Open Access Journal

Indian Journal of Medical Research and Pharmaceutical Sciences

August 2014; 1(3) ISSN: 2349 – 5340

STATUS OF PULMONARY FUNCTION TESTS IN ADOLESCENT FEMALES

Sumangali.P[1],Padmavathi.K[2], Prasadbabu.K.P[3]

[1]Assistant Professor, Department of Physiology, Siddhartha Medical College, Vijayawada. A.P., India
[2]Assistant Professor, Department of Physiology, Guntur Medical College, Guntur, A.P, India
[3]Assistant Professor, Department of Microbiology, Siddhartha Medical College, Vijayawada, India
Email: suma_penumalla@yahoo.com

Abstract

Spirometry and Pulmonary function testing is a valuable tool for the evaluation of the respiratory system to monitor the functional status of respiratory system, symptoms and signs of pulmonary diseases, to assess the influence of a disease on pulmonary function and to screen persons at risk. The present study was conducted to define the status of PFT in adolescent females as compared to males of same age group with normal reference values and ultimately to establish physiological norms to predict lung volumes. The study was conducted on 200 normal healthy volunteers of adolescent males and females of age ranging from 15 to 19 yrs of first MBBS, BDS and BPT students of Siddhartha Medical College, Vijayawada in the department of Physiology. The measurements FVC, FEV1, FEV1/FVC% and PEFR were made by using computerised spirometer SPIROWIN 0.2 version, genesis pvt. Ltd. The measurements are made according to the recommendations of the European respiratory society standards with the subject standing in an upright position and wearing a nose clip. Lung volumes appear to be 5 to 10% less than the predicted values and especially the PEFR is significantly less in both males and females of adolescent age group irrespective of height.

Keywords:
Pulmonary function tests, adolescents, females,spirowin.

Introduction

Pulmonary function tests are used to measure the effect of disease to screen individuals at risk of having pulmonary diseases to assess pre operative risk, prognosis,theraptic intervensions to monitor persons in occupations with exposure to injurious agents and for epidemiologic surveys. Before a spiro gram can be meaningfullyinterpreted one needs to inspect the graphic data to ascertain whether the study meets certain well defined acceptability and reproducibility standards. Automated spirometry systems have built in software that can generate a preliminary interpretation. The spirometry test is performed by the using a devise called a spirometer. Most spirometers display the following graphs.

- a **volume-time curve**, showing volume in liters, along the Y-axis and time in seconds along the X-axis
- a **flow-volume loop**, which graphically depicts the rate of airflow on the Y-axis and the total volume inspired or expired on the X-axis

A normal Flow-Volume loop **begins on the X-axis** (Volume axis): at the start of the test both flow and volume are equal to zero. Directly after this starting point the curve **rapidly mounts to a peak**. (Figure-1)The PEFR is **attained within thefirst 150 milliseconds** of the test. The Peak Flow is a measure for the air expired **from the large upper airways**.(trachea-bronchi).

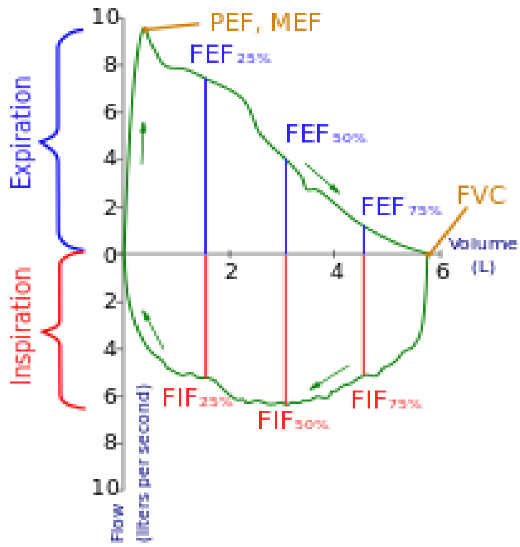


Figure - 1

Explanation of common test values in pulmonary function tests

Abbreviation	Name	Description
FVC	Forced vital capacity	the **total amount of air** that you can forcibly **blow out** after full inspiration, measured in liters.
FEV_1	Forced expiratory Volume in 1 second	**air** that you can **forcibly blow out in one second**, measured in liters.
FEV_1 / FVC	Ratio	This is **the ratio** of FEV 1 to FVC. In healthy adults it should be approximately 75 - 80%.
PEFR	Peak expiratory flow rate	The **speed** of the air moving out of lungs **at the beginning of the expiration**, measured in liters per second.

Growth affects the relationship between **the body size and spirometric indices** in children and adolescents. This relationship is **non linear**. The development and **growth of the thorax and lungs** are the main determinants of functional efficiency of respiratory systemFVC & FEV1 are related to the physical characteristics of the subject

such as **age, gender, height and weight**, several nomograms have been developed to obtain normal values for healthy children and adolescents.
MORRI' or CRAPO nomograms of the same gender, height and age are predicted values for the FVC & FEV1 are larger for males than females, thus different nomograms are used. By recording lung volumes by spirometry and comparing these values to predicted or normal values that would be expected in healthy subjects of same age group.
At adolescence, lung function no longer increases proportionally to height but rather follows a more complex pattern. Initially, trunk length lags behind leg length temporally; then the lung grows in diameter followed by length and, finally, lung volumes continue to increase after adult height has been reached due to prolonged increase in muscle strength Therefore, lung function increases proportionally to trunk and chest dimension rather than to height.

Materials and methods

Computer
Spirometry device (**SPIROWIN 2.0)** genesis Medical systems, Pvt. limited.
Mouthpiece
Noseclip
The present study was conducted on **200 normal healthy volunteers** of adolescent males and females of age ranging from 16 to19yrs **students** of Siddhartha Medical College, Vijayawada.

Exclusion criteria: The subjects were excluded from study if they had signs and symptoms of **cold or history of any respiratory diseases**.
The anthropometric indices recorded height was measured to **nearest 1mm** with out shoes; Weight was measured to the **nearest 100 mg.** All the subjects are instructed to attend the laboratory after taking light food and examined between 10am &3pm. Each subject was explained and demonstrated the technique.The subjects were asked to perform the test three times with a **minimum duration of 2 minutes** and best of the three results were taken in to consideration. The measurements such as FVC, FEV1, FEV1/FVC%and PEFR were made.

Calibrating(electronic) spirometers: It is a procedure done daily with a **calibration syringe of 3 liters**. In order to detect changes in overall **spirometric performance**, the ventilatory function of one or more subjects with stable respiratory function should be measured regularly as a part of an ongoing quality control programme.

Study protocol

The **dissertation committee** of the institute approved the design and study protocol. All the subjects were informed and their **oral consent** is taken.
The subjects were thoroughly educated to perform the test on the **computerized spirometer** and advised to be calm and quiet without any hesitation.They were asked to **stand** in front of the spirometer with mouth piece raped by lips
A soft **nose clip** was applied to the nostril to prevent air escape through the nose. Disposable mouthpieces were used to prevent the spread of microorganisms. It is seen that the subject's **trunk and neck remain erect** during the manoeuvers, looking straight forward during the entire test.
The subjects were asked to take normal respirations, and then they were instructed to take a **deep respiration of a minimum period of 3 to 6 seconds**. Immediately after this deep inspiration they were asked to **blow out the air as hard and fast** as possible in to the mouthpiece. Soon after this they were asked to **take a deep maximal inspiration**, it was ensured that the inspiration was full and unhurried, and the expiration once begun was continued without pause.

1. **Age** 15 to 19yrs
2. **Height** in centimeters.
3. **Weigh**t in kilograms.
4. **FVC**: forced vital capacity, it is the total amount of air that you can forcibly blow out after full inspiration. It is measured in liters.
5. **FEV1**: forced expiratory volume in 1 second. It is the amount of air that you can forcibly blow out in one second. It is measured in liters.Along with FVC it is considered one of the primary indicators of lung function
6. **FEV1/FVC%**: this is the rate of FEV1 to FVC in the healthy adults it should be 75 to 80%.
7. **PEFR**: peak expiratory flow rate. This is the speed of the air moving out of the lungs at the beginning of expiration. It is measured in liter.

Test procedure

There are **three distinct phases** to the FVC manoeuver, as follows:
1) Maximal inspiration;
2) A ''blast'' of exhalation; and
3) Continued complete exhalation to the end of test (EOT).
The subjects should be prompted to 'blast,'' not just ''blow,'' the air from their lungs, and then he/ she should be encouraged to fully exhale. An adequate test requires a minimum of three acceptable FVC manoeuvres. Acceptable repeatability is achieved when the difference between the largest and the next largest FVC is 0.150 L and the difference between the largest and next largest FEV1 is 0.150 L

Additional criteria

A **cough** during the first second of the manoeuvre can affect the measured FEV1 value. Coughing in the first second or any delay in the effort is in the examiner's judgment, interferes with the measurement of accurate results will render a test **unacceptable**. There must be no leak at the mouth.

FEV1 and FVC manoevuor

FVC is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, i.e. vital capacity performed with a maximally forced expiratory effort, expressed in liters at body temperature and ambient pressure saturated with water vapor**.**

FEV1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters at BTPS.

PEFR is **dependent on effort** and lung volume, with subject cooperation being essential. PEFR must be achieved as rapidly as possible and at as high a lung volume as possible, in order to obtain the maximum value

Results and data analysis

Pulmonary function test results and anthropometric data were analyzed separately for males and females. The means of the pulmonary function test data from males and females were compared by an unpaired "t" test

P-value of <0.05 was considered significant.

In order to determine the variance of pulmonary function tests, the males and females were divided in to two groups. The mean and standard deviation of the PFT results for each group were plotted against each other.

Among the 200 subjects studied 100 were adolescent females and 100 were adolescent males of same age group i.e. 16 to 19 yrs. They were distributed in to the different height groups separately.the test results is influenced by the selection of reference values as well as by the strategy adopted to compute the lower limit of normal.

Predicted mean -1.64 RSD=lower limit normal.

Observations

Anthropometric data: Mean female **age** (17.9yrs+/-1.2) was not significantly different from mean male age (18.2yrs +/-0.9).Males were taller 168+/-2.5 (range 150 to 186cms) versus females 163+/-1.5(range 150 to 178cms) .P<0.001 and heavier 56 kg (range 42 to 76 kg) versus 53 kg (range 39 to 68 kg), P<0.001 than females. (Table-1)

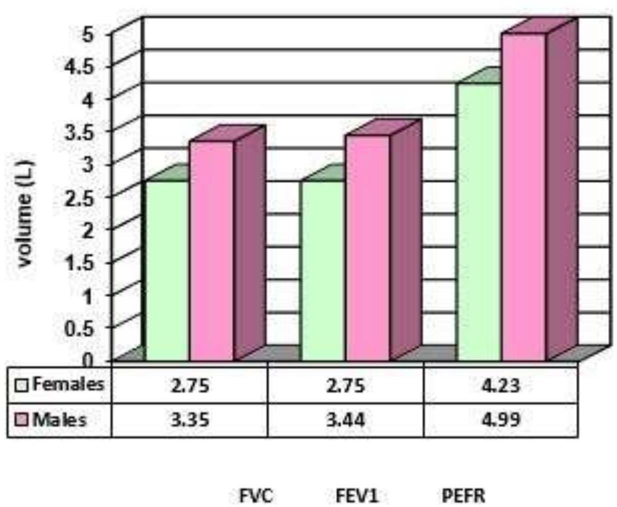
The manoeuver is normally **repeated at least three times** to ensure reproducibility. Since the results depend on patient's cooperation, FVC and FEV1 can only be underestimated, never overestimated. The results were noted from the computer .The following are the **parameters chosen** for the study:

Lung function parameters of total subjects (table -1)

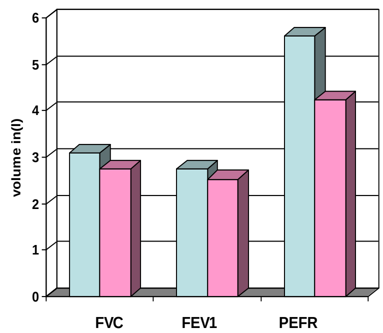
s. no	description	females	males	P value
1	Age	17.68±1.4	18.01±1.2	
2	Height (cms)	160.4±5.3	168.4±4.6	
3	Weight (kgs)	52.66±4.9	56.27±3.8	
4	FVC(l)	2.75±1.5	3.35±1.1	P>0.05
5	FEV1(L/S)	2.53±1.2	3.26±1.4	P>0.05
6	FEV1/FVC %	87.02±5.6	87.11±6.4	P>0.05
7	PEFR(L)	5.4±1.7	6.2±0.8	P<0.05

All values expressed in mean standard deviation
P>0.05 not significant, **P<0.05** significant.
95% of the subjects in the study lie 5 to 10% below the predicted values. The FVC **in the females** of adolescent age mean SD+/-17.8+/-1.2 yrs (group A) as compared with the same age (group B) males was **less by <5% (**P>0.05). When compared with the predicted values, the obtained FVC is 6.25% less in females. The FVC in males when compared with the predicted values the obtained values is 7.46% less than the predicted FVC and <5%greater when compared with FVC of females. (Graphs 1, &2).

Graph – 1



Graph – 2 Comparison of Predicted And Obtained Values In Females

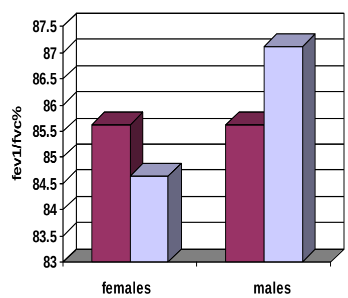


	FVC	FEV1	PEFR
Predicted	3.09	2.75	5.61
Obtained	2.75	2.53	4.23

The forced expiratory volume in 1st second (FEV1) in the adolescent females as compared with the adolescent males was less by 4.25% (P>0.05).FEV1 as compared with the predicted values showed decrease of 7.06 %.(figure 4&5).

The FEV1/FVC% in both adolescent groups remains same with a little increase of % in males. When compared with predicted values it is more by 5.34% with P>0.05. (Graphs 3).

Graph – 3 -Comparison Of Fev1 /Fvc% In Males And Female



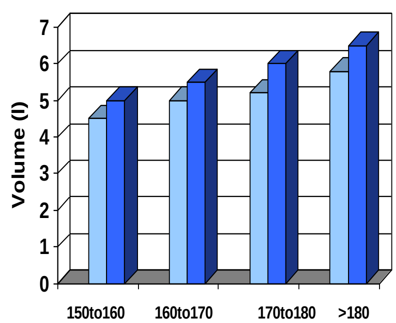
	females	males
Predicted	85.62	85.62
Obtained	84.63	87.11

FVC&FEV1 in different height groups of both males and females is increased with increase in height. (Tables 3&4).The PEFR of adolescent females as compared with males was less by 8.02 % (P<0.05). When these values are compared with the predicted values it is less by 18.32 % (P<0.05).

FVC&FEV1 in different height groups of both males and females is increased with increase in height. The PEFR of adolescent females as compared with males was less by 8.02 % (P<0.05).When these values are compared with the predicted values it is less by 18.32 % (P<0.05).PEFR is significantly increased by increase in height to some extent up to 170cms in females and is greatly increased with height in males

Open Access Journal
Indian Journal of Medical Research and Pharmaceutical Sciences
August 2014; 1(3) ISSN: 2349 – 5340

Comparison of PFFR values in different height groups of males and females.(graph-4)



height in cms	150 to 160	160 to 170	170 to 180	>180
Females	4.5	5	5.2	5.8
Males	5	5.5	6	6.5

Discussion

To input the ventilatory function tests in any individual, always compare the results of observed values with reference values obtained from a well defined population of normal subjects matched for gender, height, age and ethnic origin.95% of the subjects in the study lie 5% below the predicted values except PEFR .The predicted values are derived from ATS/ERS .

Present study is similar to the study of Al-Riyani BM, Al-Rawas OA; Hassan MO .It states that all the measured spirometric parameters increase with age and height and is significantly higher in boys than girls.Height explained the maximum variance for all parameters. The expiratory ratio (FEV1/FVC %) was higher in females than males but in my study FEV1/FVC% is equal in both sexes. The obtained values were 5 to 10% lower than the predicted values for subjects.

Lung function variables show a linear positive correlation with height. FVC&FEV1 show a linear spurt after height of 150cms.Males show a higher value for lung function than females and is similar to the study of Chowgule.RV, Shetye VM, Parmer JR study in normal Indian children and adolescents.The FEV1/FVC ratio, turned out to be a very stable measurement that remains almost unchanged among the different height groups.Only nomograms using height are provided, since better prediction was obtained with this variable. My study coincides with this statement that the FEV1/FVC%remains almost unchanged among the different height groups.

Spirometric measurements increasing with increasing height are similar to the study of Mario Chen-Mok, study of Spirometric nomograms for normal children and adolescents in Puerto Rico.Present study is a similar comparison with the study of Kumar A, Parnu BK, Manchanda.KC, for study of normal spirometry on north Indian children &adolescents (10 to 19yrs).A linear relationship of lung function was observed with age, height, weight &BSA. But in comparison to western studies our subjects have lesser lung function values.The correlations of FVC and FEV1 were generally highest with height followed by weight and age. The PEFR and FEV1/FVC% were also significantly correlated with physical characteristics (age, height, weight).

The study found that the height influences the prediction equation in males to a great extent & is similar to the study of Vijayan .VK, Reetha.AM, Kuppurao.KV, Venkatesan.P, Thilakavarthy.S- who studied the pulmonary function in normal south Indian children and adolescents.The complex process of growth affects the relation ship between indices of body size and spirometric measurements in children and adolescents. In children and adolescents the relation ship between ventilatory function and height is not linear. In this aspect my study coincides with the study of Mohammad Golshan MD, Mehdi Nemat-Bakhsh MD. Of normal prediction values of spirometric parameters in Iranian adolescents.

PEFR is of value in identifying and assessing the degree of air flow limitation of individuals. The mean difference between the predicted and the obtained PEFR value is the bias, while the mean difference +/-1.96 standard deviations indicates the limits of agreement.

FVC and FEV1 are considerably lower among Indian boys and girls compared to Chinese. A study by Conette GJ, coinsides with my study. There are differences in ventilatory function between ethnic groups. In general it is best to apply prediction values that best fit the ethnic group. Differences in lung function are attributed to various factors including diet. The less protein consumption in the south Indian subcontinent compared to their northern counterparts would contribute the smaller lung for the same height & age.

Differences in body built have an influence on ventilatory function. Negroid people have longer legs for the same trunk height. Predicted values for same standing height would be too high when compared to Caucasians, this accounts for some 10% of difference.The use of spirometric reference values that are specific for the population being tested is always preferable. The nomograms developed here will provide a simple way to use these references in clinical practice.

Considering the effect of sex in the prediction equations for lung volumes, as the females in the present study had probably completed most of their lung growth than males, the values shown by the females are equal to the adult values.

Conclusion

Several studies suggested the existence of differences in PFT in diverse populations due to race and ethnic origin. Therefore standard values developed for one population might not be suitable for another.

Pulmonary Function Test can be effectively predicted by age and height. Nomograms provide a simple way to use spirometric references that can be incorporated to clinical practice.

In normal children &adolescents the increase of height as they grow older is expected to grow along with a corresponding development of pulmonary function. That is the reason why variables like age and height are considered good predictors of pulmonary function.

The present study provides actual values for lung volumes such as **FVC, FEV1, FEV1/FVC% & PEFR** in a group of males and females aged between 16&19yrs. These reference values of lung volume in adolescents for height and age could be of help in quantifying and allowing for the variation in growth pattern between adolescents.

The measurements are made in all the persons according to the recommendations of the European respiratory society standards, Lung volumes appears to be 5 to 10% less than the predicted values and especially the PEFR is significantly less in both males and females of adolescent age group irrespective of height.

References

1. Aggarwal AN, Gupta D, Behera D, Jindal SK. Applicability of commonly used Caucasian prediction equations for spirometry interpretation in India. Indian J Med Res. 2005 Aug; 122(2):153-64.
2. Al-Riyami BM, Al-Rawas OA, Hassan MO. Normal spirometric reference values for Omani children and adolescents, Respiratory. 2004 Aug; 9(3):387-91.
3. Baur X, Isringhausen-Bley S, Degens P. Comparison of lung-function reference values. Int Arch Occup Environ Health. 1999 Mar; 72(2):69-83.
4. Becklake M, Crapo RO, Buist S, et al. Lung function testing: selection of reference values and interpretative strategies. Am Rev Respir Dis. 1991; 144:1202-1218?
5. Borsboom GJJM, van Pelt W, Quanjer PH. Interindividual variation in pubertalgrowth patterns of ventilatory function, standing height, and weight
6. Boskabady MH, Tashakory A, Mazloom R, Ghamami G. Prediction equations for pulmonary function values in healthy young Iranians aged 8-18 years. Respirology. 2004 Nov;9(4):535-42.
7. Cherniak RM and Raber MD. Normal Standards for Ventilatory Function Using an Automated Wedge Spirometer. Am. Rev. of Respir. Dis. 1972; 106:38-46.
8. Chia SE, Wang YT, Chan OY, Poh SC. Pulmonary function in healthy Chinese, Malay and Indian adults in Singapore. Ann Acad Med Singapore. 1993 Nov; 22(6):878-84.
9. Choudhury S, Alam MS, Begum QN. Lung function parameters of Bangladeshi male subjects in different living conditions. Bangladesh Med Res Counc Bull. 1997 Apr; 23(1):30-3.
10. Chowgule RV, Shetye VM,Parmar JR. Lung function tests in normal Indian children. Department of Paediatric, Respiratory Medicine, Royal Brompton National Heart and Lung Hospital, London. Indian Pediatr. 1995 Feb; 32(2):185-91
11. Clausen JL, Zarins LP, and eds. Pulmonary Function Testing, Guidelines and Controversies: Equipment, Methods, and Normal Values. New York: Academic Press, 1982.

12. Cook CD, Hamann JF. Relation of lung volumes to height in healthy persons between the ages of 5 and 38 years. J Pediatr 1961; 59: 710–714.
13. Coultas DB, Howard CA, Skipper BJ, Samet JM. Spirometric prediction equations for Hispanic children and adults in New Mexico. Am Rev Respir Dis. 1988 Dec;138(6):1386-92.
14. Crapo, RO, Morris, AH, Gardner, RM Reference spirometric values using techniques and equipment that meet ATS recommendations. Am Rev Respir Dis 1981;123,659-664
15. Dockery DW, Speizer FE, Ware JH, Ferris BG. Growth of pulmonary function between 6 and 18 years of age. Am Rev Respir Dis 1987; 187: 135.
16. Dufetel P, Wazni A, Gaultier C, Derossi G, Cisse F, Martineaud JP.Growth and ventilatory function in Black children and adolescents, Rev Mal Respir. 1995; 12(2):135-43
17. Fulambarker A, Copur AS, Javeri A, Jere S, Cohen ME. Reference values for pulmonary function in Asian Indians living in the United States. Chest. 2004 Oct;126(4):1225-33
18. Godfrey S. Spirometry. Lung volumes and airway resistance in normal children aged 5 to 18 years. British journal of diseases of the chest, 1970, 64(1):15-24
19. Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. Am J Respir Crit Care Med. 1999;159:179-187.
20. Hibbert ME, Lannigan A, Landau LI, Phelan PD. Lung function values from a longitudinal study of healthy children and adolescents. Pediatr Pulmonol. 1989;7(2):101-9.