PULMONARY FUNCTION TEST IN A COHORT OF OLDER PAKISTANI POPULATION

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Background: Pulmonary function test (PFT) depends on a number of factors as height, age, gender and race. Reference equations are used to determine a normal range of spirometry results which in turn are used clinically to determine whether the volumes measured in any individual fall within a range to be expected in a healthy person of the same gender, height and age. **Methods:** The study was conducted in Karachi on 249 healthy, nonsmoking subjects between 35 to 65 years of age were included in the study. The subjects included 149 males and 100 females whose pulmonary volumes and capacities were measured by spirometry. **Results:** Prediction equation was first derived and the reference values were then calculated for FEV_1 and FVC. The values for both these parameters were found to be lower by about 13% and 18% in females and 10% and 12% in males respectively when compared with those given by researchers for Caucasians. **Conclusion:** Pulmonary function test reference values and prediction equations for both sexes between the ages of 35-65 years were derived for healthy, nonsmoking, urban Pakistani population. A considerable difference was found between prediction equations and reference values obtained in present study compared with other studies conducted in western countries.
Keywords: PFT, FEV_1, FVC, Spirometry.

INTRODUCTION

Spirometry is the most frequently performed lung function test. Pulmonary function variables depend on height, age and gender. There is evidence of considerable variations in pulmonary function in different ethnic groups and across generations.[1]

Reference formulas are used to determine a normal range of spirometry results. The reference values so determined play an important role in establishing whether the volumes measured in an individual fall within a range to be expected in a healthy person of the same gender, height and age.[2-4] Several studies have examined development of lung function in young adults.

The most recent American Thoracic Society[5] (ATS) statement on impairment and disability secondary to respiratory disorders also acknowledges the presence of documented racial and ethnic differences. Such differences must be considered when interpreting pulmonary function tests[6].

While some authors have described a "plateau phase" of lung function development[9] starting from about 17 years of age to approximately 35 years of age when no lung growth takes place[2], others have reported a decline in lung functions beginning at approximately 35 years of age[7-10].

A number of studies have been conducted in Pakistan to establish reference values for pulmonary functions in young healthy adults but to the best of our knowledge there is no study involving elderly population of the country. The aim of the present study was thus to determine the spirometric reference formulas for the population of adult and elderly persons living in Karachi, Pakistan and to compare the measurement of pulmonary function in those populations with other available standards.

MATERIAL AND METHODS

The study area was the city of Karachi, which is the most urbanized and largest city of Pakistan. Karachi has a population of approximately 13 million people many of whom are immigrants from all over the Pakistan and as such has a mixture of number of ethnic inhabitants.

In total 293 healthy non-smoking individuals who met the inclusion criteria participated in the study, but only 249 (149 males and 100 females) completed the pulmonary function tests (PFT) and were included in the study. The rest of the subjects were not able to perform the PFT correctly and were excluded. Participants were recruited from various aspects of life, either students or employees of different organizations. Few of the participants were also recruited from workers and shopkeepers in various populated parts of the city. The participants completed a proforma that gathered information about age, sex, health and smoking habit. Body measurements were taken, including the standing height and weight. All subjects were non smokers with no history of symptoms of cardiovascular or respiratory diseases that required treatment. Subjects who had recovered from common cold at least one month prior to the study were allowed to participate.

Forced expiratory maneuvers were recorded using micromedical/microloop + microrint (airway resistant) in conjunction with spida 5 PC software. The spirometer was calibrated daily with a 3L

calibrating syringe. After explanation of the test procedure, every subject attempted to perform the test. A minimum of 3 acceptable and reproducible maneuvers were obtained, according to the standards recommended by the American Thoracic Society.

The data was entered in computer package "Microsoft Excel" and analyzed using the Statistical Package for Social Science (SPSS) version 11 for window software. Results from participants whose spirometry test session did not meet the ATS standard for acceptability and reproducibility were excluded from analysis. The data for age, weight, height and pulmonary function parameters were expressed as mean ± s.d. A graph of pulmonary function variables against height and age were initially examined for each gender. Means and standard deviation of all quantitative variables (age, height and weight) were compared according to gender by student t-test. Multiple linear regression analysis was applied to observed lung function values as a function of standing height and age. The FEV_1, FVC, etc were dependent variables, while height and age were independent variables. Correlation coefficient (r), r^2 and SEM are also reported.

In all statistical analysis, only p-values <0.05 were considered significant and correlation coefficient of > 0.4 or < -0.4 were also considered significant.

RESULTS AND DISCUSSION

Appropriate reference values are vital for the assessment of lung functions. The practice of functional testing dictates the qualification of degree of functional impairment depending on the level of FEV_1 estimated as a percent of the reference value. Improper predicted values can delay the recognition of a developing illness or may lead to inadequate rating of the observed impairment [8].

Table 1 presents the indices examined, FEV_1, FVC separately for females and males. The mean values for FVC was 3.37L and 2.37L in male and females respectively while the values for FEV_1 was 2.86L and 2.03L in males and females respectively. The prediction formulas for both male and females were derived and the reference values were calculated and compared with those given by ECSC[11], Knudson[12], Roca[13] and Crapo[14] as shown in Table 2 and Table 3. The outcome of the corresponding calculations of the predicted values for FEV_1 and FVC is presented in Table 4. Although we found that our values for both FEV_1 and VC were lower than all the studies with which we compared them, the greatest difference was observed with values given by the ECSC[11] study. Our values for FEV_1 were less by about 10.9% in males and 13.7 % in females while for FVC the values were 12.1% for males and 18.6% for females when compared with the ECSC[11] study. While the least difference in case of FEV_1 was found in males i.e. 0.2% when our values were compared with those of Roca et al[13] and in case of females the values were 5.3% less when compared with the study o Knudson et al[12].

In literature the mean average difference between Asian and Caucasian population is stated to 16% for females and 12% for males[14] however, a study conducted earlier by Ayub et. al[15] found no significant difference between our population and Caucasians during later years of life. We found that the mean difference for FEV_1 in females was 8.6% and for FVC it was 10.2% while the mean difference for FEV_1 in males was 5.9% and for FVC was 6.9% respectively when our population was compared with that to the Caucasians. This difference between our study and the one conducted by Ayub et. al[15] could be due to the fact that the latter study was conducted on subjects living at high altitudes which could effect their pulmonary functions.

The scatter of R^2 between 48% and 79% in tables 2 and 3 means that the strength of formulae varies in all the studies conducted. Taking that into consideration, it can be stated that none of the authors have managed to create a strong, universal formula and this again emphasizes the importance of ethnic, age, height and other variables that effect the pulmonary functions.

Establishing the predicted values is not easy. According to the presently accepted method of establishing of predicted values for lung function indices, it is assumed that the value of FEV_1 depends on height and age. This assumption is true as it has been confirmed in several examinations in the up-growth period and in subjects who outgrew this period. A second assumption is that the efficacy of ventilation measured with FEV_1 or FVC decreases constantly after it has reached its maximum level[16]. The age at which this occurs has been calculated to be 35 years[1]. Thus our study establishes the reference values for subjects who have attained the maximum values for pulmonary function tests and are now prove to be decline in these tests.

An important problem for such procedures is the cohort effect. Variation inside the reference group, such as overrepresentation of people with average anthropometric parameters and a simultaneous lack of people with extreme height and weight, very short and tall. Very thin and obese are responsible for the falsification of estimation.[7] We also did not exclude such representation and this play and major role in variation of reference values derived from the prediction equation in our study.

Table-1: Lung function data in cohorts evaluated

\Forced Vital Capacity (FVC)	Females	Males
Mean ±SD (L)	2.37 ± 0.76	3.37 ± 0.62
Range (L)	1.69 – 4.25	2.11 – 5.2
Forced Expiratory Volume in the First Second (FEV1)		
Mean ±SD (L)	2.03 ± 0.62	2.86 ± 0.55
Range (L)	1.33 – 3.69	1.72 – 4.71

Table-2: Comparison of different FEV1 and FVC prediction equations used for males.

FEV1(L)	Formula	R2	RSD
Memon	0.0389h - 0.0196a - 2.988	0.48	0.45
ECSC	0.0430h - 0.0290a - 2.490	-	0.51
Knudson	0.0665h - 0.0292a - 6.515	0.74	0.52
Crapo	0.0414h - 0.0244a - 2.190	0.64	0.49
Roca	0.0514h - 0.0216a - 3.995	0.56	0.45
FVC (L)			
Memon	0.0558h – 0.0143a – 5.491	0.52	0.49
ECSC	0.0576h - 0.0260a - 4.340	-	0.61
Knudson	0.0844h - 0.0298a - 8.782	0.72	0.64
Crapo	0.0600h - 0.0214a - 4.650	0.53	0.64
Roca	0.0678h - 0.0147a - 6.055	0.52	0.53

h - height in cm; a - age in years; R2 - multiple regression coefficient; RSD - residual standard deviation

Table-3:Comparison of different FEV1 and FVC prediction equations used for females

FEV1(L)	Formula	R2	RSD
Memon	0.0362h – 0.0299a – 1.722	0.52	0.39
ECSC	0.0395h - 0.0250a - 2.600	-	0.38
Knudson	0.0665h - 0.0292a - 6.515	0.74	0.52
Crapo	0.0342h - 0.0255a - 1.578	0.79	0.32
Roca	0.0326h - 0.0253a - 1.286	0.67	0.32
FVC (L)			
Memon	0.0405h – 0.0346a – 1.982	0.62	0.41
ECSC (1)	0.0395h - 0.0250a - 2.600	-	0.38
Knudson	0.0444h - 0.0169a - 3.195	0.49	0.48
Crapo	0.0342h - 0.0255a - 1.578	0.67	0.32
Roca	0.0454h - 0.0211a - 2.825	0.56	0.40

h - height in cm; a - age in years; R2 - multiple regression coefficient; RSD - residual standard deviation

Table 4: Mean FEV_1 and FVC values as % predicted by different authors

	Females*		Males**	
	FEV_1 (%)	FVC (%)	FEV_1 (%)	FVC (%)
Memon	100	100	100	100
ECSC	113.7	118.6	110.9	112.1
Knudson	105.3	110.3	109.1	111.5
Crapo	108.5	109.2	103.6	104.1
Roca	107	103	100.2	97.8

*age 51.6 year, height 161 cm; ** age 52.2 year, height 174.9 cm

A study done by Ayub et al[15] in Pakistan indicate that the FVC and FEV_1 were lower in Pakistani population compared to European population but this study was conducted on a larger age group and in lower polluted area of Pakistan. Our study results also corroborate with it in older age group of 35-65 years.

The analysis revealed differences in estimates of the predicted values for spirometric indices in different populations. Modifications of spirometric equipment and technique that have occurred during the last decade could additionally factor in the differences between the presently measured and long ago established predicted values of pulmonary function. However using the current ATS quality criteria[10] for performing the forced expiratory maneuver we obtain a reliable outcomes and factual maximum values of FEV_1 and FVC.

In conclusion, the reference formulas for males and females of Pakistani population have been derived using healthy, non-smoking, urban adults. Predicted FEV_1 and FVC values derived from the equations based on ECSC[11], Knudson[12], Roca[13] and Crapo[14] reference population are higher than the values measured in the present study. These reference formulas derived in the present study may be helpful clinically to diagnose different respiratory disorders.

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