International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Variation of Pulmonary Function Tests with Relation to Increasing Age in Healthy Adults

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Received: 20/01//2014 *Revised: 17/02/2014* *Accepted: 17/02/2014*

ABSTRACT

Background: Pulmonary function test (PFT) is a generic term used to indicate a battery of studies or maneuvers that may be performed using standardized equipment to measure lung function such as spirometry. Early assessment of PFT parameters could help in diagnosis at an initial stage and also help in prognosis of lung diseases. The present study was undertaken to determine the normal values of various parameters of PFT at different ages as they show variations with age. **Methods:** A study was undertaken taking 60 healthy subjects (males: females ratio at 1:1) with age from 18-65years. Spirometry was done using the Micro Medical Super Spiro. The subjects were categorized into different age groups of 18-35 years, 36-50years and 51-65years. Appropriate statistical analysis was applied using SPSS version 16.0 software. **Results:** There is decreased vital capacity after the age of 35years in both sexes. Other parameters such as FEV1, FEV1/ FVC ratio and PEFR also decrease with increasing age. **Conclusion:** Reference values for normal individuals obtained in this study can be used in clinical settings

Key words: Pulmonary function test, PFT, Spirometry, Healthy Adults.

INTRODUCTION

With the advent of Spirometer in 1846 by Hutchinson, [1] vital capacity and lung function testing came to the forefront. At the time of World War II, Pulmonary Function Test (PFT) assumed a vast practical importance and a rapid progress ensured. The progress has then steadily occurred with constantly improving investigation techniques and equipments. It is only during the last few decades that PFT has gained importance to add to the clinical practice of medicine. Currently, these tests are routinely used to evaluate the effectiveness of therapy, to aid in the diagnosis, to assess the prognosis and to determine the disability.

Spirometry is quick, non-invasive and painless. It is performed under various conditions with the subject breathing into a tube attached to the machine, which calculates the amount of air the lungs can hold and the rate that air can be inhaled and exhaled. The various lung parameters measured can be utilized for diagnosis of

respiratory disorders and status of ventilatory function.

The average peak expiratory flow rate (PEFR) of healthy young Indian males and females are known to be at its peak values at about 18-20years of age, recorded at 500 and 350 liters/minute respectively which then gradually declines with increasing age. [2, 3] The need for different normal values at different age groups is thus required for assessment of lung function tests. [4] The present study was undertaken with the primary objective to study the mean PFT values observed in healthy adults of different age groups from 18- 65years and to note the pattern of variation of PFT parameters with respect to age and sex.

MATERIALS AND METHODS

A cross sectional study was undertaken in the Department of Physiology, G.S.L. Medical College, Rajahmundry. The subjects were briefed about the details of the procedure and written informed consent was taken from all the subjects who participated in the study. 60 subjects were chosen from among students, staff members, doctors and non-medical personnel from different age groups from 20-65years. The subjects who had no history of cardio-pulmonary diseases which could alter the ventilatory function, non-smokers, non-pregnant and non lactating females were included in the study. those having physical abnormality of chest wall/ skeletal deformity, history of asthma, severe anemia, dementia, history of chest or abdominal pain of any cause, history of oral or facial pain exacerbated by a mouth-piece, or history of any disease which can be expected to affect pulmonary function such as neuromuscular disorder, cardiopulmonary disorder, etc were excluded from the study.

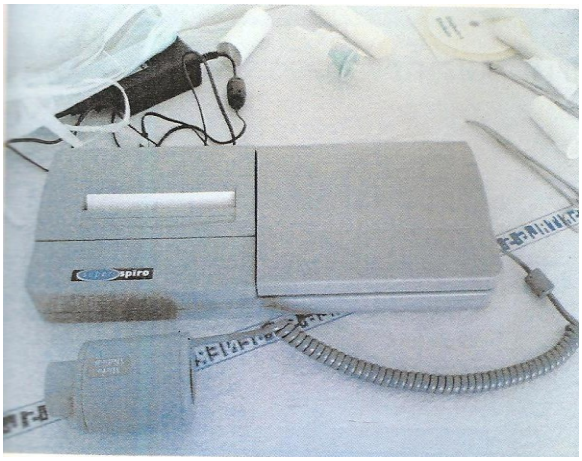

Figure-1 Super Spiro (Spirometer).

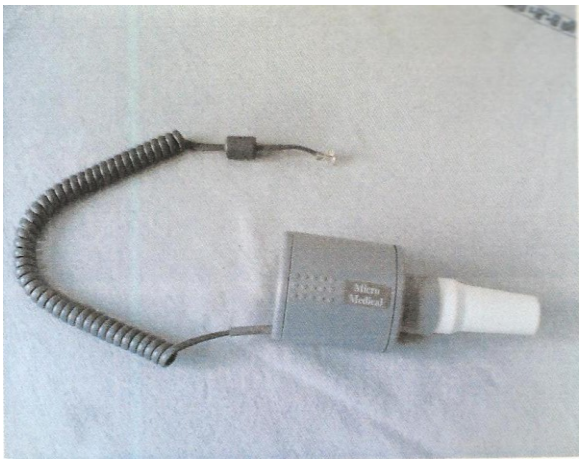

Figure-2 Transducer With Mouth Piece.

Details about the subjects such as name, age, gender, ethnic group and occupation, etc were noted and they were grouped into three age-categories of 20-35years, 36-50years and 52-65 years. Detailed medical history, physical examination and pulmonary function test was undertaken for each subject. Lung function test was done by the micro medical Super Spiro, which is a sophisticated desktop Spirometer (Figure-1). It has the facility to produce the spirometry data and graphs in a printed manner by using a thermal printing paper. A clean disposable mouth piece was inserted into the transducer holder (Figure-2). The subjects were instructed to close his/her lips tightly around the mouth piece. All the PFTs were performed in the sitting position with a nose clip, clipping the nose of the patient to prevent air flow through the nostrils (Figure-

3). The subject is asked to breathe normally for a few breaths till his breath gets stabilized. The device beeps at the start of each breath cycle, then a longer beep is triggered when the subjects' breath is stabilized. At this point, the subject was asked to take full deep inspiration followed by full expiration.

Figure-3 Subject performing the lung function test

As the subjects breathe through the transducer, a real time volume-time curve is displayed. The procedure was repeated at least 3times and the highest value of Vital capacity (VC) were taken. The next test is done in forced base where the subject is asked to take three normal cycles of breath and then forceful and maximal inspiration followed by forceful and maximal exhalation and again a forceful inspiration is produced. At least 3 similar efforts are performed by the subject and the best reading is considered. Vital capacity (VC), Forced expiratory volume after 1 second (FEV1), forced vital capacity (FVC), FEV1/ FVC ratio and PEFR were noted for each individual. Appropriate statistical analysis was done using tests of variance and z-test comparing the mean values of the lung parameters among males and females.

RESULTS

Of the total 60 subjects included in the study, equal distribution of cases was made among the 3 age-groups with 20 subjects in each category. The male: female ratio was also maintained at 1:1 with 10 males and 10 females in each category. The vital capacity in different age groups is shown in Table-1. Applying z-test, it is seen that in 20-35years, vital capacity does not show statistically significant difference among males and females while in other groups it is highly significant.

Similarly comparing the FEV1 in different age groups and between males and females (Figure- 4), we see statistically significant difference among all the groups on applying z-test. The FEV1 values are relatively lower in females. With increasing age, the FEV1 values gradually decreases. Similarly FVC is compared among the different age groups and statistically significant difference was seen between the groups and even FVC gradually decreased with increasing age as evident from Figure-5. However the FEV1/FVC ratio was not statistically significant in the different age-groups and among males and females as shown in Table-2. Comparing the PEFR in different age categories and applying z-test, the results are depicted in Table-3.

DISCUSSION

In this present study, attempt has been made to know the normal range of the parameters used in lung function test. 60 healthy individuals were categorized into three different age groups, each group consisting of 10males and 10 females. The vital capacity is seen to start declining after the age group of 35years. There are few studies done in the past which show a similar trend. [5, 6] Few studies have documented that the vital capacity declines at 30 years of age. [7] This is attributed to the reduction in elastic recoil of lungs and early closure of the airways after twenties. The

decline in vital capacity was more in females after 35 years. It might be because repeated pregnancies reduce the abdominal muscle tone leading to settling of the diaphragm at a lower level, limiting its excursion, and thereby reducing the expiratory effort by abdominal muscle. [5, 8]

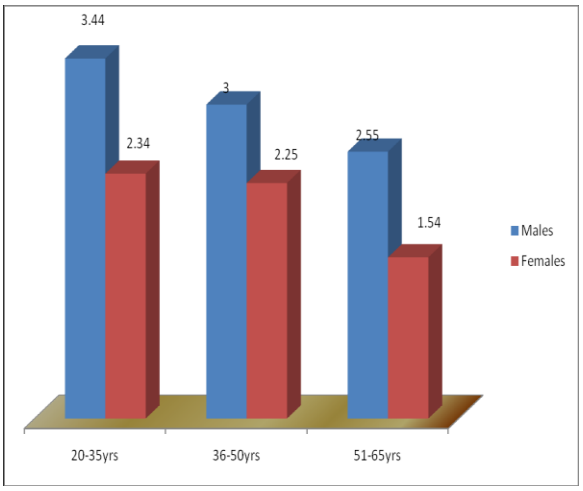

Figure-4 Comparison of FEV1 (in liters) in different age groups.

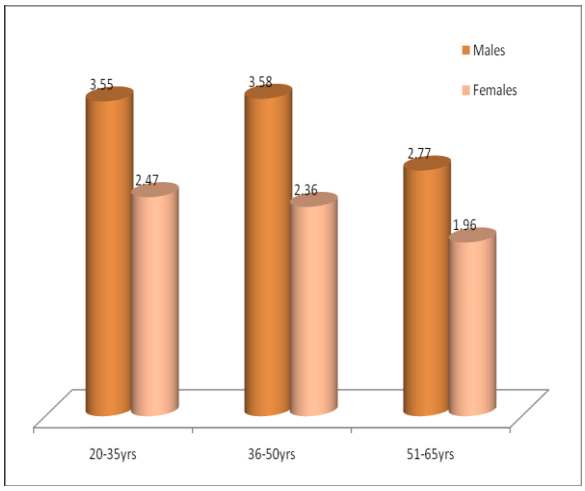

Figure-5 Comparison of FVC (in liters) in different age groups.

Table-1 Comparison of vital capacity (in liters) in different age groups.

Groups	20-35years		36-50years		51-65years	
Sex	Males	Females	Males	Females	Males	Females
n	10	10	10	10	10	10
Mean± SD	3.99± 0.70	2.52± 0.73	3.54± 0.62	2.33± 0.50	2.83± 0.70	1.53± 0.20
z-test	0.07		4.84		5.60	
p-value	>0.05^{ns}		<0.001*		<0.001*	

SD = Standard deviation, ^{ns} = not significant, * highly statistically significant

Table-2. Comparison of FEV1/FVC ratio in different age groups.

Groups	20-35years		36-50years		51-65years	
Sex	Males	Females	Males	Females	Males	Females
n	10	10	10	10	10	10
Mean± SD	88.2± 11.93	85.8± 11.01	89.8± 5.59	93.9± 4.12	91.2± 4.77	92.0± 2.16
z-test	0.47		1.86		0.48	
p-value	>0.05^{ns}		>0.05^{ns}		>0.05^{ns}	

SD = Standard deviation, ^{ns} = not significant

Table-3 Comparison of PEFR (in liters/min) in different age groups.

Groups	20-35years		36-50years		51-65years	
Sex	Males	Females	Males	Females	Males	Females
n	10	10	10	10	10	10
Mean± SD	477.5± 100.11	280± 94.70	315.7± 155.76	273.1± 75.26	328.5± 135.27	192.1± 77.59
z-test	4.51		0.77		2.76	
p-value	<0.001*		>0.05^{ns}		<0.001*	

SD = Standard deviation, ^{ns} = not significant, * highly statistically significant

The mean FEV1 gradually decreases with increasing age, more after 35years of age. It may be due to alteration in lung compliances and elastic recoil of lung as the age advances. Similar trend was seen with FVC. However, FEV1/FVC ratio was higher in males as compared to females but the difference is very less and can be considered

insignificant. As males have more number of alveoli per unit area and their alveoli are larger and have greater compliance, they are expected to have higher values of PFTs as compared to females. [9] FEV1/FVC ratio also decreases with increasing age. Previous studies document that FEV1/FVC ratio is lower in males than females and with increasing age, FEV1/FVC ratio gradually decreases but in males a rise is noted. [10]

From the present study it is seen that the PEFR falls significantly after 35years of age. Previous studies in Indian settings also document similar findings. [5, 11] These studies report that males achieve a peak at about 22-25years of age and maintain this level upto about 30years and thereafter PEFR starts to decline. Females appear to achieve a maximum flow a little before 20years and appear to maintain that level for almost 2 decades. The expected decline with age begins at about 40-45years.

CONCLUSION

The values obtained from this study can be used in clinical settings as normal range of PFTs in different age groups. One of the major limitations of this study is the lower sample size despite the attempt in maintaining the sex ratio of 1:1 (males: females). Future prospective studies with a larger population can be considered where a person aged 20 years is followed up once every year to see the pattern of variation of PFTs with advancing age.

Conflict of Interest – None declared
Source of Funding – None

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How to cite this article: Behera AA, Behera BK, Dash S et. al. Variation of pulmonary function tests with relation to increasing age in healthy adults. Int J Health Sci Res. 2014;4(3):136-141.

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