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LUNG FUNCTION DEVELOPMENT IN INDIAN MEN AND WOMEN DURING LATE ADOLESCENCE AND EARLY ADULTHOOD – A LONGITUDINAL STUDY

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Abstract : Lung function development was studied in a cohort of Indian men (n = 31) and women (n = 36), over a period of four years during late adolescence and early adulthood. Forced expiratory spirograms and peak expiratory flow rates were recorded at intervals of approximately two years. All volumes and flow rates were higher in men, but volume adjusted flow rates were higher in women. Forced vital capacity (FVC) forced expiratory volume in one second (FEV_1) and peak expiratory flow (PEF) were significantly higher in men even after standardizing for age, height and weight. Height and PEF increased significantly in men and women over the four years. Volumes showed a greater increase whereas flow rates and volume adjusted flow rates showed a greater decrerase in men. The decline in the forced expiratory flow in the middle half of the FVC (FEF 25-75%) was significantly less in women. These results suggest that although lung size is greater in men, small airway dynamics may be better in young women.

Key words : lung function pulmonary function

INTRODUCTION

Since 1846, when Hutchinson (1) measured vital capacity and described its relationship to age, body height and weight, there have been numerous studies of pulmonary function in normal adults and children of different ethnic groups. However, knowledge of lung function and its growth in late adolescence and young adulthood is relatively incomplete (2). This is especially true for Indian subjects. This is a period when lung and body growth may still continue to occur (3) and therefore lung function indices may be expected to show changes. Longitudinal studies are preferable to cross sectional studies in providing information about true growth effects (4). A prospective study of this type would also provide base-line data for determining the early effects of cigarette smoking and of industrial pollutants, to which an individual of this age group is first beginning to be exposed. The aim of this investigation was therefore to follow the normal pattern of lung function development in a cohort of Indian and women over a period of 4 years, during late adolescence and early adulthood.

METHODS

Men and women students of two consecutive batches of the Christian Medical College, formed the subjects. They were residents of the college campus throughout their medical studies and formed a relatively homogenous population of the required age group. Three serial tests were done on each subject at intervals of approximately two years. No subject was tested at a time when he or she had an upper respiratory infection. All tests were done at the same time of the day to avoid possible diurnal variations. At each test, information regarding smoking habits, episodes of respiratory infections and allergic manifestations and a history of chronic cardiovascular or pulmonary disease, if

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any, were obtained. Broder's criteria (5) were used for identifying respiratory allergy. Only data from students who were life time nonsmokers, and who had no respiratory allergies or any other chronic cardiovascular or pulmonary illness were taken for the study. Thirty one men and thirty six women satisfied the above criteria.

Forced expiratory spirograms (FES) were obtained using the Collins' Respirometer and peak expiratory flow (PEF) using the Wright Peak flow meter. The forced vital capacity (FVC), forced expiratory volume (FEV_1), FEV_1 expressed as a percentage of FVC (FEV_1%), forced expiratory flow at 25 to 75% of FVC (FEF 25-75%) and FEF 25-75% expressed as a ratio of FVC (FEF/FVC) were obtained from the FES. Height and weight of each subject were recorded.

Data obtained were computerised, and the following statistical measures (6) used. Group comparisons were made using the student t test. Using multiple regression techniques, each pulmonary function variable at the Ist study was regressed against height, weight and age. Paired t tests were used for assessing longitudinal changes between tests. Relationships between height and weight changes on the one hand and pulmonary function changes on the other, were also evaluated.

Multiple regression analysis was used to explain the values of the pulmonary function parameters with the help of interrelated variables such as age, height and weight. It was also used to determine the effect of a single variable on a parameter, after adjusting for the influence of other variables. Multiple correlation coefficient (R) was used to measure the intensity of relationship between the parameter and the other interrelated variables. R square gave the fraction of the parameter explained by the variables.

RESULTS

Table I gives the age, height, weight and pulmonary function at the start of the study. There were no significant differences between the ages of men and women. As expected, height and weight were significantly greater in men. All volumes and flow rates were higher in men, but the volume adjusted flow rates were higher in women. Correlation and regression analysis showed that in this limited age range, age had no significant relationship to the pulmonary function parameters. However, multiple correlations of age, height and weight were significant on FVC, FEV_1% and FEF/FVC in men and on FVC, FEV_1 and FEF 25-75% in women (Table II). Differences in FVC, FEV_1 and PEF between men and women were significant even after adjusting for age, height and weight.

Figures 1 to 8 show the changes in height, weight and pulmonary function over the four years. Height and PEF increased significantly in men and women. There was also a significant decrease in FEF/FVC in men. There were qualitative and

TABLE I : Physical characteristics and pulmonary function at the start of the study.

	Men n=31		*Women n=36*		*Men vs Women*	
	Mean	*SD*	*Mean*	*SD*	*t*	*P*
Age, years	19.0	1.63	18.4	0.87	1.89	NS
Height, cms	171.4	4.31	157.5	5.59	11.10	< .001
Weight, kgs	59.2	7.58	49.1	8.06	5.18	< .001
FVC, 1	3.88	0.49	2.69	0.41	10.63	< .001
FEV_1, 1	3.31	0.43	2.37	0.33	10.00	< .001
FEV_1%	85.7	7.21	88.5	5.60	1.76	NS
FEF 25-75%, 1 p sec	3.86	0.97	2.86	0.56	5.18	< .001
PEF, 1 p min	520.9	57.99	375.7	37.26	12.17	< .001
FEF/FVC	1.01	0.27	1.08	0.23	1.13	NS

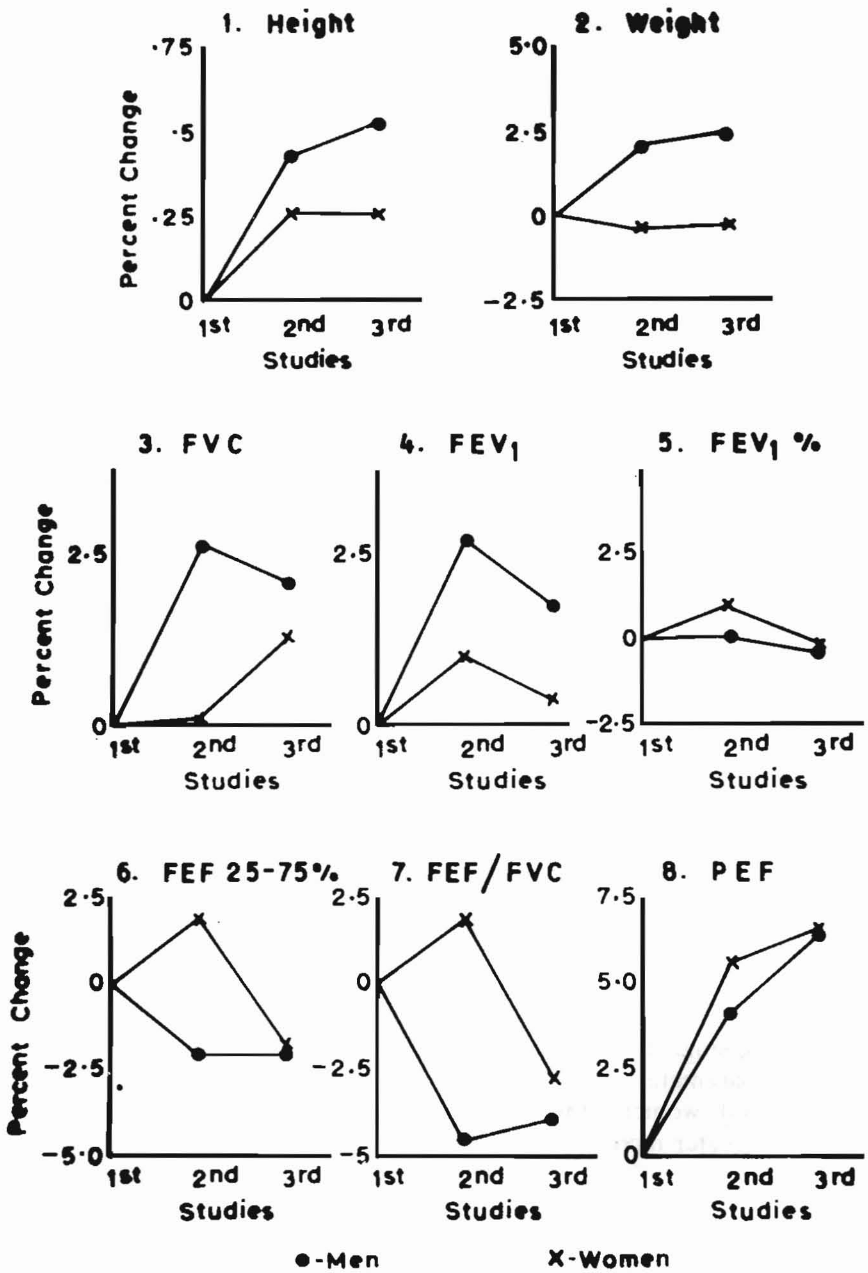

Fig. 1-8 : Height, weight and pulmonary function changes in four years. The three studies were done at intervals of approximately two years.

●—● Men; x—x Women

TABLE II : Relationship of height, weight and age on pulmonary function parameters in the first study.

	Simple correlation coefficient				*R Square of age, height and weight*	
	Height		*Weight*			
	Men	*Women*	*Men*	*Women*	*Men*	*Women*
FVC	0.468**	0.521**	0.421*	0.4267**	0.253*	0.410***
FEV_1	0.317	0.592***	0.128	0.365*	0.147	0.427***
FEV_1%	− 0.275	0.074	− 0.461**	0.202	0.292*	0.083
FEF 25-75%	0.024	0.451**	0.178	0.103	0.203	0.244*
PEF	0.291	0.362*	0.114	0.165	0.172	0.136
FEF/FVC	− 0.241	0.036	−0.384*	− 0.202	0.255*	0.053

*P < .05; **P < 0.01; ***P < .001
R Square = Fraction of the parameter explained by the variables.

TABLE III : Relationship of height and weight changes to pulmonary function changes during the four years.

	Men			*Women*		
	Ht change β	*Wt change* β	*R square Ht + Wt change*	*Ht change* β	*Wt change* β	*R square Ht + Wt change*
FVC	.171	.040	.037	− .132	− .243	.082
FEV_1	.062	.167	.041	.067	− .238	.058
FEV_1%	− .020	− .018	.001	.135	− .021	.018
FEF 25-75%	.027	.112	.016	.377*	− .167	.158
PEF	− .062	.011	.003	− .145	.071	.024
FEF/FVC	− .010	.097	.009	.490**	− .082	.239*

*P < .05, **P < .01
β = Standardized partial regression coefficients.
R square = Fraction of the parameter explained by the variables.

quantitative differences in the pattern of changes in men and women. The change from growth to decline in the different parameters occurred at different ages for men and women. Moreover, FVC and FEV_1 showed a greater increase whereas FEV_1%, FEF 25-75% and FEF/FVC showed a greater decrease in men. Table III shows the relationship between height and weight changes and pulmonary function changes during the four years. Height change had a significant positive effect on FEF 25-75% and FEF/FVC changes in women. After adjusting for height and weight changes, the decline in FEF 25-75% in women was significantly less than in men.

DISCUSSION

This paper describes the changes in spirometric indices in a cohort of normal men and women over a four year period in late adolescence and young adulthood. The population studied is admittedly small, but this was necessitated by our primary aim, viz., to follow the changes in a group which was as homogenous as possible, with no history of smoking or respiratory allergy. This requirement restricted the size of the group. The students had a limited age range, and being residents of the college campus, were exposed to the same environmental factors during the whole study period.

The results of the study show that in this age group, over a period of 4 years, there were significant changes in height and some lung function parameters indicative of continuing body and lung growth. PEF which is a reflection of the status of the large airways and body and chest development (7), continues to increase in both men and women. FVC and FEV_1 increase during the first two years and then begin to decline, while FEF 25-75% and FEF/FVC show a decline over the four years. These results corroborate findings from cross sectional studies (3) and longitudinal studies done in Caucasian populations (8, 9). The normal age related trends reported in these parameters indicate that FVC and FEV_1 reach a maximum in the early twenties and then begin to decline whereas FEF 25-75% begins to decline earlier. Male-female differences exist in the age at which the volumes and flow rates begin to decline. The pattern of normal lung growth is believed to be nonisotropic (10) i.e. the alveolar spaces show a relatively greater rate of growth as compared to the small airways. Alveolar multiplication and growth probably continue as long as somatic growth continues, and since the number of conducting airways does not change after birth (10), this means that the number of alveoli per unit small airway increases as long as somatic growth continues. This implies that exposure to atmospheric pollutants during this age could cause changes not only an airway growth and dynamics but also on alveolar growth. The finding that PEF and FVC increase in late adolescence and early adulthood is important since if this is not recognized, progressive lung function deterioration caused by disease or environmental pollution may be overlooked, if only these parameters are used for testing, in this age group. This is especially important when 17 to 20 year olds are beginning to take up employment. If the occupation exposes them to inhalant pollutants, the early damaging effects of these on the lung could be masked.

This study also shows quantitative differences in the pattern of lung function development in men and women. Volumes are higher and show a greater increase while volume adjusted flow rates are lower and show a greater decline in men. These findings are in support of some recently published data (11). The reasons for these differences between young men and women are not known. However it seems to suggest that small airway dynamics may be better in young women. It has been reported that among young smokers, abnormalities in pulmonary function (12) and the risk of development of chronic bronchitis (13) are greater among men than among women. Moreover, allergic airway diseases like asthma are much more common among boys and young men than among their female counterparts (14,15). It is an interesting speculation that the better airway dynamics in women may be a contributory factor to these sex differences.

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