FEV1% was 94.37 % with SEM 0.213 and 95% CI was 93.95 – 94.79. Mean PEFR was 5.50 L/Min with SE 0.059 and 95% CI was 5.38 – 5.62. In study group mean ±SEM FVC for Boys was 2.53±0.039 L and for Girls was 2.31±0.031 with Z value of 4.23 and P value <0.001. Mean ±SEM FEV1 for Boys was 2.39±0.038 L and for Girls 2.18±0.030 with Z value of 4.19 and P value of <0.001. Mean ±SEM FEV1% for Boys was 94.53±0.351 % and for Girls 94.26± 0.266 % with Z value of 0.61 and P value of 0.54. Mean PEFR±SEM for Boys was 5.80±0.090 L/Sec and for Girls 5.29±0.073 with Z value of 4.36 and P value <0.001. In our study spirometric parameters for boys were higher than girls. Mean FVC, FEV1 & PEFR for boys was higher (2.53, 2.39, 5.80) than girls (2.31, 2.18, 5.29).

Table 2a & 2b shows Correlation of FVC, FEV1 & PEFR with different independent variable Age, Height, and Weight & BSA found significant for both boys & girls. The correlation coefficient (r) was more than 0.5 for all four variable with P value <0.001 which is highly significant. Correlation of FEV1% with different independent variable Age, Height, Weight & BSA was not significant for both boys & girls Except for the age in girl which was found significant with p<0.05.

Table 3 shows All Spirometric values were found to increase in relation to increase in height in both girls and boys except for the FEV1 %.

Table 4 shows Regression equation for prediction of lung function values (FVC, FEV1, PEFR from independent variable (height) for boys and girls were performed (Table IV) using Equation: Spirometric parameter = Constant + (β Coefficient for age x age in years) + (β Coefficient for weight x weight in Kg) + (β Coefficient for height x height in cm) + (β Coefficient for BSA x BSA in m2). In this study nomogram of FVC and FEV1 for boys and girls were constructed on the basis of regression equation (Table V), where height was considered as independent variable.

DISCUSSION

Forced vital capacity (FVC) represents by lung dimension, compliance and respiratory muscle power whereas PEFR is determined by alveolar caliber, alveolar elastic recoil and respiratory muscle efforts[7,8]. Lung volumes and flow rates measured by means of spirometry should be interpreted in relation to proper reference values. It is well known that ethnicity, sex, age, and height are the key factors affecting the spirometric parameters. India is a subcontinent with varying geography and with a large multi-ethnic population; regional differences in lung functions in healthy Indians can thus be expected[9,10,11].

No study has been conducted in this region of India so the purpose of this study was to derive the prediction formula for estimation of the expected values of lung

function of the healthy school children aged 12-14 years based on height, weight, age, BSA and sex residing in Raipur city Chhattisgarh and to calculate regression equations. The limitation of the study was multicentric study with participation of other cities of the region was not feasible because of limited resources.

In our study All Spirometric values were found to have linear positive correlation with height and age in both girls and boys except for the FEV1 %, whereas weight shows positive correlation with all lung function parameter. Lung function values in boys were found to be significantly higher as compared to girls. Height was the most important and reliable single independent variable shown to have maximum coefficient of correlation. Other studies conducted by Rajkapoor et al and Chowgule et al showed similar relationship.

Present study found a statistically significant difference in lung function between both sex groups. Lungs functions were higher in boys as compared to that of girls ($P<0.05$). These results were comparable with the study done by Rajkapoor et al [10] in which they found that mean lung function test was higher in boys than in girls.

The values of lung function in present study are slightly more than the study conducted by Tahera H et al [12] probably because of regional variation but are comparable with the study conducted by SK Chhabra et al [12] & Chowgule et al[9].

The values obtained by Rosenthal et al[10] while studying the lung function in white girls were higher than those obtained in the present study except PEFR probably because of difference in anthropometric variables. Mean FVC and FEV 1 values for comparable heights in each age group were greater for boys than for girls as reported earlier. These results indicate that lung capacity differs by sex irrespective of body built.

We have presented prediction equations for various spirometry parameters for children Chhattisgarh region between the ages of 12 to 14 years. The FVC, FEV1, PEFR, showed moderate to strong correlations with age, height and weight in both boys and girls. The values of different lung functions, both obtained and predicted, in the present work were compared with other Indian and foreign studies shown in Table 5 [12 - 18].

Our values were found to be consistently lower than their age matched counterparts in children of American blacks, European and Australian origin [5]. Hence the same sets of references as used for Indian children are not applicable to these children. We applied additional stepwise multiple regression analysis to develop prediction equations separately for boys and girls incorporating age, height, weight, and BSA. We assume that these prediction equations could be fairly applied to the Raipur city Chhattisgarh population within this age range. Environments and technical factors, such as equipments and maneuvers could be the sources of variance.

CONCLUSION

Measurement of lung function is an important part of current management of various pulmonary diseases. We have presented reference data which help to interpret the observed lung function values in healthy school children of Chhattisgarh aged 12-14 years. We recommend further active research to establish individual population based regression equations to predict lung volumes and flow rates.

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PEER REVIEW

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CONFLICTS OF INTEREST

Nil

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Table 1 - Anthropometric parameters and Spirometry value

Anthropometric parameters of subjects in study group (n=267)				Anthropometric parameters of boys & girls in study group							
				Boys (n=109)			Girls (n=158)			Z-value	P*
Variable	**Mean**	**SEM**	**95% CI**	**Mean**	**SEM**	**95% CI**	**Mean**	**SEM**	**95 % CI**		
Age	13.07	0.048	12.98 - 13.17	13.14	0.07	13.0 – 13.28	13.03	0.06	12.9 – 13.16	1.17	0.24
Weight	41.49	0.41	40.68 – 42.30	42.93	0.67	41.70 – 44.25	40.50	0.51	39.51 – 41.49	2.91	0.004
Height	149.64	0.55	148.55 – 150.73	152.09	0.85	150.4-153.78	147.95	0.69	146.57-149.33	3.76	<0.001
FVC	2.40	0.025	2.35 – 2.45	2.53	0.039	2.45 – 2.61	2.31	0.031	2.25 – 2.34	4.23	<0.001
FEV1	2.67	0.025	2.62 – 2.72	2.39	0.038	2.32 – 2.47	2.18	0.030	2.15 – 2.21	4.19	<0.001
FEV1 %	94.37	0.213	93.95 – 94.79	94.53	0.351	93.83- 95.23	94.26	0.266	93.99-94.79	0.61	0.54
PEFR	5.50	0.059	5.38 – 5.62	5.80	0.090	5.62 – 5.98	5.29	0.073	5.15 – 5.43	4.36	<0.001

Table 2a – pulmonary function test (Mean ±SEM) in Relation to Age

variable	12 years						13 years						14 years					
	boys			girls			boys			girls			boys			girls		
	Mean	SEM	95% CI	Mean	SEM	95% CI	Mean	SEM	95% CI	Mean	SEM	95% CI	Mean	SEM	95% CI	Mean	SEM	95% CI
FVC	2.12	0.046	2.03 – 2.21	2.04	0.037	1.96 – 2.12	2.44	0.041	2.36 – 2.52	2.29	0.044	2.20 – 2.38	2.88	0.06	2.77 – 2.99	2.60	0.046	2.51 – 2.69
FEV1	2.01	0.048	1.92 – 2.10	1.90	0.038	1.82 – 1.98	2.31	0.039	2.23 – 2.31	2.16	0.043	2.07 – 2.25	2.71	0.06	2.60 – 2.82	2.47	0.046	2.38 – 2.56
FEV1%	94.74	0.584	93.53 - 95.95	93.31	0.508	92.29 – 94.33	94.86	0.563	93.73 – 95.99	94.45	0.497	93.46 – 95.45	94.01	0.63	92.73 - 95.29	94.93	0.344	94.24 – 95.62
PEFR	4.84	0.122	4.59 – 5.09	4.65	0.090	4.47 – 4.83	5.69	0.127	5.43 – 5.95	5.44	0.135	5.17 – 5.71	6.51	0.09	6.32 – 6.70	5.73	0.09	5.54 – 5.92

Table 2b - Correlation of FVC, FEV1 & PEFR with different independent variable

	FVC				FEV1				FEV1%				PEFR			
	Boys(n=109)		Girls(n=158)		Boys(n=109)		Girls(n=158)		Boys(n=109)		Girls(n=158)		Boys(n=109)		Girls(n=158)	
Variable	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**R**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Age	0.707	<0.001	0.589	<0.001	0.674	<0.001	0.599	<0.001	-0.085	0.377	0.194	0.014*	0.661	<0.001	0.468	<0.001
Height	0.868	<0.001	0.890	<0.001	0.827	<0.001	0.869	<0.001	-0.10	0.298	0.102	0.201	0.714	<0.001	0.641	<0.001
Weight	0.697	<0.001	0.747	<0.001	0.667	<0.001	0.724	<0.001	-0.063	0.513	0.065	0.416	0.523	<0.001	0.504	<0.001
BSA	0.779	<0.001	0.834	<0.001	0.744	<0.001	0.810	<0.001	-0.075	0.436	0.079	0.322	0.599	<0.001	0.576	<0.001

P<0.05 significant Z value > 1.96 significant p value- Significance(2tailed) r-correlation coefficiant

Table 3-Lung function test (Mean ±SEM) in Relation to Height

Height(cm.)	No.(n=267)		Age		FVC		FEV1		FEV1%		PEFR	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
121-130	-	04	-	12 ±00	-	1.71 ±0.01	-	1.63 ±0.02	-	93.75 ±1.56	-	3.95 ±0.05
131-140	12	32	12.42 ±0.15	12.38 ±0.09	2.01 ±0.06	1.89 ±0.03	1.91 ±0.06	1.77 ±0.03	95.11 ±0.82	94.03 ±0.61	4.77 ±0.22	4.47 ±0.09
141-150	40	61	12.80 ±0.10	12.97 ±0.10	2.27 ±0.03	2.21 ±0.03	2.15 ±0.04	2.08 ±0.03	94.66 ±0.53	94.25 ±0.41	5.24 ±0.11	5.26 ±0.11
151-160	35	48	13.34 ±0.12	13.38 ±0.10	2.68 ±0.04	2.59 ±0.02	2.54 ±0.05	2.44 ±0.03	94.56 ±0.71	93.93 ±0.53	6.31 ±0.13	5.81 ±0.11
161-170	21	13	13.81± 0.009	13.92 ±0.08	3.02 ±0.07	3.00 ±0.05	2.84 ±0.06	2.88 ±0.05	93.52 ±0.85	96.23 ±0.67	6.54 ±0.11	5.99 ±0.15
171-180	01	-	14 ±00	-	3.11 ±00	-	2.91 ±00	-	93.57 ±00	-	6.90 ±00	-

Table 5- Comparisons from other studies

	Present study		Tahera H et al		PP Sharma et al		Rajkapoor et al		SK Chabra et al		Chowgule et al		Rosenthal et al	
	Boys (n=109)	Girls (n=158)	Boys	Girls	Boys	Girls	Boys	Girls	Boys (n=365)	Girls (n=305)	Boys	Girls	Boys	Girls
Age	13.14	13.03	10.68 ± 1.34	10.63 ± 1.33					11.53±3.37	11.74±3.23				
Weight	42.93	40.50	35.73 ± 8.83	35.0 ± 8.91					44.56±18.42	40.97±13.82				
Height	152.09	147.95	142.34 ± 9.67	141.72 ± 9.56					1.49±0.18	1.45±0.14				
FVC	2.53	2.31	2.01 ±0.46	1.91 ± 0.47	2.29 ±0.8	1.91 ± 0.8,	1.63 1.47	1.63 1.47	2.88 ± 1.09	2.42 ± 0.72	2.54 - 1.94	2.54 - 1.94	2.82 - 2.17	2.82 - 2.17
FEV1	2.39	2.18	1.76 ±0.38	1.688 ± 0.40	2.15 ±0.6	1.86 ± 0.80	1.49 1.37	1.49 1.37	2.43 ±0.94	2.14 ± 0.65	2.26 - 1.77	2.26 - 1.77	2.36 - 1.91	2.36 - 1.91
PEFR	5.80	5.29	4.74 ± 0.96	4.47 ± 1.15	4.54 ± 1.0	4.30 ±1.3	3.845	3.633	5.47 ±2.02	5.0 ± 1.46	5.40 - 4.33	5.40 - 4.33	497 - 4.27	497 - 4.27

Table 4-Regression equations for spirometry parameters

Spirometry Constant	constant		βcoefficient for Age		βcoefficient for Weight		βcoefficient for Height		βcoefficient for BSA		Standard Error of Estimate		R^2	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
FVC	-3.873	-3.124	0.117	0.031	0.112	0.090	0.061	0.052	-6.831	-4.867	0.193	0.166	0.788	0.820
FEV1	-3.463	-3.180	0.109	0.048	0.085	0.085	0.050	0.049	-5.095	-4.616	0.216	0.180	0.715	0.784
PEFR	-7.868	-4.667	0.400	0.136	0.466	-0.115	0.191	0.015	-3.272	8.235	0.621	0.706	0.584	0.424