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Original Research Paper

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ASSESSMENT OF PULMONARY FUNCTION AND ITS CORRELATION WITH ANTHROPOMETRIC MEASUREMENTS AMONGST HEALTHY URBAN SCHOOL CHILDREN

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ABSTRACT

Respiratory diseases is one of the common cause of morbidity in children most commonly affected by the acute and chronic illnesses. The estimation of the pulmonary function though not useful in etiological diagnosis is useful in defining the type of process whether obstructive or restrictive and the degree of functional impairment in following the course of treatment of disease and its prognosis. Indian literature lacks the data on the spirometric analysis of children primarily d.ue to lack of cooperation of patients and trained persons, hence the present study was designed to study the pulmonary function tests through flow volume curves by spirometry in urban school children aged 10 to 15 years and to correlate the same with certain anthropometric measurements like height, weight and body surface area.

This cross sectional prospective analytical study was carried out in urban school going children in and around Raipur over a period of 6 months after obtaining the ethics committee approval. 410/550 students were screened on the basis of their health status and adequacy of their expiratory efforts while performing spirometry. The various pulmonary functions along with the anthropometric parameters were measured and correlated after maintaining the data in Microsoft Office Excel and with appropriate statistical tools like tests of proportion and significance.

A total of 410 students were included in the study. 222/410 (54.14%) were boys whereas 188/410 (45.86%) were girls. None of the participant was smoker but 215/410(52.4%) were having family history of smoking. None of the participant lived in the vicinity of factory, quarry or mine or any significant source of pollution. 408/410 (99.5%) students were having weight more than 80% of expected age as per Harvard's reference standards. Coefficient of correlation was obtained between the anthropometric measurements and pulmonary function parameters in both males and females and was found to be highly significant.

The study established the norms for various pulmonary functions in urban school going children in and around Raipur, CG. In the age group of 10 to 15 years. The Spirometric data have a positive correlation with the various anthropometric measurements.

KEYWORDS : Respiratory Diseases, Lung function tests, Spirometry

INTRODUCTION

Respiratory diseases are one of the commonest cause of morbidity in children most commonly affected by hyperactive airway disease, acute and chronic illnesses. Asthma is one of the most common admitting diagnosis in children affecting approximately 10-15% boys and 7-10% girls sometimes during childhood and results in 5 to 7 lost school days per year per child. Bronchiectasis, Empyma and other infective diseases are other major contributors of health problems causing significant alterations of pulmonary function in an individual. [1]

The estimation of the pulmonary function though not useful in etiological diagnosis is useful in defining the type of process whether obstructive or restrictive and the degree of functional impairment in following the course of treatment of disease and its prognosis. Lung volume and lung capacity individually or in combination are used commonly to yield a comprehensive description of overall lung performance. [2]

Peak flow rate (PFER) measured using the peal flow meter is most commonly assessed pulmonary parameter in Indian literature but PFER as a single measure of pulmonary function is effort dependent and not always easily reproducible. Forced efforts by the patients of obstructive diseases can give a false positive results indicating a good ventilatory status contradicting the actual status. So it is necessary to supplement PEFR with other tests like Vital capacity, Forced expiratory & inspiratory volumes, Forced expiratory volumes in one second and flow rates which can be measured by spirometer which yields flow volume curves. The initial portion of the expiratory curve is effort dependent and of limited diagnostic use but subsequent part effort independent and is altered in characteristic way depending on the alteration in mechanical properties of the lung in disease state. By identifying the characteristic contours of the flow volume curve, specific abnormalities of the respiratory tract can be identified. [3]

Indian literature lacks the data on the spirometric analysis of children primarily due to lack of cooperation of patients and trained persons, hence the present study was designed to study the pulmonary function tests through flow volume curves by spirometry in urban school children aged 10 to 15 years and to correlate the same with certain anthropometric measurements like height, weight and body surface area.

MATERIALS AND METHOD

This cross sectional prospective analytical study was carried out in urban school going children in and around Raipur over a period of 6 months after obtaining the ethics committee approval in 2016-17. A total of 550 Children of both gender and sex between 10 to 15 years were enrolled after an informed consent from the parents/ guardian of children along with necessary approvals from the school authorities. The students were enrolled after detailed physical examination with no history of acute and chronic respiratory infections, no congenital anomaly or no past history of thoracic surgery, no systemic illness which may directly or indirectly affect the respiratory system and no history of any upper respiratory tract infections is preceding 3 months.

After asserting the age from the school records the children were subjected to evaluation of physical environment by questionnaire. Presence of factories, sandstones quarry, mines and other source of pollution was enquired along with the history of smoking amongst family members. The enrolled students were then subjected to lung function test by

spirometrtic analysis as it is imperative to have a maximum respiratory efforts from the participants. The adequacy of the students efforts were assessed based on the shape and size of the flow volume curves. Around 140 students who failed to have a adequate volume on 3 consecutive efforts were rejected.

Remaining 410 students with adequate volumes were then subjected to anthropometric measurements like weight, height, surface area, Nutritional status & chest expansion by standard methods. Height was measured using standing measure and weight with school uniform to the nearest 0.1 kg with calibrated weighing scale. Body surface area was calculated using Dubois Normogram whereas nutritional status was assessed using recommendations of Indian Academy of Pediatrics wherein children upto 80% reference weight were considered within normal range and every 10% decrease thereafter constitute 1st to 4th degree malnutrition.

LUNG FUNCTION TEST –

The lung function parameters were recorded using portable Electronic Lung Function (ELF) spirometer by P.K. Morgan Co. Limited (UK). The ELF provides a high quality flow tube which can be easily detached and sterlised as well as temperature compensated pressure sensor in flow meter head. ELF is having eight sets of predictive normal values which provides norms to all lung function assessed taking anthropometric measurements into account.

The students were reassured, explained the procedure and made to seat in a normal upright posture looking straight ahead. The students were then told to hold the flow meter assembly and all appropriate data entries were made including name, age, sex, race, height, weight. After data entry internal calibration of ELF was done and the participants were connected to mouthpiece, nose clip applied with a request to participants to perform quiet breathing.

Tidal breathing pattern was traced and participants asked to exhale slowly down to residual volume. After this participants were asked to perform maximum inspiration and maximum expiration. Three such recordings were taken and best of the three was taken as lung function of the particular participant. ELF uses equations of Schoenberg and Bouys to predict the lower limits of normal values and final print out reports include calculated lung function parameters as well as flow volume curves.[4]

All the data was maintained in Microsoft Office Excel and statistical analysis done using Excel and Epi info for tests of proportion and significance.

OBSERVATION & RESULTS

A total of 410 students were included in the study. 222/410 (54.14%) were boys whereas 188/410 (45.86%) were girls. Age wise distribution of the student population enrolled was a per Table 1.

Age Group (Years)	Male (n/%)	Females (n/%)	Pooled (n/%)
9.6-10.5	25(6.1)	25(6.1)	50(12.2)
10.6-11.5	33(8)	29( )	62(15.1)
11.6 -12.5	50(12.2)	27(6.6)	77(18.8)
12.6 -13.5	35(8.5)	36(8.8)	71(17.3)
13.6 -14.5	49(12)	42(10.2)	91(22.2)
14.6-15.5	30(7.3)	29(7.1)	59(14.4)
	222(54.14)	1880(45.86)	410(100)

None of the participant was smoker but 215/410(52.4%) were having family history of smoking. None of the participant lived in the vicinity of factory, quarry or mine or any significant source of pollution. 408/410 (99.5%) students were having weight more than 80% of expected age as per Harvard's reference standards. Only 2 children, one 11 year old male and one 12 year old female had 70% of the expected weight.

The anthropometric means in different age and sex categories were as shown in Table 2. The age and sex was compared using one way and two way ANOVA with no significant difference observed with p value <0.01

TABLE 1: ANTHROPOMETRIC MEANS IN DIFFERENT AGE AND SEX CATEGORIES WITH COMPARISON WITH ANOVA

Age	Number	Sex	Height (cm)	Weight(Kg)	Surface area (m2)	Chest Expansion (cm)
9.6-10.5	25	Male	128.8±7.1	24±4	0.94±0.09	2.5±0.1
	25	Female	135.9±7.9	28±6	1.03±0.13	2.4±0.2
10.6-11.5	33	Male	137.7±7.2	31±5	1.09±0.10	2.5±0.1
	29	Female	140.3±10.8	33±10	1.14±0.19	2.5±0.2
11.6-12.5	50	Male	142±8.8	31±7	1.13±0.14	2.5±0.1
	27	Female	143.8±11.8	37±0.10	1.21±0.22	2.6±0.2
12.6-13.5	35	Male	153.7±8.6	44±9	1.39±0.17	2.5±0.1
	36	Female	151.4±7.6	39±10	1.29±0.19	2.5±0.0
13.6—14.5	49	Male	159±9.3	47±10	1.45±0.18	2.5±0.1
	42	Female	154.3±6.3	45±9	1.40±0.15	2.5±0.1
14.6—15.5	30	Male	163.5±5	50±8	1.50±0.12	2.5±0.0
	29	Female	160.3±4.6	50±8	1.50±0.12	2.5±0.1
One Way ANOVA		Age	0.0	0.0	0.0	0.360
		Sex	0.779	0.546	0.783	0.195
Two way ANOVA		Age+Sex	0.001	0.005	0.001	0.056

TABLE 2: MEANS OF LUNG VOLUMES IN DIFFERENT AGE AND SEX CATEGORIES WITH P VALUE WITH ONE WAY AND TWO WAY AONOVA

Age Yrs	Number	Sex	PEFR(L/s)@	PIER(L)#	FVC(L)$	FIVC(L)*
9.6-10.5	25	Male	3.05±0.50	2.91±0.57	1.55±0.21	1.57±0.20
	25	Female	3.03±0.74	2.69±0.82	1.32±0.25	1.41±0.28
10.6-11.5	33	Male	3.37±0.47	3.17±0.56	1.78±.0.45	1.86±0.36
	29	Female	3.5±0.90	2.79±0.92	1.48±0.41	1.50±0.35
11.6-12.5	50	Male	3.68±0.74	3.47±1.05	1.89±0.52	2.01±0.43
	27	Female	3.80±0.53	3.04±0.56	1.64±0.53	1.78±0.42
12.6-13.5	35	Male	4.51±1.03	4.12±1.11	2.29±0.80	2.58±0.59
	36	Female	4.30±1.31	3.53±1.03	1.91±0.79	2.14±0.52

13.6—14.5	49	Male	4.87±1.00	4.33±1.27	2.49±0.71	2.83±0.56
	42	Female	4.39±0.94	3.88±0.92	2.12±0.40	2.19±0.33
14.6—15.5	30	Male	5.07±0.89	4.93±0.95	2.82±0.43	3.04±0.51
	29	Female	5.09±1.02	4.13±0.86	2.49±0.21	2.49±0.20
One Way ANOVA		Age	0.0	0.0	0.0	0.00
		Sex	0.157	0.0	0.0	0.0
Two way ANOVA		Age+Sex	0.106	0.689	0.951	0.006

@ PEFR-Peak Expiratory Flow Rate #PIFR- Peal Inspiratory Flow Rate $FVC – Forced (Expiratory) Vital Capacity
*FIVC- Forced Inspiratory Vital Capacity

TABLE 3: MEANS OF FORCED EXPIRATORY AND EXPIRATORY VARIABES IN DIFFERENT AGE AND SEX CATEGORIES WITH P VALUE WITH ONE WAY AND TWO WAY AONOVA

Age Yrs	Number	Sex	FEV1(L)@	% of FEV1(L)#	FEF25(L)!	FEF50(L)~	FEF75(L)€
9.6-10.5	25	Male	1.50±0.21	95.75±11.50	5.57±0.21	2.39±0.21	1.35±0.13
	25	Female	1.28±0.21	87.20±15.96	2.68±0.42	2.53±0.36	1.36±0.20
10.6-11.5	33	Male	1.70±0.36	92.18±12.75	2.97±0.36	2.73±0.33	1.57±0.29
	29	Female	1.44±0.41	87.32±22.81	2.85±0.44	2.68±0.37	1.45±0.20
11.6-12.5	50	Male	1.78±0.48	94.62±27.66	3.11±0.44	2.89±0.39	1.77±0.52
	27	Female	1.60±0.48	90.45±22.82	3.01±0.57	2.83±0.51	1.48±0.27
12.6-13.5	35	Male	2.05±0.63	84.62±21.72	3.72±0.46	3.43±0.42	1.92±0.30
	36	Female	1.84±0.79	92.96±38.57	3.37±0.38	3.13±0.34	1.63±0.19
13.6—14.5	49	Male	2.38±0.47	89.00±26.67	4.04±0.45	3.80±0.36	2.25±0.39
	42	Female	1.93±0.42	88.95±16.80	3.60±0.35	3.26±0.36	1.73±0.25
14.6—15.5	30	Male	2.59±0.30	92.33±8.17	4.11±0.33	4.03±0.33	2.41±0.25
	29	Female	2.28±0.29	95.02±11.45	4.21±0.36	3.71±0.22	2.03±0.28
One Way ANOVA		Age	0.00	0.14	0.00	0.00	0.00
		Sex	0.00	0.93	0.65	0.96	0.00
Two way ANOVA		Age+Sex	0.45	0.31	0.79	0.21	0.001

@ FEV1-Forced Expiratory Volume in 1 second # Forced expiratory flow at specifies percentage
! FEF at 25% of expired vital capacity ~ FEF at 50% of expired vital capacity
€ FEF at 75% of expired vital capacity

TABLE 4: MEANS OF LUNG VOLUMES AND CAPACITIES IN DIFFERENT AGE AND SEX CATEGORIES WITH P VALUE WITH ONE WAY AND TWO WAY AONOVA

Age Yrs	Number	Sex	FRC @	RV(L) #	TLC *	RV/TLC!
9.6-10.5	25	Male	0.93±0.17	0.37±0.08	1.95±0.51	18.74±2.37
	25	Female	0.89±0.30	0.47±0.23	1.90±0.51	24.01±5..50
10.6-11.5	33	Male	1.16±0.21	0.45±0.12	2.30±0.42	19.78±3.97
	29	Female	0.98±0.23	0.50±0.20	2.05±0.40	23.79±6.22
11.6-12.5	50	Male	1.30±0.44	0.50±0.19	2.53±0.82	19.87±4.24
	27	Female	1.08±0.29	0.56±0.23	2.28±0.51	24.05±7.56
12.6-13.5	35	Male	1.74±0.36	0.76±0.26	3.29±0.72	22.91±6.00
	36	Female	1.45±0.38	0.78±0.28	2.90±0.71	27.13±8.12
13.6—14.5	49	Male	1.96±0.39	0.92±0.32	3.63±0.80	25.63±6.25
	42	Female	1.39±0.32	0.95±0.27	2.99±0.60	31.64±5.80
14.6—15.5	30	Male	2.01±0.45	0.92±0.32	3.86±0.77	23.36±4.85
	29	Female	1.38±0.25	0.92±0.25	3.26±0.48	27.87±6.98
One Way ANOVA		Age	0.00	0.00	0.00	0.00
		Sex	0.00	0.96	0.00	0.00
Two way ANOVA		Age+Sex	0.00	0.92	0.07	0.88

@ FRC- Functional Residual Volume*TLC – Total Lung Capacity
# RV – Residual Volume! RV/TLC Ratio of Residual Volume/Total Lung Capacity

Coefficient of correlation was obtained between the anthropometric measurements and pulmonary function parameters in both males and females and was found to be highly significant.

TABLE 5 : CORRELATION OF ANTHROPOMETRIC MEASUREMENTS WITH THAT OF PULMONARY FUNCTION

	Sex	PEFR	FVC	FEV_1	FEV_{25}	FEV_{50}	FEV_{75}	RV	TLC
Age	Male	0.66	0.52	0.62	0.58	0.58	0.53	0.64	0.68
	Female	0.54	0.61	0.54	0.47	0.45	0.34	0.59	0.65
Height	Male	0.72	0.73	0.73	0.67	0.68	0.66	0.69	0.81
	Female	0.49	0.63	0.56	0.42	0.40	1.32	0.64	0.73
Weight	Male	0.68	0.68	0.66	0.58	0.56	0.49	0.60	0.79
	Female	0.50	0.65	0.57	0.42	0.38	0.30	0.53	0.65
Body Surface Area	Male	0.73	0.72	0.71	0.64	0.63	0.58	0.69	0.83
	Female	0.52	0.68	0.60	0.45	0.41	0.32	0.56	0.69

PEFR-Peak Expiratory Flow Rate #PIFR- Peal Inspiratory Flow Rate FVC – Forced (Expiratory) Vital Capacity
FEV1-Forced Expiratory Volume in 1 second FEF at 25% of expired vital capacity
FEF at 50% of expired vital capacity FEF at 75% of expired vital capacity
TLC – Total Lung Capacity RV – Residual Volume

DISCUSSION

Normal values for spirometry have been available for long for adults and children. The present study was carried out to derive accurate predictive models for children between age group of 9.6 to 15.5 years for various spirometric end points and also to correlate the anthropometric measurements with the pulmonary functions.

Height range obtained in present study for males and females were 128.8±7.1 to 163.6±5.1 cm and 135.9±7.9 to 160.3±4.6 cm respectively which are comparable to US standards (NCHS) and within two standard deviation (Table 2) though slightly more than given by Bhandari et al.5 Weight obtained in our study ranged between 24±4 kg to 50±8 kg for boys and 28±6 to 50±8 kg for girls. Weight in children in current study was lower than those given by the Schonberg et al especially in females. Our figures for males were comparable in similar age group of 12.6 to 13.5 kg. Values of weight were found to be higher than those given by Singh et al. [2,4]

Body surface area ranged from 0.97m2 to 1.50m2 in boys and 1.03 m2 to 1.50m2 in girls which are slightly higher than those given by Singh et al at a range of 0.97 m2 to 1.25 m2 for boys and 0.95 m2 to 1.28 m2 which might be because of our samples coming from the urban affluent population.[2]

Peak expiratory flow rate in boys ranged from 3.05±0.50 to 5.07±0.89 l/s and in girls from 3.03±0.74 to 5.09±1.02 l/s in various age groups. Pande et al has reported the values to be in range of 217.60 -620.40 l/min and 201-289 l/min in boys and girls respectively. Singh et al in their study on south Indian children in same age group reported a range of 227.5 – 363.3 l/min and 214.0 – 339.4 l/min for boys and girls respectively. 6 The values in our study appears to be on lower side may be due to the difference in type of equipment used and technique employed for obtaining the PFER. All these studies were carried out using Wright's Peak Flow meter wherein a subject have to perform a single maneuver of forced expiratory flow whereas Spirometry involves a complex breathing maneuver dependent on the maximum expiratory efforts.

The values of FEV1 in our study ranged from 1.50-2.59 l in males and 1.28 to 2.28 in females in various age groups. The values when compared to Indian studies of Pande et al and Deshpande et al are comparatively higher in similar age group. [6,7]

The Forced Vital Capacity in our spirometric analysis for various age groups was ranging from 1.55 to 2.82 and 1.32 to 2.49 l in boys and girls respectively. In the comparable age group our values were comparable to 89 to 91 % of those given by Schonberg et al. 4 They were also comparable to studies carried out by Deshpande et al on 180 school children in Marathwada region of Maharashtra or by Bhattacharya et al on 1047 children.3 Our values as compared to American and European community is still lower as shown in studies by Binder et al and Dickman et al. [8,9]

Forced expiratory flow rates at 25%, 50 % & 75% as well as residual volumes (Table-4) were effort independent and thus are more comparable in different groups (Table 3). The results are similar to studies carried out by Jain and Ramaiah 10 and Schonberg et al.4 The values of residual volumes were comparable with Indian studies of Jain et al whereas were found to be lower as compared to European studies by Woolcock et al. [11]

Total Lung Capacity obtained in our study ranged from 1.95 to 3.8 liters in males against 1.90 to 3.26 liters in females which are lower as compared to Jain et al who stated the values for same age group between 2.319 to 3.855 liters.[10]

Significant correlation was obtained in our study between pulmonary function and various anthropometric measurements. (Table 5) All pulmonary functions found to increase with increase in age height & weight which is in concordance with the studies done by Pande et al , Singh et al and Bhattacharya et al. Significant correlation was obtained especially in boys than girls as regards body surface area whereas with other anthropometric parameters it is consistent in males and females.[2,3,6]

CONCLUSION –

The study established the norms for various pulmonary functions in urban school going children in and around Raipur, CG. In the age group of 10 to 15 years. The Spirometric data have a positive correlation with the various anthropometric measurements. These norms should prove useful to other clinicians in assessment of respiratory symptoms in children aged 10 to 15 years.

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