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Research Article

VARIATION IN LUNG FUNCTIONS WITH AGE-A LOCAL STUDY

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ABSTRACT
The purpose of this study was to evaluate lung functions in normal healthy subjects ranging in age from 15 years to above 60 years in district Amritsar. Pulmonary functions remain a major biologic variable that is affected by ageing. Pulmonary Function Tests (PFTs) comprising of FVC, $FEV_{0.5}$, FEV_1, FEV_3, PEFR, $FEF_{25-75\%}$, FEF_{2-12}, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, $FEV_{0.5}$/ FVC %, FEV_1/ FVC % FEV_3/FVC% and MVV respectively were performed on 200 subjects of either sex using 'Medspiror' computerized spirometer and statistically analyzed. Pulmonary functions showed a significant decline after 3rd decade.

Key Words: *Lung Functions, Ageing, Healthy Subjects, District Amritsar*

INTRODUCTION
Respiratory physiology has developed enormously in the recent years and the respiratory physiologists are trying to describe the lung functions in relation to its structure and mechanical properties. Indian norms for spirometeric test values are significantly different from norms within other countries (Lovent *et al.,* 2002),(Memon *et al.,* 2007),(Cotes *et al.,* 1966),(Singh *et al.,* 1994). Even within the country, ventilatory functions of the lungs show wide variation in people having similar socioeconomic environment but belonging to different regional areas and ethnic status (Gupta et al1979),(Miller *et al.,* 1970), (Vijayan *et al.,* 1998).
Scant data is available which compares all spirometeric values in persons from 15 years of age through youth till senior citizen status in urban population of Amritsar district. This study has evaluated independently the role of aging on all 14 parameters of pulmonary function tests (PFTs) namely FVC, $FEV_{0.5}$, FEV_1, FEV_3, PEFR, $FEF_{25-75\%}$, FEF_{2-12}, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, $FEV_{0.5}$/FVC%, FEV_1/FVC% FEV_3/FVC% & MVV respectively in normal healthy 200 subjects ranging from age 15 years to 60 years and above.

Parameters
Forced Vital Capacity (FVC), Timed Vital Capacity ($FEV_{0.5}$, FEV_1, FEV_3), Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow Rate percent of FVC ($FEF_{25-75\%}$, FEF_{2-12}, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$), Timed Vital Capacity : Forced Vital Capacity ratio ($FEV_{0.5}$/FVC%, FEV_1/FVC% ,FEV_3/FVC%) and Maximum Voluntary ventilation (MVV).

MATERIALS AND METHODS
200 healthy subjects, 117 males and 83 females varying in age from 15-60 years and above constituted the material for the present study. Subjects were selected randomly from district Amritsar. Subjects fulfilling the following criteria were accepted for detailed investigations: The persons with history of chronic smoking, current or post cardio respiratory disorder or frequent cough and colds were not considered. It was assured that subjects had no exertional dyspnoea or general debility, no obesity, no chest deformity no history of work in heavily polluted area. Hemoglobin estimation was done and persons with normal hemoglobin level were judged healthy and included in the study.
The subjects were divided into 4 age groups, i.e., group A 15-30 years, group B 31-45 years, group C 46-60 years, and group D 61 years and above. The lung function tests were carried out with spirometer 'Medspiror'. It is designed to be tested with electromechanical pneumotech. Built in printer brings out print outs containing all the information and calculated values of all the parameters of the subjects.

Volume detection is done by pneumotech sensor and flow detection by differential method. The overall accuracy is within 0.1% and its range for flow is 0 to 20 lit/sec. For the testing procedures of the subject, only 2 maneuvers i.e. for FVC and MVV were required from the subject to accumulate all the data. For every subject a minimum of 3 acceptable FVC maneuvers were obtained (Ferris 1978). MVV was recorded by asking the subject to breathe in and out as rapidly and as deeply as possible for 6 secs (Chatham 1980). A written consent was taken from the parents or guardians of the subject of less than 18 years of age. Before the test, the subject was familiarized with the equipment and its working so as to get maximum co-operation. The tests were performed in the quite setting of laboratory during morning hours in standing position. Before doing the test, brief history was taken and age, height & weight were recorded in completed years, Cms & Kgs respectively. Body surface area was calculated from Du-Bois formula (quoted by Keel *et al.,* 1982). The subjects were adequately encouraged to perform at optimum level. A nose clip was applied and 3 readings were taken & the best matching results were analyzed. The results of ventilatory function tests were presented as mean SD for each of the parameters and statistical comparison done between different age groups. Mean values within each age group were compared using student 't' test. Any 'p' value <0.05 was considered significant.

RESULTS AND DISCUSSION

200 normal healthy males and females between ages 15 years and above 60 years were studied. Little work has been done to study the simultaneous changes in all the 14 lung function parameters in different age groups in healthy individuals of district Amritsar.

Table 1: Mean and Standard Deviation of 14 Respiratory Parameters in different Groups

Parameters	Group A	Group B	Group C	Group D
FVC(L/Sec)	2.83±0.59	2.59±0.68	2.16±0.69	1.88±0.60
$FEV_{0.5}$ (L/Sec)	2.08±0.52	1.79±0.47	1.48±0.40	1.18±0.46
FEV_1 (L/Sec)	2.73±0.53	2.35±0.57	2.05±0.58	1.60±0.49
FEV_3 (L/Sec)	2.83±0.59	2.59±0.68	2.36±0.69	1.86±0.57
PEFR (L/Sec)	6.37±1.75	6.17±1.64	4.88±1.90	4.15±1.93
$FEF_{25-75\%}$(L/Sec)	4.17±1.22	3.46±0.96	2.64±0.95	2.12±1.04
FEF_{2-12}(L/Sec)	5.54±1.70	4.95±1.56	3.51±1.60	2.84±1.59
$FEF_{25\%}$(L/Sec)	6.11±1.77	5.74±1.53	4.46±1.70	3.59±1.78
$FEF_{50\%}$(L/Sec)	4.63±1.37	4.08±1.05	3.15±1.24	2.16±1.12
$FEF_{75\%}$(L/Sec)	2.63±0.93	2.06±0.68	1.44±0.56	1.33±0.61
$FEV_{0.5}$/FVC%	73.99±12.15	70.61±15.36	67.02±13.29	64.42±20.60
FEV_1/FVC%	96.18±4.73	91.58±8.29	87.71±11.40	86.56±15.87
FEV_3/FVC%	100.00±0.00	99.90±0.52	99.84±0.44	99.18±3.27
MVV(L/min)	111.38±28.42	107.66±28.56	85.80±28.24	67.24±22.14

Except for age, other anthropometric parameters i.e. weight, height and BSA showed relatively non significant difference when comparison of one group is done with subsequent group. Table 1 shows the mean and standard deviation of 14 respiratory parameters in group A, B, C &D.

't' and p values indicating the level of significance of various lung function parameters on comparison between two groups is shown in table 2, comparison amongst males of different groups in table 3 and amongst females in table 4.

Table 2: Showing 't' Value with Statistical Significance of Various Lung Function Parameters on Comparison between Two Groups

	Liters/Second										**Percentage**			**Lts/ Minute**
	FVC	$FEV_{0.5}$	FEV_1	FEV_3	PEFR	$FEF_{25-75\%}$	FEF_{2-12}	$FEF_{25\%}$	$FEF_{50\%}$	$FEF_{75\%}$	$FEV_{0.5}$/ FVC%	FEV_1/ FVC%	FEV_3/ FVC%	MVV
Group A & B														
t-value	1.89	2.94	3.47	1.89	0.59	3.25	1.82	1.12	2.26	3.52	1.23	3.80	1.36	0.66
p-value	>0.05	<0.01	<0.001	>0.05	>0.05	<0.01	>0.05	>0.05	<0.05	<0.001	>0.05	<0.001	>0.05	>0.05
Significance	***NS	*HS	HS	NS	NS	HS	NS	NS	**S	HS	NS	HS	NS	NS
Group B & C														
t-value	2.69	3.57	2.68	2.69	3.65	4.31	4.58	3.98	4.07	5.00	2.13	1.95	0.20	3.87
p-value	<0.01	<0.001	<0.01	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.05	>0.05	>0.05	<0.001
Significance	HS	HS	HS	HS	HS	HS	HS	HS	HS	HS	S	NS	NS	HS
Group C & D														
t-value	3.73	3.50	4.21	3.97	1.92	2.72	2.71	2.81	2.77	0.94	0.03	0.42	1.59	3.68
p-value	<0.001	<0.001	<0.001	<0.001	>0.05	<0.01	<0.01	<0.01	<0.01	>0.05	>0.05	>0.05	>0.05	<0.001
Significance	HS	HS	HS	HS	NS	HS	HS	HS	HS	NS	NS	NS	NS	HS

HS: Highly Significant* ***S: Significant* ** NS: Non-Significant*

Table 3: Showing 't' Value with Statistical Significance of Various Lung Function Parameters on Comparison between Males of Different Groups

	Liters/Second										**Percentage**			**Lts/ Minute**
	FVC	$FEV_{0.5}$	FEV_1	FEV_3	PEFR	$FEF_{25-75\%}$	FEF_{2-12}	$FEF_{25\%}$	$FEF_{50\%}$	$FEF_{75\%}$	$FEV_{0.5}$/ FVC%	FEV_1/ FVC%	FEV_3/ FVC%	MVV
Group A & B														
t-value	1.32	3.34	3.42	1.32	0.64	3.77	1.81	0.82	3.36	4.23	1.71	2.88		0.17
p-value	>0.05	<0.01	<0.01	>0.05	>0.05	<0.001	>0.05	>0.05	<0.01	<0.001	>0.05	<0.01	-	>0.05
Significance	NS	HS	HS	NS	NS	HS	NS	NS	HS	HS	NS	HS		NS
Group B & C														
t-value	2.64	3.57	2.72	2.64	2.13	3.07	3.31	2.70	2.69	2.93	1.52	1.04	1.08	3.12
p-value	<0.05	<0.001	<0.01	<0.05	<0.05	<0.01	<0.01	<0.05	<0.05	<0.01	>0.05	>0.05	>0.05	<0.01
Significance	S	HS	HS	S	S	HS	HS	S	S	HS	NS	NS	NS	HS
Group C & D														
t-value	2.96	2.67	3.64	3.25	1.18	2.16	2.11	2.09	2.14	0.33	0.44	0.11	1.39	3.36
p-value	<0.01	<0.01	<0.001	<0.01	>0.05	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05	>0.05	<0.01
Significance	HS	HS	HS	HS	NS	S	S	S	S	NS	NS	NS	NS	HS

Table 4: Showing 't' Value with Statistical Significance of Various Lung Function Parameters on Comparison between Females of Different Groups

	Liters/Second										**Percentage**			**Lts/ Minute**
	FVC	$FEV_{0.5}$	FEV_1	FEV_3	PEFR	$FEF_{25-75\%}$	FEF_{2-12}	$FEF_{25\%}$	$FEF_{50\%}$	$FEF_{75\%}$	$FEV_{0.5}$/ FVC%	FEV_1/ FVC%	FEV_3/ FVC%	MVV
Group A & B														
t-value	2.61	2.38	3.85	2.61	0.31	1.62	1.36	1.01	0.56	1.09	0.14	2.46	1.45	1.23
p-value	<0.05	<0.05	<0.001	<0.05	>.05	>0.05	>0.05	>0.05	>0.05	>0.05	>0.05	<0.05	>0.05	>0.05
Significance	S	S	HS	S	NS	NS	NS	NS	NS	NS	NS	S	NS	NS
Group B & C														
t-value	2.16	2.67	3.32	2.16	5.60	3.87	5.29	4.64	3.53	4.66	1.49	1.66	0.54	5.39
p-value	<0.05	<0.05	<0.01	<0.05	<0.001	<0.001	<0.001	<0.001	<0.01	<0.001	>0.05	>0.05	>0.05	<0.001
Significance	S	S	HS	S	HS	HS	HS	HS	HS	HS	NS	NS	NS	HS
Group C & D														
t-value	4.87	3.75	4.33	4.94	2.67	2.37	2.99	2.97	2.45	1.18	0.59	0.45	0.90	4.49
p-value	<0.001	<0.001	<0.001	<0.001	<0.01	<0.05	<0.01	<0.01	<0.05	>0.05	>0.05	>0.05	>0.05	<0.001
Significance	HS	HS	HSH	HS	HS	S	HS	HS	S	NS	NS	NS	NS	HS

The mean value of all respiratory parameters was more in males as compared to females. Maximum values were obtained up to 30 years of age. There was a marked decline after the age of 45 years. The mean value of forced expiratory volumes showed a similar trend. PEFR remained at a fairly constant level up to 45 years and then had a definite tendency to fall. Thereafter the values were comparatively higher in males than females.

$FEF_{25-75\%}$, FEF_{2-12}, $FEF_{25\%}$, $FEF_{25\%}$, $FEF_{50\%}$ and $FEF_{75\%}$ reach peak at 30 years and then decline significantly, values being higher in males than females.

Forced expiratory volume: Forced vital capacity ratio expressed as percentage ($FEV_{0.5}$-FVC%, FEV_1/FVC% + FEV_3/FVC %) don't show any significant variation with age and sex. Decline in FEV_1/FVC% in all 4 groups showed a continuous decline which was however not statistically significant. It is observed that MVV is fairly constant up to 45 years of age and thereafter there is marked decline with advancing age.

In this study, age showed a strong negative correlation with pulmonary functions. The ageing process reduces the elastic recoil of lung tissue (Cotes 1993) and is also associated with a decrease in muscle mass of respiratory accessory and diaphragmatic muscles as well as decrease in work output for the same level of neural stimulation (Enright *et al.,* 1994).

Wide variations in pulmonary functions were observed among each age group and between male and females. Factors such as individuals' circadian rhythm, genetic and biological characteristics, physical activity, muscle structure, race and seasonal changes can also influence PFT results. Errors due to biological difference and technical factors should be eliminated as much as possible (American Thoracic Society 1991). Circadian rhythm causes some changes in PFTs. Maximal expiratory flow is at its lowest level during early morning hours and at peak in afternoon (Hetzel 1981). Our tests were performed at midday between 11.00 – 14.00 hours.

FVC is considered to be an important single parameter of respiratory functions of an individual. In our study, it was found to attain peak levels around 30 years and thereafter it declined. Mean values of FVC in males were higher than in females. This is in conformity with earlier observations (Lovent *et al.,* 2002; Vijayan *et al.,* 1998; and Quintero *et al.,* 1996).

$FEV_{0.5}$, FEV_1 and FEV_3 are supposed to indicate the contractile power of respiratory muscles of an individual. $FEV_{0.5}$ and FEV_3 decreases more significantly after 45 years, whereas FEV_1 decrease is significant after 30 years more so in females (Lovent *et al.,* 2002; Miller *et al.,* 1970; Vijayan *et al.,* 1998; Quintero *et al.,* 1996; Mathur *et al.,* 1998; and Chatterje *et al.,* 1993).

PEFR suffers non significant fall up to 45 years but thereafter the fall becomes steep (Mathew *et al.,* 1984; and Japegnanum *et al.,* 1996). Maintenance of relatively prolonged peak value of PEFR in females may be due to the affect of female sex hormones on airway behavior (Becklake *et al.,* 1999). $FEF_{25-75\%}$, $FEF_{50\%}$, $FEV_{75\%}$, FEF_{2-12}, $FEF_{25\%}$ and FEV_1/FVC% all are reduced significantly with age, females showing faster decline. Repeated pregnancies might be leaving the abdominal muscles with diminished tone and this may affect the lung volumes and force of expiration (Cotes *et al.,* 1966; Mathur *et al.,* 1998; and Jain *et al.,* 1967).

$FEV_{0.5\%}$/FVC% and FEV_3/FVC% don't show any significant variation with age (Matsumoto 1989). MVV is a dynamic test and depends upon the speed and efficiency with which filling and emptying of lungs takes place and not upon actual size of range of movements. There is progressive decline in MVV with advancement of age, peak being reached at 30 years and then maintained fairly up to 45 years, followed by a sharp decline, in accordance with other studies(Lovent *et al.,* 2002; Jain *et al.,* 1967; and Selvamurthy 1999).

Thus the present study deals with assessment of various lung functions in healthy urban population of district Amritsar in different age groups, which are comparable with the available data. Variations can be explained by different physical characteristics, racial factors, climates and degree of chest expansion. Method of sample collection and type of population, techniques and instruments employed for measuring lung functions also play some role. Our country being heterogeneous, health status and physical fitness of population varies in different areas.

We conclude that the ventilatory functions are best achieved up to the end of 3rd decade and then start waning in all parameters gradually till the end of 4th decade. Thereafter the decline is more rapid and definite. In order to define the exact age at which PFTs peak, smaller group interval between age group need be employed. The present study will provide a suitable yard stick to assess pulmonary functions in this part of North India.

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