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PULMONARY FUNCTION STUDIES IN GUJARATI SUBJECTS

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Abstract : In this study a miltiple regression equation for prediction of ventilatory pulmonary function tests (FVC, $FEV_{1\%}$, $FEF_{25-75\%}$ and PEFR) is developed in average healthy non-smoker male and female Gujarati subjects. The average adult female values showed a reduction varying from 21.0 to 29.0% compared to adult male subjects. There is a deviation of the present study values from other studies in Indian subjects and values from European studies are higher than the present values. This study demonstrated that the present regression equation is the most ideal and appropriate for prediction of pulmonary function values in Gujarati subjects either for assessing physical fitness in normal subjects or for determining the pattern of ventilatory impairment in respiratory disease patients. The pulmonary function values assessed by substituting the average age, height and weight of females in male regression equation revealed lower values in females ranging from 14.0 to 19.0% attributable only due to difference in sex.

Key words : pulmonary function

INTRODUCTION

Single breath pulmonary function tests of the Forced Expiratory Volume in one second (FEV_1) and Forced Vital Capacity (FVC) are commonly used parameters in assessing the pattern of ventilatory impairment in chest disease patients and in epidemiological studies in subjects exposed to toxic dust and fumes. A wide variation of these parameters in Indian subjects was observed (1, 2, 3, 4) which was attributed to regional variation in population and climate. It is also that data collected on highly selected groups like soldiers, policemen, highlanders, students, sportsmen and industrial workers may not be truely representative of average population (5).

Although the average pulmonary function values has been reported in Gujarati subjects (6, 7), no multiple regression equation has been developed for prediction of ventilatory function values. This has been attempted in the present study on healthy average non-smoker population of Ahmedabad city.

METHODS

The study subjects are 71 male and 25 female in the age group 15-40 yrs of Ahmedabad less polluted area residents. All these subjects were non-smokers and free from any respiratory signs and symptoms. Physical parameters such as age, height and weight were noted.

A thorough instructions and demonstration was given for recording pulmonary function tests in sitting posture. The parameters forced expiratory volume in one second (FEV_1) and its percentage of FVC ($FEV_{1\%}$) and forced expiratory flow between 25-75% ($FEF_{25-75\%}$ lit/sec) were all derived from FVC curve recorded by using single breath vitalograph spirometer. Peak expiratory flow rate (PEFR) was metered by using Wright's peak flow meter and expressed in liters per minute. All the values are corrected to BTPS level. These values are feeded in a computer for finding out the average values and for correlation coefficient between age, height, weight and FVC,

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FEV_1, $FEF_{25-75\%}$ and PEFR. Their significance was tested from zero by applying 't' test. Multiple regression equation analysis for all these functional parameters on age, height and weight, regression coefficient (R) and residual standard error (S.E.E.) (SD) were calculated and presented.

The present average values are compared with other Indian and European study values by substituting the present subjects average age, height and weight in their regression equations. The deviations from the present values are presented. A sex difference in pulmonary function was assessed by substituting the average age, height and weight in male regression equation and the percentage difference in female subjects.

RESULTS

Physical parameters and PFT values in male and female subjects is given in Table I. The average values in male subjects are age 21.4 yrs, height 169.8 cms, weight 58.6 kg, FVC 4.11 lit, FEV_1 3.65 lit, $FEV_{1\%}$ 88.5%,

TABLE I : Physical parameters and PFT values in Male and Female subjects. (Values Mean ± S.D.)

Parameter	*Male N = 71*	*Female N = 25*	*Difference (%)*
Age (yrs)	21.4±4.5	20.1±3.9	1.3 (-6.1)
Height (cms)	169.8±8.0	158.3±5.5	11.5 (-6.7)
Weight (kg)	58.6±7.8	49.1±7.8	9.5 (-16.2)
FVC (lit)	4.11±0.72	2.92±0.51	1.19 (-28.9)
FEV_1 (lit)	3.65±0.65	2.61±0.31	1.04 (-28.5)
FEV_1 (%VC)	88.5±5.2	91.4±5.5	2.9 (+3.3)
$FEF_{25-75\%}$ (lit/sec)	4.00±1.20	2.90±0.60	1.1 (-27.5)
PEFR (lit/min)	507.0±63.0	398.0±45.0	109 (-21.13)

- = Decreased value
+ = Increased value

$FEF_{25-75\%}$ (lit/sec) 4.00 and PEFR 507 (lit/min). These values in female subjects are age 20.1 yrs, height 158.3 cms, weight 49.1 kg, FEV 2.92 lit, FEV1 2.61 lit, $FEV_{1\%}$ 91.4, $FEV_{25-75\%}$ 2.90 lit/sec and PEFR 398 lit/min. In female subjects low values in physical findings are associated by a reduction in FVC and FEV_1 to the extent of 28.5%, $FEF_{25-75\%}$, 27.5%, PEFR 21.5% and an increase in $FEV_{1\%}$ by 3.3%.

Multiple regression equation for prediction of PFT values is given in Table II. The regression coefficients showed a negative relation between age and on FVC, FEV_1, $FEF_{25-75\%}$ and PEFR in male subjects whereas in female, it is seen only in $FEF_{25-75\%}$ and PEFR. The regression coefficients of height and weight showed positive association with all functional parameters in both the sex. In male subjects higher regression coefficients are observed for all parameters except in PEFR than female subjects.

TABLE II : Multiple regression equation for prediction of PFT values in Male and Female subjects.

Group and parameter	*Regression equation*	*S.E.E.*	*R*	*R^2*
MALE				
FVC (lit)	-0.036A+0.042H+0.03W-3.98	0.50	0.70**	0.53
FEV_1 (lit)	-0.045A+0.043H+0.014W-3.53	0.47	0.70**	0.49
$FEF_{25-75\%}$ (lit/sec)	-0.065A+0.043H+0.01W-2.42	1.10	0.40**	0.17
PEFR (lit/min)	-1.4A+3.26H+0.6W-51	57.0	0.46**	0.22
FEMALE				
FVC (lit)	0.024A+0.024H+0.03W-3.03	0.40	0.73**	0.53
FEV_1 (lit)	-0.025A+0.020H+0.02W-0.82	0.30	0.60*	0.35
$FEF_{25-75\%}$ (lit/sec)	-0.07A+0.04H+0.002W-2.0	0.60	0.46	0.21
PEFR (lit/min)	1.73A+0.95H+0.85W+172.0	46.0	0.34	0.11

A = Age (yrs) H = Height (cms) W = Weight (kg)
** = Significant at 5% level S.E.E. = Standard error
* = Significant at 1% level R = Regression coefficient

Table III shows the comparison of PFT values between present study and other Indian studies. The study conducted in average population of Delhi (2,8), showed minimum deviation (1.0%) in both male and female subjects for FVC whereas $FEF_{25-75\%}$ value showed lower values in their male subjects (–8.6%). In Southern (Tamil Nadu) average population study (3)

TABLE III : Comparison of PFT values with different regression equation of Indian male and female subjects.

Group and parameter	*Present*	*Different regression equations*			
		Jain's	*Kamat's*	*Rastogi's*	*Mohan Rao's*
MALE					
FVC (lit)	4.12	4.16 (+1.0)	3.80 (-8.0)	4.20 (+1.9)	4.03 (-2.2)
FEV_1 (lit)	3.65	—	3.14 (-14.0)	3.41 (-6.6)	3.51 (-3.8)
$FEV_{1\%}$	88.5	—	82.6 (-5.9)	81.2 (-7.3)	87.1 (-1.4)
$FEF_{25-75\%}$ (lit/sec)	4.05	3.70 (-8.6)	—	3.63 (-10.4)	—
PEFR (lit/min)	507.0	—	564.0 (+11.2)	435 (-14.2)	—
FEMALE					
FVC (lit)	2.84	2.80 (-1.0)	2.52 (-11.0)	—	—
FEV_1 (lit)	2.60	—	2.45 (-6.0)	—	—
$FEV_{1\%}$	91.4	—	97.2 (+5.8)	—	—
$FEF_{25-75\%}$ (lit/sec)	2.92	2.89 (-1.0)	—	—	—
PEFR (lit/min)	398.0	—	435.0 (+9.3)	—	—

$FEV_{1\%}$ is calculated from FEV_1 and FVC values.
Figures in parenthesis indicate percentage.
- = Decreased value, + = Increased value.

revealed low FVC (–8.0%), FEV_1 (–14%) and an increase in PEFR (+11.2%) values, but in female FVC is below 11.0% and FEV_1 below 6.0%. The calculated $FEV_{1\%}$ is decreased by 5.9% in male and an increase by 5.8% in female subjects. The study in Northern India male workers (4) only FVC showed higher values by 1.9% and all the other values are reduced. (FEV_1 6.6%, $FEF_{25-75\%}$ 10.4% and PEFR 14.2%). The calculated $FEV_{1\%}$ is about 7.3% lower than present values. In Gujarat State, male industrial workers (9) revealed a loss of 2.2% in FVC, 3.8% in FEV_1 and 1.4% in $FEV_{1\%}$.

A comparison of Indian subjects PFT values with European studies (10, 11, 12, 13, 14) are presented in Table IV. These results revealed an increase in values in European subjects varying from 14.1 to 20.4% in FVC, 6.3 to 12.6% in FEV_1, 9 to 15% in $FEF_{25-75\%}$ and 12.3 to 24.8% in PEFR. However, the calculated $FEV_{1\%}$ is reduced from 2.9 to 5.4% value.

In Table V, the sex difference in pulmonary function was seen by reduction of 14.6% VC, 14.7% FEV_1 18.8%, $FEF_{25-75\%}$ and 14.6% PEFR in female compared to males.

DISCUSSION

This study evidenced that the pulmonary physiological function values showed a reduction to the extent of varying 21.0 to 28.5 percent in adult female subjects than adult male. Higher values in $FEV_{1\%}$ in female is also observed which may be due to small lung volume leading to quick emptying from lung during forcible blow. A careful observations of other Indian studies presented in Table III reveals the difference between average adult male and female about 32.7% FVC and 21.9% in $FEF_{25-75\%}$ in Delhi subjects (2, 8) whereas in Tamil Nadu subjects (3) the differences in FVC 33.7%, FEV_1 21.9%, PEFR 22.8%. This suggests that PEFR difference is comparable with other Indian subjects, but FVC difference is low in the present subjects. This indicates that average healthy Gujarati women has better lung volume than their other Indian counterpart.

This is the first study in Gujarati subjects in which multiple regression is developed for prediction of FVC, FEV_1, $FEF_{25-75\%}$ and PEFR values in average population. A simple regression equation developed

separately using age alone or height alone was developed for calculating values using Medical College students and staff at Jamnagar, Gujarat State (7). The value of VC in these subjects is 17.5% less than present value. This may be due to difference in the instrument used, and the difference in choice of population. The regression equations developed in other Indian subjects are not useful to calculate predicted values for Gujaratis as they yield low values, for most of the parameters except FVÇ in some studies (Table III). A study in South Indian population (3) revealed significantly lower values than North Indians and this is also true in comparison to Gujaratis, as evidenced (Table III). The larger lungs observed in Western Indians in comparison to southern subjects may be due to genetic constitution difference as reported (15). In the present study $FEV_{1\%}$ is higher than other Indian subjects indicating better dynamic lung function attrributable to strong compliance of the thoracic lung system, airway resistance and muscular strength in these present subjects (2,16).

This study also suggested that average healthy population in Gujarat showed better pulmonary function values than industrial workers (Table III). This difference would be a significant finding when predictive values are computed for a large number of subjects. Therefore, the regression equation of industrial workers is not suitable for average population.

The present study confirms the observations made by other workers (17) that people from Indian sub-continent have significantly lower lung volumes than people of European descent. Lower VC values (30.0 to 35.0%) in Indian males than in comparbale western population were also reported (18) but the present study indicates decreased values in FVC (14.1 to 20.4%) FEV_1 (9.8 to 12.6%), $FEF_{25-75\%}$ (9.0 to 15.0%) and PEFR (12.3 to 24.8%). This may be due to difference in the population and the methods used. The smaller lung volumes in Indians have been attributed to climatic conditions and other factors like chest cage size as well as mechanical properties of the chest cage (19, 20). The low calculated $FEV_{1\%}$ in Europeans may be due to exposure to frequent inversions, industrial pollution and passive smoking.

Overall this study demonstrates that the present regression equation is the most ideal equation for prediction of ventilatory function values in Gujarati subjects.

In this study after adjusting the average age, height and weight of females in male regression equation, the residual differences is due to difference in sex. These values (Table V) are much lower than that of average adult male and female difference (Table I). The lower values in female subject might be due to a smaller thoracic build, frequent pregnancies and abortions etc.

TABLE V : Sex difference in pulmonary function value.

Parameter	*Male**	*Female*	*Difference (%)*
FVC (lit)	3.42	2.92	-0.50 (14.6)
FEV_1 (lit)	3.06	2.61	-0.45 (14.7)
$FEV_{1\%}$	89.5	91.4	+1.9 (1.9)
$FEF_{25-75\%}$ (lit/sec)	3.57	2.90	-0.67 (18.8)
PEFR (lit/min)	466	398	-68 (14.6)

*Values in males obtained by substituting the female age, height and weight in male regression equation.

This study demonstrates that the present regression equation is suitable for prediction of ventilatory function values in Gujarati subjects.

TABLE IV : Comparison of PFT values between present and European studies (Male).

Parameter	*Present*	*Cotes et al*	*Ferries et al*	*Kory et al*	*Knudson et al*	*Selby et al*	*Leiner et al*
FVC (lit)	4.11	4.95 (+20.4)	4.57 (+16.7)	4.69 (±14.1)	—	—	—
FEV_1 (lit)	3.65	4.11 (+12.6)	3.88 (+6.3)	(4.01 (+9.8)	—	—	—
$FEV_{1\%}$	88.5	83.1 (-5.4)	85.0 (-3.5)	85.6 (-2.9)	—	—	—
$FEF_{25-75\%}$ (lit/sec)	4.00	—	—	—	4.36 (+9.0)	4.60 (+15.0)	—
PEFR (lit/min)	5.07	—	—	—	—	+ 62 (12.3)	633 (+24.8)

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