Spirometric reference values in healthy, non-Smoking, Iraqi population

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Abstract

Background: Pulmonary function test depends on a number of physiological factors as height, age, gender and race. Reference mathematical equations are used to determine a normal range of spirometric results which in turn are used clinically to determine whether the results measured in any individual fall within a range to be expected in a healthy person of the same gender, height and age.

Objectives: To derive the prediction equation for healthy, non smoking Iraqi subjects.

Methods: The study was conducted in Baghdad (IRAQ) on one hundred eighty two (182) healthy, nonsmoking subjects between 20 to 60 years of age were included in the study. The subjects included were 79 males and 103 females whose pulmonary volumes and capacities were measured by spirometry.

Results: The prediction equation was derived first and then the reference values were then calculated for forced expiratory volume in 1st second (FEV1) and force vital capacity (FVC). The values for both parameters were found to be lower by about 5.58% and 6.14% in females and 4.78% and 12.65% in males, respectively, when compared to researchers done on Caucasians.

Conclusion: Pulmonary function test reference values and prediction equations for both sexes between the ages of 20-60 years were derived for a sample of healthy, nonsmoking, Iraqi 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: FEV1, FVC, Spirometry, Iraqi subjects

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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 spirometric results.

The reference values so determined play an important role in establishing whether the values measured in an individual fall within a range to be expected in a healthy Person of the same gender, height and age[(2,3,4)].

The most recent American Thoracic Society [ATS] [(5)] 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

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functions beginning at approximately 35 years of age [7,8,9,10].

A number of studies have been conducted in Europe, united state, Asia, and Mediterranean population to establish reference values for pulmonary functions in healthy subjects. To the best of our knowledge, no study was conducted in this country involving young and elderly subjects.

The aim of the present study was, thus to determine the spirometric reference formulas for a sample of young and elderly subjects living in Baghdad, and to compare the measurement of pulmonary function in those subjects with other available standards such as ECSC [European Community for Coal and Steal][11] published in 1993, predicted values of lung indices unchanged (almost universally applied in Europe), white American population (Knudson et al) [12], Mediterranean population (Roca J et al)[13], and Caucasian populations (Crapo et al)[6] .

Methods

In a total of two hundred and two healthy non-smoking subjects who met the inclusion criteria were participated in the study. Yet only one hundred eighty - two [103 females and 79 males] with an age ranged between 20 and 60 years were completed the pulmonary function tests and included in the study. The age of the male subjects was 37.10 ±9.84 years, and the females 41.30±9.44 years. The rest of the subjects were not able to perform the pulmonary function tests correctly and thus were excluded.

The lung function testing was performed in the lung function unit-at AL-Kindy Teaching Hospital, Baghdad-IRAQ. The standing height and weight was measured for all the subjects. The tested subjects were non smokers with no history of symptoms of cardiovascular or respiratory diseases that required treatment. The forced expiratory maneuvers including forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1) were recorded using " Master lab body pro a universal lung function testing station- Version 4.5" in conjunction with 3 PC software. The spirometer was calibrated with a calibrating syringe. A minimum of three acceptable and reproducible maneuvers were obtained, according to the standards recommended by the American Thoracic Society [ATS].

Prediction Equation

Four sets of prediction equations were used in this study. Predicted values were derived from these equations described regression equations commonly used in Caucasian subjects. "The Crapo" equations were derived from 251 non smoking American subjects, aged 15-19 years and residing in Utah 1400 m above sea level, using a water seal spirometer (8). The Knudson equations were obtained from 746 American nonsmoking subjects, aged 8-90 years and residing in Arizona, using a Pneumotachygraph device (9). The European Community for Steel and Coal (ECSC) equations are summary equations derived for Caucasian subjects aged 5-70 years. Roca- equations were obtained from 870 adult subjects, aged 20-70 years and living in Barcelona area. Roca-equations provides reliable spirometric equations from a large Urban Mediterranean sample which were lacking so far in the literature. All four equations and this study predict FEV-1, and FVC based on gender, age, and height of a subject as primary variables. All equations, except the

Crapo and ECSC equations, are nonlinear with respect to age.

Statistical Analysis

The data was entered in computer package "Microsoft Excel" and analyzed using the statistical package for Social Science (SPSS) version-16 for window software. The data for age, height and pulmonary function parameters were expressed as mean ± Standard deviation. A graph of pulmonary function variables against the age were examined for each gender. Means and standard deviation of quantitative variables (age, and height) 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 and FVC were dependent variables, while height and age were independent variables. In all statistical analysis, only P-value <0.05 were considered significant.

Results

The age and gender distribution of the subjects are shown in figure 1.

Table 1 presents the indices examined, FEV-1, FVC separately for females and males. The mean values for FVC was 3.66 ± 0.49 liter and 2.52 ± 0.40 liter in males and females, respectively, while the values for FEV-1 was 3.56 ± 0.49 liter and 2.44 ± 0.42 liter in males and females, respectively. The prediction formulas for both males and females were derived and the reference values were calculated and compared with those given by ECSE (1993), Knudson (1983), Roca (1981), and Crapo (1986) as shown in table 2 and table 3.

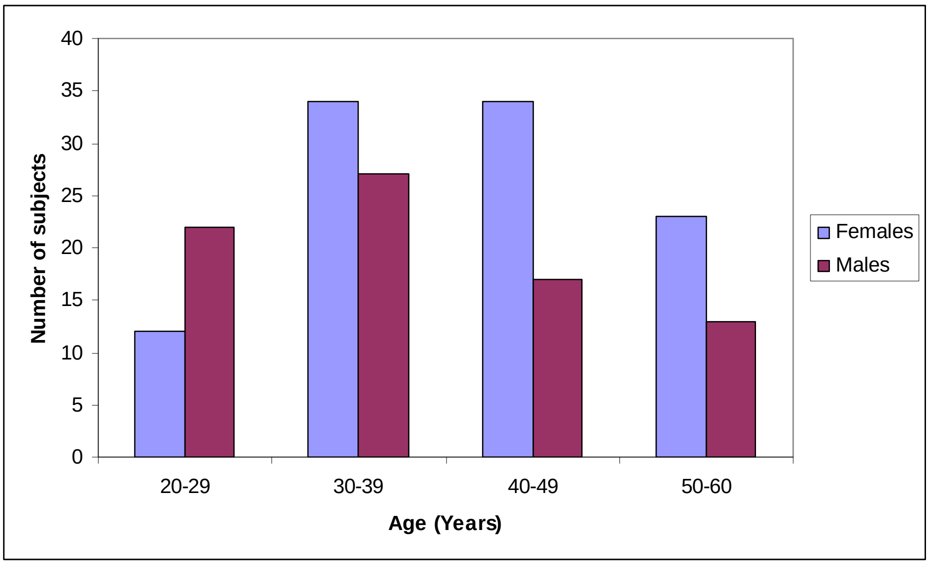

Figure 1: The age and gender distribution of the subjects.

Table 1: The lung function data in the studied subjects

	Females N =103		Males N =79	
	Mean ±SD (L)	Range (L)	Mean ±SD (L)	Range (L)
FVC	2.52 ± 0.40	1.67 – 3.14	3.66 ± 0.49	2.51 – 5.1
FEV1	2.44 ± 0.42	1.51-3.35	3.56 ± 0.49	2.51 – 5.04

FVC= Forced Vital Capacity
FEV1= Forced Expiratory Volume in the First Second

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

FEV1(L)	Formula	R2	RSD
This study	-0.2935 -0.0169*A+0.0261*H	0.657	0.38
ECSC (1993)	-2.490-0.0290*A+0.0430*H	----	0.51
Knudson (1983)	-6.515-0.0292*A+0.0665*H	0.74	0.52
Crapo (1981)	-2.190-0.0244*A+0.0414*H	0.64	0.49
Roca (1986)	-3.995-0.0216*A+0.0514*H	0.56	0.45
FVC (L)			
This study	-0.3566-0.0184*A+0.0273*H	0.679	0.37
ECSC (1993)	-4.344-0.026*A+0.0576*H	-----	0.61
Knudson (1983)	-8.782-0.0298*A+0.0844*H	0.72	0.64
Crapo (1981)	-4.650-0.0214*A+0.0600*H	0.53	0.64
Roca (1986)	-6.055-0.0147*A+0.0678*H	0.52	0.53

H = height in cm; A= age in years; R2 = multiple regression coefficient; RSD = residual standard deviation.
FVC= Forced Vital Capacity
FEV1= Forced Expiratory Volume in the First Second

Table 3: Comparison of FEV1 and FVC prediction equations used for females in different studies.

FEV1(L)	Formula	R2	RSD
This study	-0.3378-0.0223*A+0.0234*H	0.672	0.28
ECSC (1993)	-2.600-0.0250*A+0.0395*H	----	0.38
Kundson (1983)	-6.575-0.0292*A+0.0665*H	0.74	0.52
Crapo (1981)	-1.578-0.0255*A+0.0342*H	0.79	0.32
Roca (1986)	-1.286-0.0253*A+0.0326*H	0.67	0.32
FVC (L)			
This study	-0.3078-0.0194*A+0.0229*H	0.659	0.28
ECSC (1993)	-2.600-0.0250*A+0.0395*H	----	0.38
Knudson (1983)	-3.195-0.0169*A+0.044*H	0.49	0.48
Crapo (1981)	-1.578-0.0255*A+0.0342*H	0.67	0.32
Roca (1986)	-2.825-0.0211*A+0.0454*H	0.56	0.40

H= height in cm; A = age in years; R2 = multiple regression coefficient; RSD = residual standard deviation.
FVC= Forced Vital Capacity
FEV1= Forced Expiratory Volume in the First Second

Comparisons of the reference values for FEV-1, FVC from this study with those of Caucasian subjects are shown in table -4. Although we found that our values for both FEV-1 and FVC were lower than in all the studies with which they were compared, the greatest difference was observed with the values given by "Roca”. Our values for FEV-1 were less by about 11.78% in males and 13.56% in females while for FVC the values were 27.73% for males and 27.86% for females compared with the Mediterranean population “Roca”. On the other hand , the least difference in case of FVC was found in females i.e. 3.95% when our values were compared with those of European population “ECSE” and in case of males the values of FEV-1 were 6.68% less when compared with white American population “study of “ Knudson et al “. Further illustrations of the comparisons of predicted spirometric values obtained in this study and others are shown in figures (2, 3, 4, and 5).

Table 4: Mean FEV1 and FVC values and standard deviation in different studies

	FEMALES		MALES	
	FEV-1 "L"	FVC " L"	FEV-1 "L"	FVC "L"
This study	2.45 ±0.29	2.52±0.27	3.57±0.28	3.66±0.29
ECSA(1993)	2.62± 0.39	2.62±0.0.39	3.84±0.47	4.61±0.53
Knudson et al.(1983)	2.80±0.57	3.13±0.36	3.85±0.28	4.64±0.72
Crapo et al.(1981)	2.78±0.37	2.78±0.37	4.03±0.42	4.88±0.52
Roca et al.(1986)	2.83±0.36	3.49±0.39	4.05±0.46	5.07±0.53

FVC= Forced Vital Capacity
FEV1= Forced Expiratory Volume in the First Second

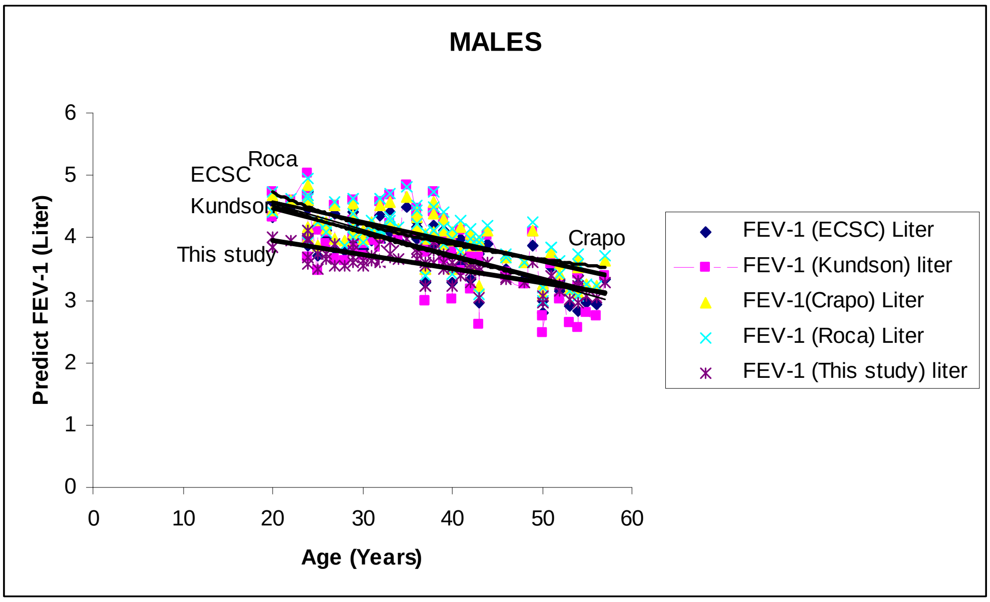

Figure 2: comparison of prediction equations of FEV-1 in males.

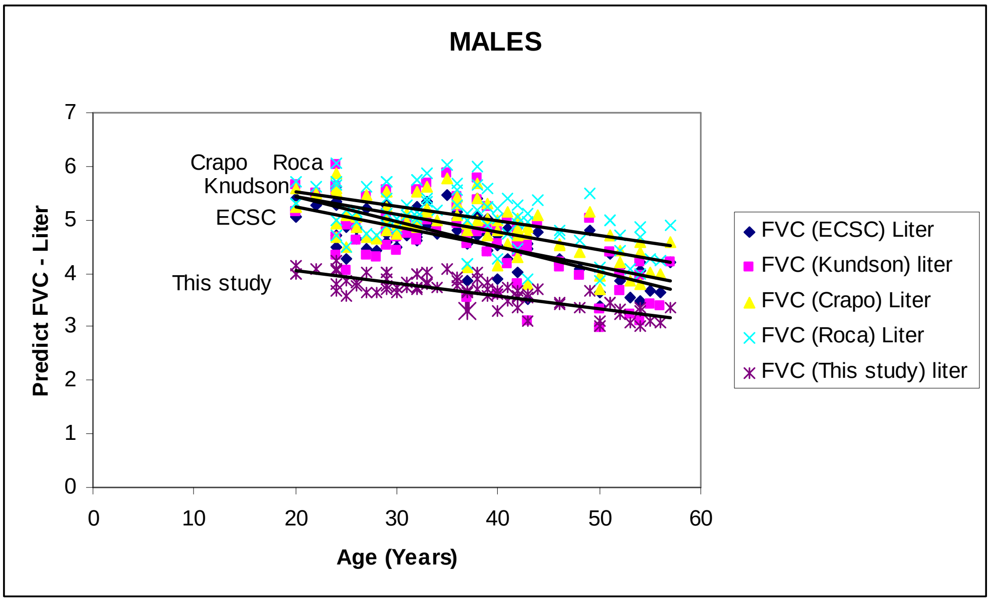

Figure3: Comparison of prediction equations of FVC in males.

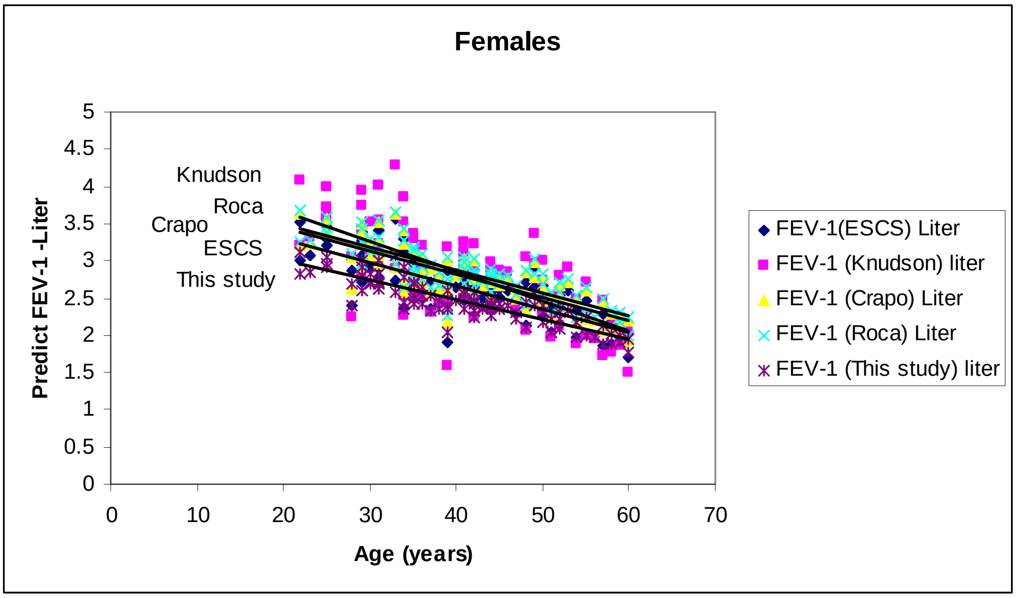

Figure 4: Comparison of prediction equations of FEV-1 in females.

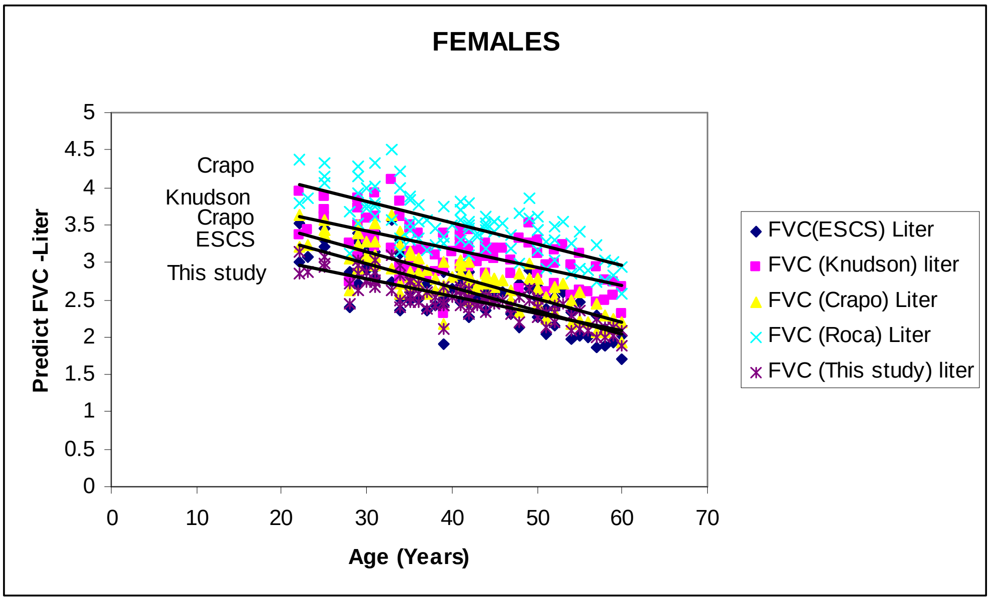

Figure5: Comparison of prediction equations of FVC in females.

Discussion

This is a study of reference values of lung function test in a random sample of healthy non smoker Iraqi subjects from Baghdad. All relevant data were obtained by trained technicians using standardized equipment & techniques that produce reproducible data. The predicted spirometric values derived from this study showed varying degrees of difference when compared with those derived from studies on Caucasians.

In the literature, the mean average difference between the Asian and Caucasian population is stated to be 16% for females and 12% for males [(6)]. In this study, we found that the mean difference for FEV-1 in females was 5.58% and for FVC was 6.14% ($p<0.01$) while the mean difference for FEV-1 in males was 4.78% and for FVC was 12.65% ($p<0.01$), respectively when samples were compared with that to the Caucasians. Similarly, a significant difference was found for FEV-1 7.19% and FVC 16.14% with ($P<0.01$) for females. The mean difference for FEV-1 was 6.61% and FVC 16.15% ($P<0.01$) for males when Iraqi subjects was compared with that to Mediterranean population [(13)].

The scatter of (R^2) was between 49% and 79% in tables 2 and 3 which mean that the strength of formulae varies in all the studies conducted. Taking that into consideration, it can be stated that non 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.

According to the presently accepted method of establishing 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.

Differences in the predicted values obtained in various studies may be attributed to the technical factors involved in lung function testing. For example different lung function devices have been used with the more recent studies have employed computerized systems that portend to high precision, but between instrument variability would still exist contribute to variations in measurement [14].

The posture has also been shown to result in slightly lower spirometric values in sitting than standing [15]. However, the postural effects are small and probably much less important in determining the measurements than the quality with which the tests were conducted [15].

Similar to many previous studies in which Asians, such as Chinese, Indians, Japanese and Malaysians, have smaller lung volumes than whites [16, 17, 18, 19], we found that the FEV-1 and FVC values in samples of Iraqi subjects were lower than those of whites for all age groups with the same age and height.

When assessing lung functions values, it is also important to take into account biologic variations [20, 21, 22, 23, 24]. The most important host factors responsible for inter-individual variations in adults were sex (±30%), body size (±20%), and age (±8%) [25,26,27,28]. The age range of subjects in our study was 20 -60 years, whereas ECSC prediction equations apply to men and women of European descended aged 18-70 years.

It has been suggested that ethnic group could be an important source of inter-individual variations in the studied populations: an estimated variability due to this factor is ± 10% [21, 25].

Limitations

The limitations of this study were the age-range of the subjects and lack of anthropometric measurements. Thus, these results are not applicable to men older than 64 year and women older than 66 years. Considering that ventilatory functions vary with anthropometric variables, the measurements of anthropometric variables of Iraqi population should be introduced into research such as sitting height, weight, hip/waist circumference and ratio, and body mass index.

<u>Conclusions</u>

In conclusion, the reference formulas for males and females in a sample of healthy, non-smoking, Iraqi subjects have been derived. Predicted FEV1 and FVC values derived from the equations based on ECSC, Knudson , Roca and Crapo reference population are higher than the values measured in the present study. For this reason, each laboratory should have its own reference value.

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