A Comparative Study Of Pulmonary Functions In Different Age Groups

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Abstract: Background and objectives: The respiratory system changes with age and understanding these changes helps detect and prevent respiratory dysfunctions in the elderly. Pulmonary function, as measured by spirometry is an important predictor of morbidity and mortality of elderly persons. The aim of the present study was to see the effects of aging on pulmonary functions. Methods : The study included 150 subjects of different ages from 20 years and above. Subjects were divided in six groups depending on their age. (1) 20-29 yrs (2) 30-39 yrs (3) 40-49 yrs (4) 50-59 yrs (5) 60-69 yrs (6) 70 yrs and above. 25 subjects were included in each group. FVC , FEV_1, FEV_1 /FVC%, PEFR, $FEF_{25\%-75\%}$, MVV were measured. Results: Comparing 20-29 yrs with 70 yrs and above show mean FVC (4.33 vs 1.68 litre, p<0.001) ,FEV_1(3.91 vs 1.19 litre p<0.001), FEV_1 /FVC%(90.30 vs 70.0 p<0.001), PEFR(9.81 vs 3.31 lit/sec p<0.001), $FEF_{25\%-75\%}$(6.65 vs 1.89 lit/sec p<0.001), MVV(93.94 vs 55.96 lit/min p<0.001). Conclusion: Our study concluded that FVC, FEV_1, FEV_1/FVC, PEFR, $FEF_{25-75\%}$ and MVV decrease with age. It is probably a result of decreased strength of expiratory muscles, decreased chest wall compliance and increased tendency of airways to close during forced expiratory effort causing air trapping in the lungs. [Vidja K et al NJIRM 2013; 4(3) : 13-17]

Key Words: Aging, FVC, FEV_1, FEV_1/FVC, PEFR, MVV

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Introduction: The respiratory system changes with age and understanding these changes helps detect and prevent respiratory dysfunctions in the elderly. Pulmonary function, as measured by spirometry is an important predictor of morbidity and mortality of elderly persons[1].Elderly persons constitute the fastest growing segment of the global population and this growth is predicted to continue well into the coming century. In 2000 there were 69 million people in the world over 80 years of age. By year 2050 this number is predicted to have risen to 379 million[2]. As of today, the more developed countries of the world have relatively more aged populations than underdeveloped areas. Aging is a natural process that reduces the number of healthy cells in the body.

Therefore the body loses its ability to respond to a challenge (external or internal) to maintain homeostasis. The respiratory system changes with age and understanding these changes helps detect and prevent respiratory dysfunctions in the elderly. Growth and development of the human respiratory system is essentially complete by about 18-20 years of age[3]. After about age 20, the number of alveoli and the number of lung capillaries gradually begin to decrease. Although aging affects compliance, lung volumes, airflow, diffusing capacity, and other parameters of lung function, purely age-related changes do not lead to clinically significant symptoms or changes in non-smokers.

Studies of effect of aging on respiratory system may be difficult to interpret for several reasons[4].Exposure to environmental pollutants, frequency of acute, self limiting lung diseases, smoking and differences in life style conditions may cause alterations in respiratory system that are not easy to distinguish from changes due to aging alone. The aim of the present study was to see the effects of aging on pulmonary functions.

Material and Methods: The study was conducted at Physiology department with the permission of Institutional Ethics Committee. It included 150 subjects of different ages from 20 years and above. Subjects were divided in six groups depending on their age. (1) 20-29 yrs (2) 30-39 yrs (3) 40-49 yrs (4) 50-59 yrs (5) 60-69 yrs (6) 70 yrs and above. 25 subjects were included in each group. They were all healthy, asymptomatic, non obese, non smoker males with moderate built and non sedentary, moderately active life style. The subjects with history of or evidence of respiratory and cardiovascular disease, alcohol and drug abuse and thoracic, spinal and muscular deformity were excluded from our study. The subjects were informed that the test was non invasive and would not cause any harm to their body. After obtaining their consent pulmonary function tests were conducted. The study was carrying out in the morning from 8am to 10am. Pulmonary function tests were measured using computerized spirometer which had Windows based Software & Smart Communication unit which turns computer into a full fledged Spirometer, which is simple, easily operatable, giving highly accurate result which represents pulmonary function of subjects (it measures by flowing sensing device such as pneumotechnometer). The test was applied at least three times and highest values were recorded. Full series of tests take 4 to 5 minutes. Only FVC (forced vital capacity) and MVV (maximum voluntary ventilation) maneuvers were performed to collect all data.

For FVC maneuver, subject had to take a maximal forceful inspiration after which he has to close his nose and then expire forcefully into the mouthpiece as quick as possible with maximum effort and in same way again to inspire forcefully as quick as possible with maximum effort through the mouth-piece. Then value of FVC and its component were obtained.

For MVV maneuver, subjects were asked to performed inspiration and expiration as fast as possible for 10 seconds. All actual and predicted values were obtained.

Following pulmonary function parameters were recorded: FVC (forced vital capacity), FEV_1(forced expiratory volume at 1 second), FEV_1 /FVC%, PEFR(peak expiratory flow rate), $FEF_{25\%-75\%}$(forced expiratory flow at an average between 25%-75%), MVV(maximum ventilator volume). After collecting data of all subjects in each group, mean and standard deviation were calculated. The probability value (p) of less than 0.05 was considered statistically significant. Data was analyzed using Anova with post hoc student-Newman-Keuls test for difference between study groups.

Result: As shown in table 1 mean age increased significantly while mean height and weight did not change within the study groups.

TABLE-1 Height and Weight in different age Groups (value are mean±SD).

Age groups (years)	Age (years)	Height (cm)	Weight (kg)
20-29	23.52±2.40	166.69±4.36	63.0±5.85
30-39	34.44±3.00	165.57±4.63	63.35±5.5
40-49	44.32±2.82	163.30±4.17	65.69±5.0
50-59	54.52±3.16	164.5±4.6	60.85±3.7
60-69	64.88±3.30	160.56±7.2	60.46±3.35
70 & above	74.96±3.65	160.60±5.4	57.86±4.5
ANOVA (P value)	**<0.0000**	**>0.05**	**>0.05**

TABLE-2: Pulmonary Function Tests of male subjects in different age groups (all values are mean±SD).

Age groups (years)	FVC (lit)	FEV_1 (lit)	FEV_1/FVC%	PEFR (lit/sec)	$FEF_{25-75\%}$ (lit/sec)	MVV (lit/min)
I- 20-29	4.33±0.5	3.91±0.6	90.30±7.2	9.81±5.0	6.65±1.3	93.94±12
II- 30-39	3.81±0.4	3.33±0.4	87.56±4.50	7.48±1.0	4.57±1.2	119.12±9
III- 40-49	3.02±0.5	2.52±0.5	83.47±11.7	6.49±1.9	3.34±1.5	89.8±8.8
IV- 50-59	2.55±0.4	2.02±0.4	79.09±12.3	4.70±1.5	2.66±1.2	75.96±11
V- 60-69	2.07±0.4	1.49±0.3	73.86±17.8	3.83±1.3	1.75±0.6	69.97±10
VI- 70&above	1.68±0.5	1.15±0.2	70.00±25.0	3.39±1.6	1.58±0.4	55.96±94
ANOVA (p value)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Student-Newman-Keuls post hoc test	P<0.01 for all groups	P<0.01 for all groups	P>0.05 for group III,IV,V,VI P<0.01 for all other groups	P>0.05 for group IV,V,VI P<0.01 for all other groups	P<0.01 for all groups	P<0.01 for all groups

Our study demonstrated that most dynamic measurements of lung volumes and capacities decreases with age (table 2). A student-Newman-Keuls post hoc test indicates that each age group was significantly different from all others for FVC, FEV1, $FEF_{25-75\%}$, and MVV. PEFR was not significantly different between the age groups above 50 years (group IV,V,VI) while FEV1/FVC was not significantly different between the age groups above 40 years (group III,IV,V,VI), all other groups were significantly different for PEFR and FEV1/FVC.

Discussion: From our study it is evident that FVC progressively decreases with age and it is a statistically highly significant (p value is < 0.001). In comparison with FVC values in 3rd decade, these values are reduced to 47.8%, and 38.7% in 7th and 8th decade respectively. These findings are in tune with findings of S.S Verma et al [5]. In their study mean value of FVC was 4.39±0.11 in 21-25 years of age group while it was 3.10±0.14 in 61-70 years of age group. These values progressively decrease with age and it is statistically highly significant. Levent kart et al [6] also found mean value of FVC was 4.0±9.3 in 20-29 years of age group while it was 2.5±6.9 in > 60 years of age group. . Findings of our study are also in tune with findings of many other studies [7,8].

FEV_1 progressively decreases with age in our study (p value is < 0.001). In comparison with FEV_1 values in 3rd decade, these values are reduced to 38.1%, and 29.41% in 7th and 8th decade respectively. The age related decline in FEV_1 begins earlier and at a faster rate than that in FVC. These findings are in tune with findings of S.S Verma et al [5.] In their study mean value of FEV_1 was 3.44±0.09 in 21-25 years of age group while it was 2.11±0.12 in 61-70 years of age group. These values progressively decreased with age and it was statistically highly significant. Levent kart et al [6]. In their study mean value of FEV_1 was 3.9±8.8 in 20-29 years of age group while it was 2.5±6.6 in > 60 years of age group. Findings of our study are also in tune with findings of many other studies. [9,10]

FEV_1/FVC% progressively decrease with age in our study and it is statistically highly significant (p value is < 0.001). However, the values of FEV_1/FVC% remain within normal range till 6th decade. These findings are in tune with findings of Hyun wook kim,md; et al [11]. In their study mean value of FEV_1/FVC% was 90.17±4.90 in 20-29 years of age group while it was 76.72±8.13 in 70-79 years of age group. These values progressively decrease with age and it was statistically significant. Findings of our study are also in tune with findings of many other studies [12,13]**.**

PEFR significantly decreases with age in our study (p value is < 0.001). In comparison with PEFR values in 3rd decade, these values are reduced to 38.77%, and 34.73% in 7th and 8th decade respectively. These findings are in tune with findings of M. B. Dikshit et al [14]. In their study mean value of PEFR was 544.1±37.5 in 20-29 years of age group while it was 379.2±67.9 in > 60 years of age group. These values progressively decrease with age and it was statistically significant. Levent kart et al [6]. In their study mean value of PEFR was 5.19±9.8 in 20-29 years of age group while it was 4.10±8.9 in > 60 years of age group. These values progressively decrease with age and it was statistically significant. Findings of our study are also in tune with findings of many other studies [15,16]

$FEF_{25-75\%}$ progressively decrease with age in our study and it is a statistically highly significant (p value is < 0.001). In comparison with $FEF_{25-75\%}$ values in 3rd decade, these values are reduced to 26.31%, 23.75% in 7th and 8th decade respectively. These findings are in tune with findings of Hyun wook kim,md; et al [11]. In their study mean value of $FEF_{25-75\%}$ was 4.43±0.8 in 20-29 years of age group while it was 1.78±0.48 in 70-79 years of age group. These values progressively decrease with age and it was statistically highly significant.

MVV significantly decreases with age and it is a statistically highly significant (p value is < 0.001). In comparison with MVV values in 3rd decade, these values are reduced to 52.73%, and 42.17% in 7th and 8th decade respectively. These findings are in tune with findings of S.S Verma et al [5]. In their study mean value of MVV was 144.20±3.18 in 21-

25 years of age group while it was 77.20±5.34 in 61-70 years of age group. These values are progressively decrease with age and it was statistically highly significant. Findings of our study are also in tune with findings of many other studies. [17,18]

Three structural changes in the respiratory system associated with aging that influence pulmonary ventilation includes [19]**.**changes in the chest wall, respiratory muscles and lung parenchyma. Chest wall compliance decreases progressively with age, meaning it gets stiffer, because of calcification of the chondral cartilage and kyphoscoliosis [20].Major determinants of the age-related decrease in muscle strength and peak tetanic tension are: a decrease in muscle mass (cross-sectional fibre area); a decrease in the number of muscle fibers, especially type II"fast twitch" fibres and motor units; alterations in neuromuscular junctions; and loss of peripheral motor neurons with selective denervation of type II muscle fibers [21,22]

After about age 40, the lungs begin to lose some of their tissue. The number of alveoli decreases, and there is a corresponding decrease in lung capillaries. The lungs also become less elastic (able to expand and contract) due to various factors including the loss of a tissue protein called elastin. Our current knowledge of lung senescence is incomplete. Almost all of the information concerning changes in pulmonary function with age has come from cross-sectional studies (those in which groups of people of different ages are compared with each other at the same time) rather than from longitudinal studies. (those in which a group of people is tested repeatedly as they age).

Our cross-sectional study demonstrates progressive age related decline in many predictors of lung functions. However, a longitudinal study evaluating a single cohort shall be more useful in determining age related changes in lung functions.

Conclusion Our study concluded that FVC, FEV_1, FEV_1/FVC, PEFR, $FEF_{25-75\%}$ and MVV decrease with age. This is an important finding which should be considered in old aged when pulmonary functions are tested for various diseases and compared with young healthy adults. A minor decline in pulmonary function can be catastrophic in elderly and can affect their routine activity severely, as they have already compromised pulmonary functions.

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