

Forced expiratory indices in normal Libyan men

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ABSTRACT Forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), forced expiratory ratio in the first second ($FEV_1\%$ VC), forced expiratory flow between 200 and 1200 ml ($FEF_{200-1200}$), and forced mid expiratory flow between 25% and 75% of FVC (FMF) were measured in 275 Libyan men ranging from 20 to 60 years. All values were lower with increasing age and, apart from $FEV_1\%$ VC, were positively correlated with standing height. This study can be used as a source of reference for Libyan men.

Introduction

Lung function tests have been performed in various populations and ethnic variations have been documented.¹⁻⁹ Europeans have higher values of forced expiratory indices than Indians and Africans.⁷⁻⁹ Indian adults have a lower forced expiratory volume in one second (FEV_1) than African adults.^{10,11} Normal values for a particular population must be derived from a sample of that population. The aim of the present study was to establish normal lung function values for healthy Libyan men as these are unknown.

Methods

SUBJECTS

We recruited 275 healthy Libyan adult men, 20-60 years of age, as a random sample of employees from five large companies in Benghazi on the Mediterranean coast. The men were mainly employed in light engineering and service industries where atmospheric pollution was low. With the help of the local physician, we excluded men with a history of respiratory or cardiovascular problems and those who were currently smoking. Almost a quarter of the population studied had smoked but had stopped 5-10 years previously.

MEASUREMENTS

Each subject carried out a forced expiration while standing (without nose clip) with an expired gas bellows spirometer (PFT II Plus S-Model,

Vitalograph Inc). The spirometer was calibrated with a one litre precision syringe (Vitalograph). Only recordings that satisfied the validity test of Segall and Butterworth,¹² which takes into account the maximal mid expiratory flow time, were considered, and the best of three attempts was selected. The best curve was that which produced the highest forced expiratory volume in one second (FEV_1), provided that the forced vital capacity (FVC) was within a small percentage of the subject's best FVC. The following measurements and calculations were obtained from the tracing: FEV_1 , FVC, forced expiratory ratio ($FEV_1\%$ VC), forced expiratory flow between 200 and 1200 ml of FVC ($FEF_{200-1200}$), and forced mid expiratory flow between 25% and 75% of FVC (FMF). Volumes were corrected to BTPS and the same equipment and observer were used for all subjects. The recordings were made between 8.00 am and 1.00 pm over six months.

Age was recorded to the nearest six months on the basis of birth certificates, body weight to 0.1 kg (measured with portable field survey scales—CMS Weighing Equipment Ltd), and standing height to 0.1 cm (measured with a portable stadiometer—Holtain Ltd), according to the recommendations of the International Biological Programme.¹³ The mean ambient temperature in the laboratory was 20° (SD 1°) C (air conditioning thermocontrol).

DATA ANALYSIS

Correlation coefficients were calculated for the various physical and lung function measurements. The data were analysed by multiple regression of the lung function measurements on the independent variables age, standing height, and body weight, and on age and height alone. Calculations were performed by means of the Statgraphics computer program.¹⁴

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Table 1 Anthropometric and spirometric values (mean (SEM)) in Libyan men

Variable	Age (y)			
	20-29 (n = 101)	30-39 (n = 87)	40-49 (n = 42)	50-59 (n = 45)
Height (cm)	172.8 (0.62)	172.8 (0.66)	170.8 (1.51)	167.8 (1.02)
Weight (kg)	68.1 (1.09)	69.7 (2.12)	71.5 (3.73)	76.5 (2.32)
FVC (l)	4.43 (0.07)	4.46 (0.08)	4.21 (0.10)	3.24 (0.10)
FEV ₁ (l)	3.79 (0.07)	3.59 (0.06)	3.27 (0.06)	2.63 (0.08)
FEF (l/s)	6.67 (0.23)	6.30 (0.22)	5.55 (0.29)	3.88 (0.25)
FMF (l/s)	3.98 (0.13)	3.30 (0.15)	2.91 (0.12)	1.70 (0.17)

FVC—forced vital capacity; FEV₁—one second forced expiratory volume; FEF—forced expiratory flow between 200 and 1200 ml; FMF—forced mid expiratory flow between 25% and 75% of FVC.

Results

The 275 non-smoking healthy Libyan men who took part in the study were of the same ethnic origin. There was little variation in socioeconomic conditions among the population studied.

Anthropometric and spirometric variables are shown in table 1. Multiple regression analysis showed that weight did not have a significant influence on any of the measurements after age and height had been allowed for. The analysis including age and height only is shown in table 2. All lung function values were negatively related to age ($p < 0.001$) and, apart from FEV₁% VC, increased with standing height ($p < 0.001$). Mean FEF and FMF at age 55 years were about half the values at age 25 years (table 2). The regression equations obtained in the present study are compared with those based on other populations in table 3.

None of the spirometric variables differed between never-smokers and ex-smokers.

Table 2 Coefficients in the multiple regression equation of lung function measurements on age and height in men (standard errors of the regression coefficients in parentheses)

Variable	Constant	Age	Height	Sy.x	R ²
FVC	-4.805 (1.190)	-0.026 (0.004)**	0.057 (0.007)**	0.678	0.363
FEV ₁	-2.690 (1.000)	-0.030 (0.003)**	0.042 (0.006)**	0.571	0.403
FEV ₁ %VC	110.301 (13.190)	-0.360 (0.043)**	-0.095 (0.074) NS	7.53	0.198
FEF	-8.440 (3.559)	-0.072 (0.012)**	0.099 (0.020)**	2.03	0.224
FMF	0.942 (2.285)	-0.067 (0.008)**	0.027 (0.013)*	1.30	0.261

* $p < 0.05$; ** $p < 0.001$; NS: $p > 0.05$.

Sy.x—average residual deviation about the regression line. For the abbreviations and units see table 1.

Discussion

The objective of the present study was to derive prediction formulae for measurement of ventilatory lung function in Libyan men. The present study confirms earlier findings^{14,5} that standing height and age are significant predictors of lung function. The regression line of FVC on height in these men (adjusted to age 30 years) follows the regression line for adult Pakistani subjects¹⁵ quite closely but is lower than that for American men.² FEV₁ and FMF in Libyan men were about 10% higher than the predicted values for adults from Pakistan¹⁵ of the same height and age. This may be due to ethnic differences. Predicted values of FVC, FEV₁ and FMF in Libyan men were about 18% lower than the predicted values for adult Jordanian subjects of the same height and age¹⁶ (table 3). The difference in FMF was particularly noticeable in the older age group (55 years). Respiratory adaptation to the higher altitude at which the Jordanians lived may explain these differences. Similar differences were present in our study of Libyan children.¹⁷

Patrick³ reported FVC value of 4.0 l for African men adjusted to 1.65 m and 35 years. This value is lower than the FVC value (4.4 l) in the present study. Cotes and others¹ derived a regression equation for FEV₁ by combining data from several studies, and this gave an age coefficient of 0.031 l/y and a height coefficient of 0.036 l/cm. These are close to the present values for Libyan men (0.030 l/y and 0.042 l/cm). Lowe *et al.*,¹⁸ who studied normal steel workers in South Wales, and Ashford *et al.*,¹⁹ who studied coalminers in the United Kingdom, have given values for the age coefficient for FEV₁ varying from 0.02 to 0.05 l/y, with the height coefficient varying from 0.01 to 0.05 l/cm.

The present results reflect the normal values derived

Table 3 Multiple regression equations of forced vital capacity (FVC) and one second forced expiratory volume (FEV₁) on height (H) in centimetres and age (A) in years, in Libyan men (present study) compared with those from other studies

Population	n	Regression equation	R ²	Sy.x
Libyan	275	FVC = 0.057H - 0.026A - 4.81 FEV ₁ = 0.042H - 0.030A - 2.69	0.36 0.40	0.67 0.57
British ¹	275	FVC = 0.051H - 0.032A - 3.02 FEV ₁ = 0.035H - 0.033A - 1.12	0.67 0.68	0.52 0.45
Pakistani ¹⁵	314	FVC = 0.046H - 0.019A - 3.19 FEV ₁ = 0.028H - 0.024A - 0.88	0.39 0.88	0.59 0.49
Jordanian ¹⁶	144	FVC = 0.059H - 0.024A - 4.17 FEV ₁ = 0.052H - 0.027A - 3.70	0.17 0.70	0.55 0.46
Egyptian ²⁰	209	FVC = 0.037H - 0.053A - 0.18 FEV ₁ = 0.024H - 0.050A - 1.25	0.57 0.56	0.66 0.61

Sy.x—average residual deviation about the regression line.

from pulmonary function tests on a group of Libyan men and can be used as a source of reference for this population.

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