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AN EPIDEMIOLOGICAL STUDY OF PULMONARY FUNCTION TESTS IN GERIATRIC POPULATION OF CENTRAL INDIA

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Abstract : We have studied Pulmonary Function Tests (PFTs) namely Vital Capacity (VC). Forced Vital Capacity (FVC), and Forced Expiratory Volume in First Second (FEV_1). Forced Expiratory Flow(FEF 25–50%) in 1200 elderly subjects above60 years of age of which 570 were females and 630 males. Mean age was 69.22 ± 5.57 years in males and 68.77 ± 5.44 in females. The mean value of ventilatory parameters were as follows-1) VC 2.99 ± 0.5 lt in males and 1.89 ± 0.29 lt in females. 2) FVC 2.69 ± 0.58 lt. in males and 1.76 ± 0.21 lt in females. 3) FEV_1/FVC% 83.82 ± 10.62% in males and 83.37 ± 11.93% in females. 4) FEF 25–75% was 2.81 ± 1.20 lt/sec in males and 2.13 ± 1.27 lt/sec.

Physical as well as ventilatory parameters were less in females than for males. The correlation of age with VC and FEV_1 was highly significant ($P<0.01$) but with FVC was not significant ($P>0.05$). The correlation of height, weight and body surface area was not significant with any ventilatory parameter ($P>0.05$).

Multiple regression equations for VC, FVC and FEV_1 were formulated for males and females taking height and age as variables. The predicted values correlated excellently with observed values.

Key words : pulmonary function tests elderly prediction equation

INTRODUCTION

Aging of population is a significant product of demographic transition. The elderly population in India in the current year is projected as high as 70 million (1).

The aging process is associated with progressive constriction of homeostatic reserve resulting in homeostenosis of every organ. This increases the vulnerability of myriad afflictions. Pulmonary diseases like COPD are second only to cardiac diseases in morbidity and mortality in elderly.

Pulmonary functions remain a major biologic variable that is affected by aging. Several epidemiological studies of pulmonary functions have been conducted

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in elderly men and women from population based samples (2–6).

The constantly increasing life expectancy of the general population require the physician to consider more closely the effect of aging upon the so called 'normal function' of different organs. Reference values for PFTs are rather complex. There are several potential sources of variability ranging from individual characteristics (gender, age, body size, race, level of ragular physical activity, circadian rhythms) to environmental (socioeconomic status, exposures to altitude, smoking history, posture, and technical aspects (7). In attempt to reduce the variability and improve accuracy the use of reference values from a geographically related population has been strongly recommended. Ideally such population should be a general random population.

To the best of our knowledge no such reference values have been set for PFTs in central Indian elderly population. Therefore the major purpose of this prospective study was to establish a comprehensive set of predictive equation for PFTs from a randomized sample of urban, elderly central Indian population. This study has evaluated the independent role of age alone on PFTs namely VC, FVC, FEV1 and FEF25–75% and to correlate these parameters with height, weight and body surface area in a population based sample of 1200 subjects above 60 years. The data can be used subsequently in evaluating the changes due to primary aging due to longevity, secondary aging due to disease and tertiary aging due to lifestyle (eigarette smoking, cotton mill workers, cooking fuels, atmospheric pollution etc).

METHODS

Subjects were selected randomly from general population in Nagpur city, Maharashtra Central India. Six hundred and thirty elderly males aged 69.22 ± 5.57 years, height 161.43 ± 5.31 cms. and weight 57.26 ± 8.47 Kgs were chosen. Five hundred and seventy elderly females aged 68.77 ± 5.44 years, height 146.67 ± 4.83 cms. and weight 56.06 ± 10.03 kgs were chosen.

Criteria for inclusion in the study were :–

1) Absence of any intensive athletic training.

2) Non smokers.

3) No history of family history of cardiopulmonary disease.

4) No evidence of cardiorespiratory dysfunction on physical examination, X-ray chest and ECG.

5) Absence of any symptoms of rhinitis common cold, dyspnoea or cough.

Detailed explanation of the purpose and methodology of tests was given to all subjects. All tests were done according to ATS standards. The tests were done between 10 am to 12 noon after whole night rest and light breakfast in the morning. Rest of one hour was allowed before performing the tests. The tests were done in the sitting position. Age, barefoot height and weight were recorded. Surface area was calculated from Du Bois formula (8).

Pulmonary function tests were recorded using Vitalograph S model spirometer (Buckingham M <181 SW, England) after volume calibration at 6 liters and temperature calibration at room temperature to give values at BTPS. Subjects were encouraged persistently for maximum efforts. Three readings were taken and best of three recorded for analysis. The best acceptable values were those without false start back-extrapolated volume is less than 10% of FVC or 100 ml whichever is greater. The best two of the three acceptable tracings did not differ by more than 5% or 100 ml whichever was greater (9).

Mean, standard deviation, standard error of mean and 95% confidence interval were calculated. Coefficients of correlation and significance by student's t test were analyzed by using a computer. Prediction equation were derived and estimated values were correlated with observed values.

RESULTS

One thousand and two hundred normal elderly subjects; 630 males and 570 females were studied.

The physical parameters and values of PFTs in males are shown in Table I and in females are shown in Table II.

TABLE I : Physical characteristics and lung functions tests in males (n=630).

Parameter	*Mean±S.D.*	*95% Confidence Interval*	*Correlation with (r Value)*			
			Age	*Height*	*Weight*	*BSA*
Age (Years)	69.22±5.57	67.78–70.66				
Height (cms)	161.43±5.31	160.05–62.81				
Weight (kg)	57.26±8.47	55.08–59.44				
BSA (sq.m)	1.60±0.12	1.56–1.64				
VC (lts)	2.99±0.5	2.87–3.11	0.36**	0.04	0.16	0.157
FVC (lts)	2.69±0.58	2.53–2.85	0.08	0.01	0.012	0.102
FEV1/FVC%	83.82±10.62	81.08–86.56	0.01	0.0	0.0	0.001
FEF25–75% (lts/sec)	2.81±1.20	2.51–3.11	0.07	0.006	0.10	0.010

**P<0.01

TABLE II : Physical Characteristics and Lung Functions Tests in Females (n=570).

Parameter	*Mean±S.D.*	*95% Confidence Interval*	*Correlation with (r value)*			
			Age	*Height*	*Weight*	*BSA*
Age (Years)	68.77±5.44	67.37–70.17				
Height (cms)	146.67±4.83	145.43–147.91				
Weight (kg)	56.06±10.03	53.48–58.64				
BSA (sq.m)	1.48±0.13	1.44–1.52				
VC (lts)	1.89±0.29	1.81–1.97	0.44**	0.14	0.19	0.15
FVC (lts)	1.76±0.21	1.70–1.82	0.19	0.14	0.94	0.22
FEV1/FVC%	83.37±11.93	80.29–8.645	0.11	0.05	0.08	0.09
FEF25–75% (lts/sec)	2.13±1.27	1.81–2.45	0.18	0.07	0.12	0.14

**P<0.01

The subjects were divided into 4 groups according to age as follows :–

Group A– 60–64 years i.e.155 males and 148 females

Group B– 65–69 years i.e.158 males and 136 females

Group C– 70–74 years i.e.160 males and 147 females

Group D– 75 years and above. i.e.157 males and 139 females.

There was a continuous decline in VC in both males and females which was highly significant ($p<0.01$) in Group C and D. The mean values in these groups were outside the lower limit of 95% confidence interval. (Table III). The correlation of VC with age was highly significant ($P<0.01$) both in males as well as females whereas the correlation with height, weight and body surface area was not significant ($P>0.05$).

A continuous diminution in FVC values was observed when subjects were separated in age groups by half decade (Table IV). The mean FVC in Group D was outside the lower limit of 95% confidence interval; both in males as well as females thus the decline in this age group was statistically significant ($P<0.05$). The correlation of FVC with physical parameters was not significant in males and females.

The already decrease in FEV1 was statistically highly significant in group C and D in males and group D in females ($P<0.01$) (Table V). The correlation of FEV1 with all physical parameters was not statistically significant. The mean FEV1/FVC % in all four groups in males as well as females showed a continuous decline which was however not statistically significant (Table VI).

TABLE III : VC in males and females divided in half decade age groups.

Gr.	Age in year	Males			Females		
		Mean±S.D.	*S.E. of mean*	*95% confidence interval*	*Mean±S.D.*	*S.E. of mean*	*95% confidence interval*
A	60–64	3.47±0.47	0.12	3.23–3.71	2.15±0.26	0.07	0.02–2.28
B	65–69	3.08±0.42	0.11	2.86–3.30	1.94±0.33	0.09	1.77–2.11
C	70–74	2.73±0.33*	0.08	2.57–2.89	1.79±0.18*	0.05	1.69–1.88
D	75 & above	2.70±0.03*	0.08	2.54–2.86	1.69±0.11*	0.03	1.63–1.75

TABLE IV : FVC in males and females divided in half decade age groups.

Gr.	Age in year	Males			Females		
		Mean±S.D.	*S.E. of mean*	*95% confidence interval*	*Mean±S.D.*	*S.E. of mean*	*95% confidence interval*
A	60–64	3.04±0.53	0.14	2.76–3.32	1.88±0.22	0.06	1.76–2.00
B	65–69	2.69±0.54	0.14	2.41–2.97	1.77±0.21	0.05	1.67–1.87
C	70–74	2.54±0.51	0.13	2.28–2.80	1.76±0.11	0.03	1.70–1.82
D	75 & above	2.48±0.59*	0.15	2.18–2.78	1.63±0.13*	0.03	1.57–1.69

*$P<0.05$

TABLE V: FEV1 in males and females divided in half decade age groups.

Gr.	Age in year	Males			Females		
		Mean±S.D.	*S.E. of mean*	*95% confidence interval*	*Mean±S.D.*	*S.E. of mean*	*95% confidence interval*
A	60–64	2.54±0.03	0.08	2.38–2.70	1.65±0.23	0.06	1.53–1.77
B	65–69	2.22±0.32	0.08	2.06–2.38	1.51±0.24	0.06	1.39–1.63
C	70–74	2.08±0.29*	0.08	1.92–2.24	1.43±0.24	0.06	1.31–1.55
D	75 & above	2.01±0.32*	0.08	1.92–2.17	1.28±0.16*	0.04	1.20–1.36

*P<0.05

TABLE VI: FEV_1/FVC% in males and females divided in half decade age groups.

Gr.	Age in year	Males			Females		
		Mean±S.D.	*S.E. of mean*	*95% confidence interval*	*Mean±S.D.*	*S.E. of mean*	*95% confidence interval*
A	60–64	84.75±8.12	2.10	80.55–88.95	88.26±12.17	3.14	81.98–94.55
B	65–69	83.94±9.88	2.55	78.84–89.04	85.64±11.16	2.88	79.88–91.40
C	70–74	83.58±2.80	2.80	77.98–89.18	81.23±13.12	3.39	74.45–88.01
D	75 & above	83.03±3.35	3.35	76.33–89.73	78.33±8.62*	2.23	73.87–82.78

*P<0.05

The decline in FEF 25–75% was statistically significant only in females of group D (P<0.05) (Table VII). The correlation of FEF25–75% with physical parameters was not statistically significant.

The prediction equations for VC, FVC and FEV1 in all the subjects were derived and the correlation between the observd and estimated values were statistically highly significant (Table VIII).

TABLE VII: FEF 25–75% in litres/second in males and females divided in half decade age groups.

Gr.	Age in year	Males			Females		
		Mean±S.D.	*S.E. of mean*	*95% confidence interval*	*Mean±S.D.*	*S.E. of mean*	*95% confidence interval*
A	60–64	3.35±1.03	0.27	2.81–3.89	2.82±1.41	0.36	2.10–3.54
B	65–69	2.82±1.21	0.31	2.20–3.44	2.43±1.52	0.39	1.65–3.21
C	70–74	2.58±1.05	0.27	2.04–3.12	1.82±0.83	0.21	1.40–2.24
D	75 & above	2.51±1.30	0.34	1.83–3.19	1.43±0.68*	0.17	1.09–1.77

*P<0.05

TABLE VIII : Prediction equations for VC, FVC and FEV1 in all subjects.

Parameter	*Sex*	*Prediction equation*	*r Value*
VC (L)	M	3.7565–0.0276A+0.0071H	0.595**
	F	0.980528–0.01491A+0.013203H	0.63**
FVC (L)	M	2.8514–0.0153A+0.0056H	0.268*
	F	0.819091–0.00689A+0.009661H	0.47**
FEV1 (L)	M	3.0039–0.0167A+0.0022H	0.472**
	F	0.437672–0.01149A+0.01242H	0.57**

r value = coefficient of correlation between observed and estimated values
A = Age in years
H = Height in cms
* = significant $P<0.05$
** = Highly significant $P<0.01$

DISCUSSION

In this study age was the strongest negative correlate with pulmonary functions. The aging process is associated with a reduction in the total diaphragmatic and respiratory accessory muscle mass as well as with decline in the work output for the same level of neural stimulation (10).

Elastic recoil of the lung tissue is reduced in elderly. Residual volume increases but total lung capacity does not increase significantly as diminution in the elastic recoil is offset by a reduction in the strength of respiratory muscles and in the compliance of the thoracic cage (11). The physiological adaptations may contribute to age associated decline in pulmonary function values.

The data may have both clinical and public health significance due to factors such as demographic changes, selective survival and potential changes in the strength of associations between risk factors and pulmonary functions in older population (12). To estimate the expected annual changes in pulmonary functions clinicians and epidemiologists often utilize the age regression coefficients derived from cross sectional analysis of normal population (13).

Prediction equations are descriptive of a specific reference population and may not be predictive of the changes in pulmonary function with age in future. There is evidence to show that poor lung function is highly predictive of mortality, so that persons with low FVC and FEV1 will tend not to survive to the older ages. A survival effect is important in cross sectional data and the figures must not be read as representative of longitudinal changes within individuals (14).

Thus pulmonary function test values and prediction equations obtained in our study can be used as reference by

a) Clinicians, to assist in defining a differential diagnosis, to estimate prognosis, to follow the course of disease, to estimate the risk of surgical procedures, to detect the reactions to drugs and to assess impairment or disability in occupational settings.

b) Clinical researcher, to exclude or include subjects with specific dysfunction or degrees of impairment

c) An epidemiologist, to identity the prevalence of adverse responses to environmental exposure or specific causes such as nutrition or aging and to develop predictors of mortality or disease.

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