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ASSESSMENT OF PULMONARY FUNCTIONS IN YOUNG ADULTS - THREE CROSS-SECTIONAL STUDIES

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Abstract : This study reports the results of 3 cross-sectional surveys and demonstrates a birth cohort effect for pulmonary functions in students admitted to our Institute in 1974, 1986 and 1991. Improvement in height, weight and haemoglobin of students was accompanied with improvement in ventilatory (FVC, FEV_1/FVC%,$FEF_{25-75\%}$) as well as diffusion functions ($TLCO_{SB}$, Dm, VC), specially in Group 2 and 3. Study of some vital statistics of state of Haryana from 1974 to 1992 significantly visualizes this period as period of green revolution and industrialization of the state. These quantitative indices are responsible for improvement of physical parameters and pulmonary functions of younger subjects. It is concluded that in view of the expected improvement in socio-economical status of developing countries and health of their individuals, physical and functional norms reported by different laboratories must be periodically reviewed.

Key words : pulmonary functions cross-sectional surveys ventilatory and diffusion studies

INTRODUCTION

Correlation of different pulmonary functions with height and age of subjects is well documented in literature. Haryanvi subjects are taller and their pulmonary function norms are better than those reported from other Indian states and are well comparable to western subjects (1). Correlation of pulmonary parameters with arm span and upper body segment has also been reported from this laboratory (1). Malik et al (2) had reported higher PEFR in good socio-economic status teachers than their earlier observations in general population (3).

Some observations on published reports on pulmonary function tests from this laboratory in subjects of Haryana from 1978-1995 revealed that basal pulmonary functions of the subjects had improved with passage of time (4–7). In order to confirm these observations, the present study was undertaken to analyse the data in the form of 3 cross-sectional studies of physical and pulmonary functions recorded in students admitted to our Institute during 1974, 1986 and 1991 sessions. Further we probed to find out the status of development of Haryana during this period so that the two observations could be correlated.

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METHODS

Three hundred and ten healthy male medical students, 17-20 years of age, admitted to MBBS course from all categories (open as well as reserved categories), were studied. It was ensured that all groups had subjects of similar socio-economic distribution. The sample so chosen for study could be considered to be a reasonable representation of the male population from all walks of life in Haryana. All the subjects were non-smokers and had no past or present history of cardio-respiratory or allergic illness that could modify their pulmonary functions. The ventilatory pulmonary functions were studied in three groups (Group I: 1974, Group 2: 1986 and Group 3: 1991), while diffusion studies were undertaken only in Group 2 and 3. The following anthropomorphic and pulmonary functions were recorded for analysis and comparison in different groups.

1. Anthropomorphic parameters

Age was calculated in years to the nearest birthday.

Height was measured in meters without shoes while standing erect.

Weight was recorded in Kilograms

2. Pulmonary Functions Tests

These included measurement of Forced vital capacity (FVC), Forced expiratory volume in first second as percentage of FVC (FEV_1%), Peak expiratory flow rate (PEFR) and Maximum voluntary ventilation (MVV) directly using low resistance water seal spirometer. Functional residual capacity (FRC) was measured using helium dilution method. The tests were performed while the subject was sitting on a stool with nose closed by a nasal clip. At least three satisfactory ventilatory records were taken at an interval of 5 min and the best of these tests was selected for further calculations.

3. Diffusion Function Tests

Using Morgan transfer test model C and computer Magna 88 (P.K. Morgan, Kent, UK), Transfer factor for CO (TLCO) was measured in duplicate by using single breath technique ($TLCO_{SB}$) (8). Measured TLCO was corrected to a standard haemoglobin concentration of 14.6 gm%. For high oxygen tension studies, subject breathed pure O_2 for 5 min, before $TLCO_{SB}$ test with an inspiratory gas mixture containing a high O_2 concentration (85%), was performed. Diffusion capacity of alveolar membrane (Dm) and effective alveolar capillary blood volume (VC) were computed from the graphic records (8).

From the Haryana Government data, various parameters of Health, Income, Development, Education etc. were noted for the year 1967-68, 1974-75, 1986-87 and 1991-92 (9). The percentage improvement in these facilities were calculated over the study period to look for the effect of 'Industrialization' and 'Green Revolution' on the development of the State.

RESULTS

Three hundred and ten healthy non-smoker male subjects in three groups, matched closely for age (±1 year), height (±2 cms), socio-economic status and physical activity, completed this study. Anthropomorphic data and results of

TABLE I : Assessment of anthropomorphic parameters and pulmonary functions over 17 yrs in young adult males.

	Group 1 (1974)	*Group 2 (1986)*	*Group 3 (1991)*	*Statistical analysis (Student 't' test)*		
				1 vs 2	*1 vs 3*	*2 vs 3*
Ventilatory function studies						
n	110	100	100			
Age, range, years	17–21	17 - 21	17 - 21			
Age, years	18.83 ± 1.18	18.80 ± 1.59	19.04 ± 1.48	NS	NS	NS
Height, m	1.69 ± 0.08	1.69 ± 0.14	1.72 ± 0.06	NS	<0.001	<0.05
Weight, kg	53.45 ± 4.55	54.05 ± 5.49	56.07 ± 6.72	NS	<0.001	<0.05
Hb, gm%	13.02 ± 0.40	13.12 ± 0.62	14.04 ± 0.76	NS	<0.001	<0.001
FVC,l	3.82 ± 0.47	3.95 ± 0.51	4.08 ± 0.58	NS	<0.001	<0.05
FEV_1/FVC, %	81.30 ± 13.50	85.06 ± 6.60	86.72 ± 6.50	NS	<0.001	<0.05
$FEF_{25-75\%}$,l/s	4.58 ± 0.61	4.58 ± 1.04	4.92 ± 1.08	NS	<0.01	<0.05
PEFR,l/min	501.40 ± 46.0	496.40 ± 35.74	510.36 ± 43.12	NS	NS	NS
MVV,l/min	135.60 ± 20.80	130.22 ± 16.67	143.97 ± 28.71	NS	NS	NS
Diffusion functions						
n	–	51	62			
FRC,l	–	2.62 ± 0.5	2.60 ± 0.50	–	–	NS
$TLCO_{SB}$,ml/min/mmHg	–	32.91 ± 4.81	33.94 ± 4.00	–	–	NS
V_A,l	–	5.32 ± 0.65	5.57 ± 0.98	–	–	NS
K_{CO}, TL/V_A	–	6.09 ± 0.80	6.21 ± 1.20	–	–	NS
Dm,ml/min/mmHg	–	60.40 ± 7.98	61.44 ± 3.40	–	–	NS
VC,ml	–	74.68 ± 11.02	77.20 ± 9.50	–	–	NS

Values are Mean ± SD NS - Statistically not significant

pulmonary function tests of the subjects in 3 groups are given in Table I. Diffusion functions were studied in 113 subjects (51 in Group 2 and 62 in Group 3, Table I).

Division of composite Punjab into Haryana and present Punjab states took place in 1966. Details of some of the data in Table II provides some quantitative indices of Haryana state from 1967 to 1992. As shown in the table, there has been substantial increase in the per capita income, total food-grain production and irrigation facilities, metalled roads as well as industrial facilities. There was improvement in medical care and educational status as well. Haryana has been pioneer in providing electricity to its every village by 1986 and potable water facilities are available in every village since 1990.

DISCUSSION

Study of ventilatory and diffusion studies is recommended as a sensitive index of pulmonary functions to detect structural and functional lung diseases (10,11). Rosenzweig et al. (12) reported ventilatory functions in a normal middle-aged population after 7 years interval and obtained a slight decline in performance. In a similar study, Pelt et al. (13) are of opinion that in older people at any one age, the

ventilatory functions seem to improve in successive birth cohorts. We planned to undertake 3 cross-sectional studies at an interval of 12 and 5 yrs from 1974 to 1991. As age of subjects influences pulmonary functions, so well matched subjects 17-20 yrs of age, were carefully selected for the three groups. An interesting observation was that the mean age of students of Group 3 was a little higher (statistically not significant) than subjects of other two groups. The probable reason for it was that these days some students get admission to the MBBS course after appearing for more than once in the medical entrance test which is held annually. In the present study, height and weight of subjects showed a progressive increase over a passage of 17 yrs. This increases in height is in accordance with earlier report as well in which younger adults were found to be taller than older adults (14). This improvement in height and weight of students admitted to this Institute from different parts of Haryana over a period of 17 yrs led us to analyze pulmonary functions, already reported by Mahajan et al and others from this lab (1, 4-7), to find out if this physical state is accompanied with improvement in their pulmonary functions as well. Ventilatory functions (FVC, FEV_1% and $FEF_{25-75\%}$) of subjects improved from Group 1 to Group 2 and then to Group 3 under study. Their ventilatory functions were closer to western and north Indian reports (10, 12) than to south Indian reports (15, 16). MVV and PEFR were though higher in the most recent study (1991 group) than Group 1 and 2, but still were not statistically significant. FRC showed no change.

Data of TLCO and its components was well comparable to other studies (17). TLCO being dependent on Dm and VC, showed an improvement as these parameters increased, though statistically insignificant. Haemoglobin concentration improved from 13.02±0.40 gm% to 14.04±0.76gm% from Group 1 to Group 3 and this could be responsible for better VC in the Group 3 subjects. Further, improved effective alveolar volume and MVV could be responsible for better ventilatory and diffusion functions as well. V_A and Dm have direct positive correlation with height and are inversely proportional to age of subjects (7, 17).

As is evident from Table II, the development of Haryana state is suggestive of industrialization and green revolution. Better health care, increased per capita income and better education indices indicate improvement in standard of living of people of this state. The higher percentage data observed from 1967–68 to 1991–92 (columns 5,6 and 7 in the Table II) support the above observations. An important point to be noted is that improvement in physical parameters and pulmonary functions also has been observed during this period.

To conclude, the observations of present study support the presumption that economical uplift of Haryana due to the industrialization and green revolution has resulted in an improvement in physical parameters and pulmonary functions of the younger subjects. Further in this study parameters like Height. Weight, Haemoglobin, FVC, FEV_1%, $FEF_{25-75\%}$ etc. which did not change statistically from Group 1 to Group 2, showed statistically significant improvement when these parameters of Group 1 and 2 were compared to Group 3 (Table I). Although PEFR and

TABLE II : Haryana at a glance: Some quantititative indices regarding 'Industrialization' and 'Green Revolution'.

Item	*Unit*	*1967-68* (1)	*1974-75* (2)	*1986-87* (3)	*1991-92* (4)	*Percentage improvement (%)* 1 vs 2 (5)	2 vs 4 (6)	1 vs 4 (7)
Area and Population								
Geographical area	Sq. Km.	44222	44222	44212	44212	-	-	-
Population	Lakh	91.52	110.34	150.26	165.98	21.1	51.3	83.3
State Income: Per capita income	Rs.	399	470	1233	3445	17.8	632.9	763.4
Agriculture								
Total cropped area	Lakh Hectare	45.99	48.42	53.80	55.70	5.3	11.1	21.1
Foodgrain production	Lakh Tonnes	39.70	49.61	72.94	91.02	25	83.5	129.3
Tubewell/pumping set	No.	38461	191074	415527	510068	396.8	166.9	1226.2
Irrigation: Gross area irrigated	Lakh Hectare	17.80	26.98	36.90	43.40	51.6	60.8	143.8
Electricity: Villages electrified	No.	1312	6745	6745	6745	414.1	-	414.1
Roads and Transport								
Metalled roads	Kms.	5651	15493	20719	22013	174.2	42.1	289.5
Villages connected with pucca roads	No.	1563	5193	6639	6680	232.2	28.6	327.4
Industry								
Registerd working factories	No.	1200	1976	4595	4977	64.7	151.8	314.7
Workers	Thousands	75.5	122.9	233.2	275.5	62.8	124.1	264.9
Health								
Health Institutes	No.	785	972	2711	3040	23.8	212.7	287.3
Per capita expenditure on health	Rs.	4.63	18.76	41.26	69.50	305.2	270.5	1401.1
Birth rate (crude)	per 1000 population	34.40	28.45	21.29	20.85	17.30	26.71	39.40
Death rate (crude)	per 1000 population	8.69	7.78	5.06	5.14	10.47	33.93	40.85
Infant mortality rate	per 1000 live births	53.47	48.28	25.12	18.83	9.71	61.0	64.78
Maternal mortality rate	per 1000 live births	0.33	0.68	0.99	0.70	–06.06	–2.94	–112.12
Education								
Institutions:Colleges	No.	54	110	157	167	103.7	51.8	209.3
High/Hr. sec. schools	No.	713	1210	1965	2446			
Middle schools	No.	747	954	1125	1362	83.9	10.4	55.4
Primary schools	No.	4348	4758	5131	5167			
Scholars in colleges	Thousands	35	108	138	154	268.6	42.6	340
Scholars in schools	Thousands	1216	1624	2496	3186	33.6	96.2	162
Teachers in schools	No.	33717	39178	71852	78465	16.2	100.2	132.7
Miscellaneous								
Villages with drinking water	No.	204	3192	4676	6745	1464.7	111.3	3260.4

MVV did not show statistically significant increase, still there is a trend towards betterment and it is likely that these parameters too will improve to statistically significant levels in next 10–15 yrs.

Marked variability in values of pulmonary functions seen in these cross-sectional studies suggests that in view of the expected improvement in socio-economic status of developing countries and health of their individuals, physical and functional norms reported by different laboratories must be reviewed periodically.

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