The Influence of Age on Pulmonary Function, A Cross Sectional Study on a Sample of Healthy Iraqi Males and Females Population

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Abstract. This study was done to show the effect of age on spirometry test for sample of healthy males and females. Forced expiratory volume in one second (FEV1), forced vital capacity FVC, and vital capacity (VC) were measured in healthy subjects (228) male and (212) female under age group from 10 to greater than 60 years, further divided into five age groups (20-30 years, 30-40 years, 40-50 years, 50-60 years, and age group 5 > 60 years) for Iraqi individuals. The values of function test were found to be the same for individual’s ages between 20-60 year and decline with age greater than 60 years. It was concluded that pulmonary performance for normal people is changed with age, this change does not appear for ages less than 60 yrs, and the ratio of FEV1/FVC% is significantly reduced for age >60 years.

1. Introduction

Spirometry plays an important role in the identification and management of lung disease [1]. In spirometry, certain lung volumes, called dynamic lung volumes are measured; the two most important dynamic lung volumes measured are the forced vital capacity (FVC) and the forced expiratory volume in the 1st second (FEV 1) [2].

Lung functions decline with age, even in healthy person; cross sectional analysis have suggested that the decline with age results in changes in pulmonary mechanics, respiratory muscle strength, gas exchange and ventilator control [3]. Increased rigidity of chest wall and decrease in respiratory muscle strength with aging result in an increased closing capacity and decreased forced expiratory volume in first second (FEV1) [4].

2. Methods

The data of this study was carried out at the Pulmonary Function Test Unit of Al-Imamein Al-Kadhimein Medical City, Baghdad, from February 2017 to June 2017. A total of (440) subjects were selected; (228) adult males and (212) adult females of healthy volunteers or hospital visitors subjects whom were nonsmokers of cigarettes, electronic cigarettes and water pipes (Hookah) with their age ranged from 20-60 year. They divided into five age groups (age group 1, 20-30 years; age group 2, 31-40 years; age group 3, 41-50 years; age group 4, 51-60 years; age group 5, > 60 years). Weight was measured using a weighing machine with measurement an error in weight < 0.5 Kg due to clothes worn and height of subjects was measured by Stadiometer.

Respiratory function parameters were measured by experienced technicians using the (Gager-Germany, 1997). The following parameters were assessed by computerized spirometry for the values of study groups – vital capacity (VC), forced vital capacity (FVC), and forced expiratory volume in one second (FEV1).

Statistical analyses were performed using SPSS v19.
3. Results and Discussion

Analysis of 440 apparently healthy subjects (228 males and 212 females) was performed using a spirometric device. Comparisons of the following pulmonary function tests (PFT); VC inspiratory, VC expiratory, FEV1, FVC, and FEV1/FVC respectively were done separately for males and females between different age groups.

**Comparison between different age groups in males**

Table (1) reveals that the P value of comparison of different age groups in males by using ANOVA is significant for VC in, VC ex, FEV1, FVC, and FEV1/FVC respectively.

Figure (1) shows that the highest means of VC in, VC ex, FEV1 and FVC were shown in age group (31-40) yr, while it is obvious from figure (2) that the highest FEV1/FVC ratio were in the youngest age group (10-20) yr.

The comparison between age groups 10-20 year with other age groups in males that shown in table 2, illustrated significantly higher values for VC in, VC ex, FEV1, and FVC with age groups (21-30), (31-40), and (41-50), but no significant with age groups (51-60) and age > 60 year. The ratio of FEV1/FVC were not significant when compared with age group (21-30) year but significantly lower in comparison with other older age groups.

Table (3) shows comparison between age group (21-30) with higher ages; there were non-significant differences in values VC in, VC ex, FEV1, FVC, and FEV1/FVC ratio respectively with age group (31-40) and age group (41-50) except FEV1 and FEV1/FVC ratio which were significantly higher in age group (41-50) year. All the measured PFT values of age (51-60) were significantly lower than that of (21-30). Likewise for values of age group (> 60) except for FEV1/FVC ratio.

The means of VC in, VC ex, and FEV1 were significantly lower in age group (31-40) in comparison with other age groups > 40 year, while FVC was non-significant only in age group (41-50). However, FEV1/FVC ratio means were not significantly lower in comparison with other age groups > 40 year, as observed in table (4).

Table (5) revealed that the means of VC in, VC ex, FEV1, and FVC were significantly lower in age groups older than 50 when compared with age group (41-50) though the means of FEV% and FEV1/FVC ratio were not significantly different for the same comparison.

Only VC in, was significantly lower when compared >60 with age group (51-60), other parameters revealed no significance difference, as illustrated in table (6).

**Comparison between different age groups in females**

Table (7) illustrates the significant difference of all tested parameters of PFT in this study (VC in, VC ex, FEV1, FVC, and FEV1/FVC) among the six study groups of different age in females.

The highest means of VC in, VC ex, FEV1, FVC were in age group (21-30) yr as it is clear in figure (3), however as males, the FEV% and FEV1/FVC were highest in the youngest age group (10-20) yr. (figure 4).

The means of all tested PFT parameters of age group (21-30) and age group (31-40) year were significantly higher than that of age group (10-20) year, except for FEV1/FVC ratio which were significantly lower. Regarding comparison of age group (10-20) with age group (41-50) year, there was non-significant difference for the parameter VC in, VC ex, FEV1, FVC, while means of FEV1/FVC ratio were significantly lower; P value < 0.001. On the other hand, comparison of age group (10-20) with age group (51-60) year, the VC in, VC ex, only FEV1, FEV%, and FEV1/FVC were significantly lower. The comparison with age > 60 year showed a significant lower means for all tested parameters. These results are illustrated in table (8).

Table (9) showed the comparison of tested parameters for age group (21-30) with other groups, with age group (31-40), only the VC in, FEV1, FVC and FEV1/FVC are significantly lower than that of age group (21-30). All the parameters are significantly lower in age group (41-50) in comparison
with age group (21-30). Also, all parameters are significantly lower in both age groups (51-60) and (> 60) in comparison with age group (21-30) except for FEV%.

The comparison of age group (31-40) year with other older age groups that are shown in table (10). Only FEV1, FEV% and FEV1/FVC in age group (41-50) were significantly lower than that of age group (31-40). While all parameters were significantly lower in the two age groups older than 50 year except for FEV% and FEV1/FVC which had no significant difference with that of age group (31-40).

Table (11) show that the comparison between age group (41-50) year with older age groups in female, the means of VC in, VC ex, and FVC were significantly higher than older age groups, while the comparison of mean of FEV1 were significantly higher than that of > 60 nonsignificant but insignificant with that of age group of (51-60). The FEV1 and FEV% for age (41-50) showed non-significant difference with older age groups.

Table (12) illustrates the comparison between age group (51-60) and the age > 60 year for female, VC in, VC ex, FVC, and FEV1 were significantly higher than those of > 60, however, FEV% and FEV1/FVC showed non-significant difference.

Studying age dependent changes of lung function through the lifespan reveals distinct differences; FEV1 and FVC keep increasing from birth to the age 20 years [7].

The lung undergoes a phase of growth and maturation during the first two decades of life and achieves maximal lung function around ages 20 years in females and 25 year in males [8], this is what match with our study lung function remain steady with very minimal change from age 20-40 years and starts declining thereafter in both gender; except for FEV1/FVC ratio which increase once again after age 60 in males and after age of 50 in females.

The VC (vital capacity) was more in the male than in female and degrees from youth to old age when exactly this deterioration commences from young to old age in population, the volume of adult female lungs is typically 10-12% smaller than that of males who have the same age(9), the smaller lung volume in female appearance to be established in first few years of life, the rib cage cross sectional area is smaller in females than males. Also, differences in thoracoabdominal configuration could impact the function of respiratory muscles [9].

On reviewing our data both FVC and FEV1 reached a maximum in male of age of (31-40) year and then reduced with increase of age, but in females a maximum value at age (21-30) year.

For FEV1% only a slight, but statistically significant decrease with increasing age was noted in both genders. Few studies report results obtained in large samples of elderly subject. The present study has shown the values that are similar to the study Woo and Pruthi studies [6,10].

Results of comparison between the ratios of FEV1/FVC in relation to their differences in age reveal that there is a significant reduction in the ratio of (FEV1/FVC) percent for the older people regardless of their gender and increased up to greater than 60 years.

The present finding could be explained on the basis of two major changes to the pulmonary system associated with the aging. These changes are decreased elastic recoil and stiffening of the chest wall [11].

Pulmonary functions remain the major biologic variable that is affected by aging. Extent of the aging process in the lungs shows great inter individual variation. Even in individuals who enjoy apparently good health, there are measurable decrements in function of the respiratory system with age [12].

4. Conclusion:

Pulmonary performance for normal people is changed with age, this change does not appear for ages less than 60 yrs, and the ratio of FEV1/FVC% is significantly reduced for age >60 years. The effect may be attributed to some changes in the airways together with possible weakness in the muscles.
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Table (1): Comparison between different age groups in males by ANOVA

| Parameter         | 10-20 yr N=26 Mean±SD | 21-30 yr N=37 Mean±SD | 31-40 yr N=38 Mean±SD | 41-50 yr N=32 Mean±SD | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD | P value |
|-------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|---------|
| VC In actual (L)  | 2.93±0.72             | 3.8±0.55              | 3.82±0.53             | 3.58±0.41             | 3.22±0.4              | 2.99±0.43             | <0.0001 |
| VC Ex actual (L)  | 3.03±0.75             | 3.92±0.57             | 3.94±0.52             | 3.7±0.44              | 3.27±0.41             | 3.06±0.43             | <0.0001 |
| FEV1 actual (L)   | 2.9±0.71              | 3.69±0.5              | 3.66±0.43             | 3.42±0.4              | 2.98±0.33             | 2.84±0.44             | <0.0001 |
| FVC actual (L)    | 2.98±0.75             | 3.83±0.52             | 3.87±0.49             | 3.65±0.43             | 3.23±0.42             | 3.02±0.43             | <0.0001 |
| FEV1/FVC          | 97.46±4.48            | 96.44±4.74            | 94.72±5.56            | 93.68±4.87            | 92.52±6.42            | 94.0±5.85             | 0.0071  |

Table (2): Comparison between age group (10-20yr) with other age groups in males by unpaired T-test

| Parameter         | 10-20 yr N=26 Mean±SD | 21-30 yr N=37 Mean±SD | 31-40 yr N=38 Mean±SD | 41-50 yr N=32 Mean±SD | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD |
|-------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| VC In actual (L)  | 2.93±0.72             | 3.8±0.55              | 3.82±0.53             | 3.58±0.41             | 3.22±0.4              | 2.99±0.43             |
| VC Ex actual (L)  | 3.03±0.75             | 3.92±0.57             | 3.94±0.52             | 3.7±0.44              | 3.27±0.41             | 3.06±0.43             |
| FEV1 actual (L)   | 2.9±0.71              | 3.69±0.5              | 3.66±0.43             | 3.42±0.4              | 2.98±0.33             | 2.84±0.44             |
| FVC actual (L)    | 2.98±0.75             | 3.83±0.52             | 3.87±0.49             | 3.65±0.43             | 3.23±0.42             | 3.02±0.43             |
| FEV1/FVC          | 97.46±4.48            | 96.44±4.74            | 94.72±5.56            | 93.68±4.87            | 92.52±6.42            | 94.0±5.85             |

* P value < 0.05, ** P value < 0.001
Table (3): Comparison between age group (21-30 yr) with other age groups in males by unpaired t-test

| Parameter            | 21-30 yr N=37 Mean±SD | 31-40 yr N=38 Mean±SD | 41-50 yr N=32 Mean±SD | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD |
|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|
| VC In actual (L)     | 3.8±0.55              | 3.82±0.53             | 3.58±0.41             | 3.22±0.4**            | 2.99±0.43**          |
| VC Ex actual (L)     | 3.92±0.57             | 3.94±0.52             | 3.7±0.44              | 3.27±0.41**           | 3.06±0.43**          |
| FEV1 actual (L)      | 3.69±0.5              | 3.66±0.43             | 3.42±0.4*             | 2.98±0.33**           | 2.84±0.44**          |
| FVC actual (L)       | 3.83±0.52             | 3.87±0.49             | 3.65±0.43             | 3.23±0.42**           | 3.02±0.43**          |
| FEV1/FVC             | 96.44±4.74            | 94.72±5.56            | 93.68±4.87*           | 92.52±6.42*           | 94.0±5.85            |

* P value < 0.05, ** P value < 0.001

Table (4): Comparison between age group (31-40 yr) with other age groups in males by unpaired T-test

| Parameter            | 31-40 yr N=38 Mean±SD | 41-50 yr N=32 Mean±SD | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD |
|----------------------|-----------------------|-----------------------|-----------------------|----------------------|
| VC In actual (L)     | 3.82±0.53             | 3.58±0.41*            | 3.22±0.4**            | 2.99±0.43**          |
| VC Ex actual (L)     | 3.94±0.52             | 3.7±0.44              | 3.27±0.41**           | 3.06±0.43**          |
| FEV1 actual (L)      | 3.66±0.43             | 3.42±0.4*             | 2.98±0.33**           | 2.84±0.44**          |
| FVC actual (L)       | 3.87±0.49             | 3.65±0.43             | 3.23±0.42**           | 3.02±0.43**          |
| FEV%F                | 94.97±5.59            | 93.67±4.81            | 93.33±6.5             | 94.69±4.93           |
| FEV1/FVC             | 94.72±5.56            | 93.68±4.87            | 92.52±6.42            | 94.0±5.85            |

* P value < 0.05, ** P value < 0.001

Table (5): Comparison between age group (41-50 yr) with other age groups in males by unpaired T-test

| Parameter            | 41-50 yr N=32 Mean±SD | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD |
|----------------------|-----------------------|-----------------------|----------------------|
| VC In actual (L)     | 3.58±0.41             | 3.22±0.4**            | 2.99±0.43**          |
| VC Ex actual (L)     | 3.7±0.44              | 3.27±0.41**           | 3.06±0.43**          |
| FEV1 actual (L)      | 3.42±0.4              | 2.98±0.33**           | 2.84±0.44**          |
| FVC actual (L)       | 3.65±0.43             | 3.23±0.42**           | 3.02±0.43**          |
| FEV1/FVC             | 93.68±4.87            | 92.52±6.42            | 94.0±5.85            |

* P value < 0.05, ** P value < 0.001

Table (6): Comparison between age group (51-60 yr) with age group (> 60 yr) in males by unpaired T-test

| Parameter            | 51-60 yr N=24 Mean±SD | > 60 yr N=31 Mean±SD |
|----------------------|-----------------------|----------------------|
| VC In actual (L)     | 3.22±0.4              | 2.99±0.43*           |
| VC Ex actual (L)     | 3.27±0.41             | 3.06±0.43            |
| FEV1 actual (L)      | 2.98±0.33             | 2.84±0.44            |
| FVC actual (L)       | 3.23±0.42             | 3.02±0.43            |
| FEV1/FVC             | 92.52±6.42            | 94.0±5.85            |
## Table (7): Comparison between different age groups in females by ANOVA

| Parameter          | 10-20 yr | 21-30 yr | 31-40 yr | 41-50 yr | 51-60 yr | > 60 yr | P value |
|--------------------|----------|----------|----------|----------|----------|---------|---------|
|                    | N=32     | N=36     | N=54     | N=34     | N=31     | N=25    |         |
| VC In actual (L)   | 2.38±0.39 | 2.8±0.34 | 2.63±0.46 | 2.52±0.53 | 2.25±0.39 | 1.94±0.32 | <0.0001 |
| VC Ex actual (L)   | 2.44±0.38 | 2.84±0.3 | 2.5±0.42  | 2.58±0.61 | 2.31±0.39 | 1.97±0.34 | <0.0001 |
| FEV1 actual (L)    | 2.36±0.42 | 2.72±0.26 | 2.57±0.4  | 2.35±0.51 | 2.15±0.32 | 1.87±0.35 | <0.0001 |
| FVC actual (L)     | 2.37±0.42 | 2.83±0.3 | 2.67±0.42 | 2.56±0.61 | 2.28±0.39 | 1.96±0.32 | <0.0001 |
| FEV/FVC            | 99.64±1.33 | 96.51±3.98 | 96.7±4.64 | 92.37±5.65 | 94.85±5.16 | 94.39±4.84 | <0.0001 |

## Table (8): Comparison between age group (10-20 yr) with other age groups in females by unpaired T-test

| Parameter          | 10-20 yr | 21-30 yr | 31-40 yr | 41-50 yr | 51-60 yr | > 60 yr | P value |
|--------------------|----------|----------|----------|----------|----------|---------|---------|
|                    | N=32     | N=36     | N=54     | N=34     | N=31     | N=25    |         |
| VC In actual (L)   | 2.38±0.39 | 2.8±0.34* | 2.63±0.46** | 2.52±0.53 | 2.25±0.39 | 1.94±0.32** | <0.0001** |
| VC Ex actual (L)   | 2.44±0.38 | 2.84±0.3** | 2.7±0.42** | 2.58±0.61 | 2.31±0.39 | 1.97±0.34** | <0.0001** |
| FEV1 actual (L)    | 2.36±0.42 | 2.72±0.26** | 2.57±0.4* | 2.35±0.51 | 2.15±0.32** | 1.87±0.35** | <0.0001** |
| FVC actual (L)     | 2.37±0.42 | 2.83±0.3** | 2.67±0.42* | 2.56±0.61 | 2.28±0.39** | 1.96±0.32** | <0.0001** |
| FEV1/FVC           | 99.64±1.31 | 96.55±3.99** | 96.26±4.73** | 92.35±5.71** | 94.83±5.17** | 95.7±6.72** | <0.0001** |

* P value < 0.05, ** P value < 0.001

## Table (9): Comparison between age group (21-30 yr) with other age groups in females by unpaired T-test

| Parameter          | 21-30 yr | 31-40 yr | 41-50 yr | 51-60 yr | > 60 yr | P value |
|--------------------|----------|----------|----------|----------|---------|---------|
|                    | N=36     | N=54     | N=34     | N=31     | N=25    |         |
| VC In actual (L)   | 2.8±0.34 | 2.63±0.46* | 2.52±0.53* | 2.25±0.39** | 1.94±0.32** | <0.0001** |
| VC Ex actual (L)   | 2.84±0.3 | 2.7±0.42 | 2.58±0.61* | 2.31±0.39** | 1.97±0.34** | <0.0001** |
| FEV1 actual (L)    | 2.72±0.26 | 2.57±0.4* | 2.35±0.51** | 2.15±0.32** | 1.87±0.35** | <0.0001** |
| FVC actual (L)     | 2.83±0.3 | 2.67±0.42* | 2.56±0.61* | 2.28±0.39** | 1.96±0.32** | <0.0001** |
| FEV1/FVC           | 107.98±10.39 | 102.86±7.39* | 95.9±4.69** | 88.5±5.24** | 80.9±6.68** |         |

* P value < 0.05, ** P value < 0.001

## Table (10): Comparison between age group (31-40 yr) with other age groups in females by unpaired T-test

| Parameter          | 31-40 yr | 41-50 yr | 51-60 yr | > 60 yr | P value |
|--------------------|----------|----------|----------|---------|---------|
|                    | N=54     | N=34     | N=31     | N=25    |         |
| VC In actual (L)   | 2.63±0.46 | 2.52±0.53 | 2.25±0.39** | 1.94±0.32** | <0.0001** |
| VC Ex actual (L)   | 2.7±0.42 | 2.58±0.61 | 2.31±0.39** | 1.97±0.34** | <0.0001** |
| FEV1 actual (L)    | 2.57±0.4 | 2.35±0.51* | 2.15±0.32** | 1.87±0.35** | <0.0001** |
| FVC actual (L)     | 2.67±0.42 | 2.56±0.61 | 2.28±0.39** | 1.96±0.32** | <0.0001** |
| FEV1/FVC           | 96.26±4.73 | 92.35±5.71* | 94.83±5.17** | 95.7±6.72** |         |

* P value < 0.05, ** P value < 0.001
Table (11): Comparison between age group (41-50 yr) with other age groups in females by unpaired T-test

| Parameter          | 41-50 yr N=34 Mean±SD | 51-60 yr N=31 Mean±SD | > 60 yr N=25 Mean±SD |
|--------------------|------------------------|------------------------|----------------------|
| VC In actual (L)   | 2.52±0.53              | 2.25±0.39*             | 1.94±0.32**          |
| VC Ex actual (L)   | 2.58±0.61              | 2.31±0.39*             | 1.97±0.34**          |
| FEV1 actual (L)    | 2.35±0.51              | 2.15±0.32              | 1.87±0.35            |
| FVC actual (L)     | 2.56±0.61              | 2.28±0.39*             | 1.96±0.32**          |
| FEV%F              | 92.37±5.65             | 94.85±5.16             | 94.39±4.84          |
| FEV1/FVC           | 92.35±5.71             | 94.83±5.17             | 95.7±6.72           |

* P value < 0.05, ** P value < 0.001

Table (12): Comparison between age group (51-60 yr) with other age groups in females by unpaired T-test

| Parameter          | 51-60 yr N=31 Mean±SD | > 60 yr N=25 Mean±SD |
|--------------------|------------------------|----------------------|
| VC In actual (L)   | 2.25±0.39              | 1.94±0.32**          |
| VC Ex actual (L)   | 2.31±0.39              | 1.97±0.34**          |
| FEV1 actual (L)    | 2.15±0.32              | 1.87±0.35*           |
| FVC actual (L)     | 2.28±0.39              | 1.96±0.32*           |
| FEV1/FVC           | 94.83±5.17             | 95.7±6.72            |

Figure (1): Comparison vital capacity, forced expiratory volume at first second and forced vital capacity between different age groups in males
Figure (2): Comparison of FEV1/FVC ratio among different age groups in males.

Figure (3): Comparison of vital capacity, forced expiratory volume at first second and forced vital capacity between different age groups in females.
Figure (4): Comparison of FEV1/FVC ratio among different age groups in females