

# Correlation of Lung Function Tests with Nutritional and Socio-economic Status in Male Children

MANISH GUPTA, PRATIBHA GUPTA, SATISH K. BHARGAVA\*

Departments of Physiology & Radiology\* & Imaging, University College of Medical Sciences & G.T. B. Hospital, Dilshad Garden, Delhi-110095, India

**Abstract:** This study was carried out on hundred male children (5-12 years) fifty each from lower and middle socioeconomic strata. Body mass index and total body fat (TBF) were assessed by measuring skinfold thickness to know their nutritional status. Lung function tests including forced vital capacity (FVC), forced expiratory volume in one second (FEV<sub>1</sub>) and peak expiratory flow rate (PEFR) were measured by spirometry. Children of lower socioeconomic status (group I) showed more prevalence of malnutrition, lower value of the mean TBF and pulmonary functions tests as compared to children belonging to middle socioeconomic status. Results of our study reveal poor nutritional status and compromised lung functions in children living in vulnerable indoor environment of lower socioeconomic strata.

**Keywords :** *Nutritional profile, pulmonary function.*

## Introduction

Multiple non-hereditary factors including radiation, malnutrition, passive smoking and hazardous outdoor and indoor environment may influence individual's health in many ways<sup>1-10</sup>. Among the above devastating factors the role of poor nutritional status become quite dominating. Norms established in previous studies, carried out in well nourished Delhi Children under the age group of 10-15 years act as reference standards for various lung functions<sup>11,12</sup>. Kapil et al<sup>13</sup> in their study show 81.1% prevalence of protein energy malnutrition among the pre-school children of urban communities in Delhi. Nutritional differences influence qualitative aspect of lung development in childhood beyond simple isotropic lung growth<sup>14</sup>. Work on malnourished children<sup>15</sup> have shown significant reduced lung functions (FVC, FEV<sub>1</sub>) as compared to normal population. Pulmonary functions correlate better with physical parameters e.g. height-arm span, weight and upper segment than with age<sup>16</sup>. Measurement of pulmonary function tests are not only providing a direction regarding any deviation in health status of population studied but they also add a lot for required informations. On going through the literature, it is found that studies on Indian Children particularly belonging to low socioeconomic strata are very few<sup>15-19</sup> and therefore, we have made an attempt to coordinate the effect of various vulnerable factors such as indoor pollution including passive smoking and others on their complete health profile so that causative factors could be identified.

## Material and Methods

This study was performed in 100 male children, aged 5-12 year, 50 each from middle and lower socioeconomic strata of East Delhi. They were further divided into four groups: group A (age 5-8 years) and B (age 9-12 years) from group I and group C (age 5-8 years) and D (age 9-12 years) from lower socioeconomic strata (group II). Each group consisted of 25 children.

The general information regarding number of total and earning members in family, approximated monthly income, household area to live (HAL, ft<sup>2</sup>), fuel used for cooking, number of smokers in family, and child's vaccination under routine immunization,

programme were collected by introducing a standard questionnaire for each children. The subjects were also grouped in various combinations of abovementioned groups as well as in groups based upon fuel used for cooking (gas-users and non-gas-users), number of smokers in family (passive smokers and non-smokers) and child's vaccination (vaccinated and unvaccinated).

The height (ht, cm) and weight (wt, kg) of each child were measured and the body surface areas (BSA m<sup>2</sup>) was calculated using DuBois formula<sup>20</sup>.

$$BSA = ht^{0.725} \times wt^{0.425} \times 0.007184$$

To assess the child's nutritional profile the body fatness was measured by using the swiss precision GPM Skinfold Caliper (Swiss make). The thickness of skinfold at each of the ten standard sites-namely, cheek, chin, chest, flank, waist, para-umbilical, triceps, subscapula, calf and knee was measured thrice and the mean value calculated. The sum, ( $\Sigma$ SD, mm) of the mean-skinfold-thickness for the ten above mentioned sites was calculated and used to estimate the total body fat (TBF, kg) the percentage fat PF, (%) and the fatless tissue (FT, kg) using following formula:

$$TBF = wt \times \frac{(\text{âSF } 40) \times BSA \times 0.039}{20 \times w} \quad 0.03$$

$$PF (TBF / wt) \times 100$$

$$\text{And } FT = Wt - TBF$$

The Body Mass Index (BMI)<sup>21</sup> was also calculated by using wt/ht<sup>2</sup> and a value < 0.15 was considered for designating the child as malnourished.

The pulmonary functions namely, forced vital capacity (FEV, L), forced expiratory volume in 1 sec (FEV<sub>1</sub>, L) and peak expiratory flow rate (PEFR, L/min) - were measured by using PK Morgan's Pocket Spirometer (PK Morgan Pvt. Ltd. England). The procedure was demonstrated to the satisfaction of each subject.

Nose clip was used on the subject during assessment. For each function, three measurements were made and the best result out of three was included. The Empey index (EI, ml/l/min.) was calculated using formula<sup>22</sup>.

$$EI = (FEV_1 / PEFR) \times 10000$$

All the collected data was analysed by applying the 'SPSS version

5.0' statistical package and the scatterograms were computer-drawn wherever significant correlations were observed.

## Results

Table 1 shows the general information including number of total earning members in family, monthly income, HAL, gas-user families, number of smokers in family and unvaccinated children. As shown, the number of members in family was greater but the monthly income and HAL were lesser in groups II (lower socioeconomic stratum) than in group I (middle socioeconomic stratum) forming the basis for grouping them socioeconomically.

Table 1 : General profile of subjects and their families

Sr. No.	Parameter	Socioeconomic (Group I)	Stratum (Group II)	pvalue
1	Number of Subjects	50	50	
2	Mean age(Yr)	8.62	8.28	>.005
3	Total members/family	5.04 + 1.75	7.86 + 0.64	<.005
4	Earning members/family	1.46 + 0.10	1.32 + 0.11	>.005
5	Monthly income (Rs.)	7204 + 582	1527 + 139	<.005
6	Gas-user/family (%)	100	30	<.005
7	Household area to life (ft <sup>2</sup> )	762 + 12	200 + 0	<.005
8	Smokers/family	0.32 + 0.08	0.74 + 0.10	<.005
9	*No of malnourished subjects	6	25	<.005

Values are Mean SEM statistical analysis using unpaired t-test

\*Quetelet BMI < 0.15 as per ref.<sup>16</sup>

Although all families of middle socioeconomic status are found using LPG fuel for cooking, whereas only 30% of families of lower socioeconomic status used the same and rest of them used other less efficient and more smoke producing fuels such as kerosene oil, coal and wood. There were more number of smokers and unvaccinated children in group II families as compared with group I.

The ht, wt and BSA values as well as  $\Sigma$ SF, TBF, PF and FT values were found toward lower side in children of group II. These values further showed a declined pattern for non-gas-users, passive smokers and unvaccinated children (Table 2).

Table 2 : Nutritional profile and pulmonary functions in subjects.

Sr. No.	Parameter	TBF (kg)	FF (%)	FVC (L)	FEV <sub>1</sub> (L)	PEFR (L/min)
1.	Socioeconomic status					
	Group I (n=50)	2580	8.48	1.334	1.219	1572
		+0.392	+1.14	+0.061	+0.054	+72
	Group II (n=50)	0.961	5.04	0.939	0.881	127.0
		+0.142	+0.74	+0.045	+0.040	+65
	p value	<.005	<.005	<.005	<.005	<.005
2.	Fuel used for cooking					
	Gas users (n=65)	2.332	8.25	1.244	1.138	148.7
		+0.313	+0.93	+0.054	+0.048	+64
	Non-gas-users (n=35)	0.726	3.98	0.937	0.885	129.9
		+0.143	+0.81	+0.056	+0.049	+80
	p value	<.005	<.005	<.005	<.005	<.005
3.	Passive smoking					
	Passive smokers (n=41)	1.507	6.60	1.066	0.976	128.3
		+0.257	+0.94	+0.068	+0.058	+72
	Non-smokers (n=59)	1.953	6.87	1.186	1.102	151.7
		+0.332	+0.99	+0.054	+0.048	+68
	p value	>.005	>.005	>.005	>.005	>.005
4.	Nutritional status					
	Well nourished (n=69)	2.348	8.71	1.200	1.093	141.9
		+0.292	+0.87	+0.057	+0.049	+63
	Malnourished (n=31)	0.484	2.74	1.003	0.954	142.7
		+0.130	+0.78	+0.050	+0.049	+84
	p value	<.005	<.005	<.005	<.005	>.005

Values are Mean SEM Statistical analysis using unpaired t-test

Table 2 exhibits the results of pulmonary functions (FVC, FEV<sub>1</sub>, PEFR and EI) of the children. Results of FVC, FEV<sub>1</sub> and PEFR showed a decrement in children belonging to group II as compared with others (group I) and the pattern of lower results continued in non-gas-users, passive smokers and unvaccinated children.

The prevalence of malnourished children in group II is more (50%) as compared with group I (12%) children (Table 2).

Further the FVC and FEV<sub>1</sub> values increased with increase in HAL as  $r = 0.4613$  and  $0.4315$ ,  $P < 0.001$  respectively. The FVC value was observed to be more with increasing age as :

$$FVC(1) - 0.1379, \text{ age (yr)} 0.0271, r = 0.6864, P < 0.0001$$

Results show a linear relationship of FVC and FEV<sub>1</sub> with increasing TBF ( $r=0.4618$  and  $0.4119$ ,  $p<0.0001$ ) respectively.

The PEFR results also indicated a similar pattern being on lower side in children of group II as well as in non-gas-users and passive smokers. There was a linear increase in PEFR with increasing age, ht, wt, and BSA as exhibited by  $r$  values ( $r=0.6168$ ,  $0.6814$ ,  $0.6223$  and  $0.6696$  respectively,  $P<0.0001$ ) respectively. The PEFR results depicted a direct relationship with HAL ( $r=0.3386$ ,  $P<0.0007$ ) whereas an inverse pattern was observed with number of smokers in family (NOSMO) as well as with number of smokers/number of total members in family (S/FM) as exhibited in Fig. 1 and 2 ( $r=0.2505$  and  $-0.2028$ ,  $P<0.05$ )

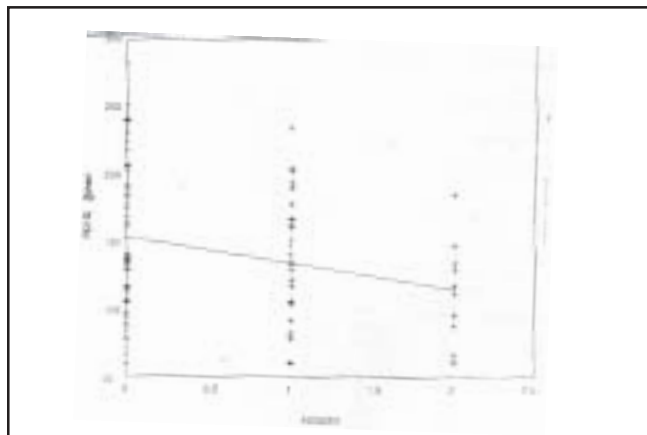


Fig. 1: Scatterogram showing PEFR (peak expiratory flow rate) in relation with NOSMO (no. of smokers in family). Regression equation :  $PEFR = (-18.09xNOSMO) + 151.7$ ;  $r = -0.2505$ ;  $P < 0.05$

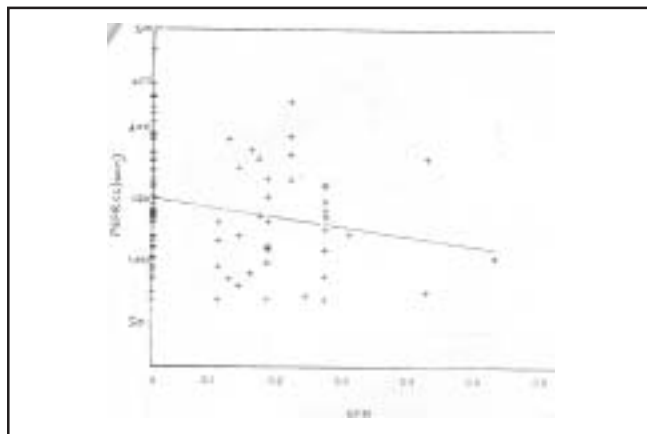


Fig. 2: Scatterogram showing PEFR (peak expiratory flow rate) in relation with S/FM (no. of smokers/no. of total members in family) Regression equation :  $PEFR = (-90.42xS/FM) + 149.6$ ;  $r = -0.2028$ ;  $P < 0.05$

respectively PEFR values also indicated an improvement with increasing FVC and  $FEV_1$  Values (Fig 3,  $r=0.6482$  and Fig. 4,  $r=0.7042$  retrospectively,  $P<0.0001$ ).

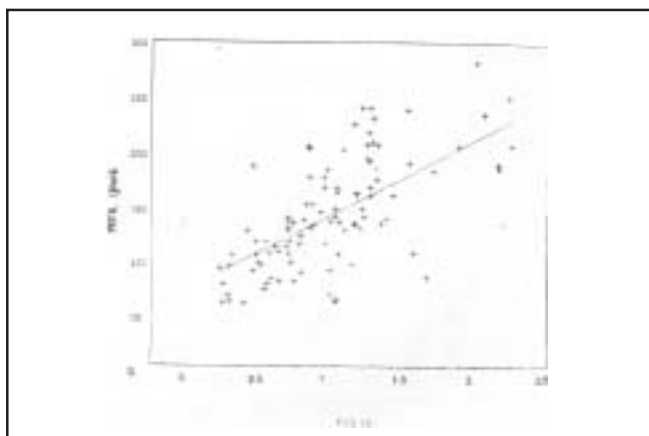


Fig. 3: Scatterogram showing PEFR (peak expiratory flow rate) in relation with FVC (forced vital capacity). Regression equation :  $PEFR = (76.95 \times FVC) + 54.66$ ;  $r=0.6482$ ;  $P>0.0001$

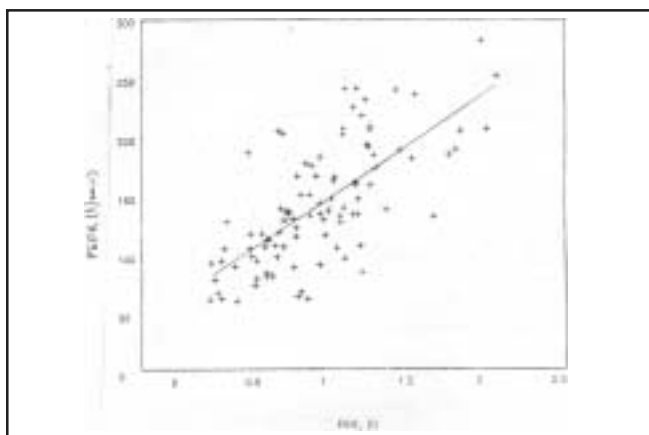


Fig. 4: Scatterogram showing PEFR (peak expiratory flow rate) in relation with  $FEV_1$  (forced expiratory volume in 1 sec.). Regression equation :  $PEFR = (95.81 \times FEV_1) + 41.54$ ;  $r=0.7042$ ;  $P<0.0001$ .

In present study, the EI was found to be higher in children of groups B and D (age 9-12 yr) then in group A and C (age 5-8 yr) though less than 10 in all groups. The EI exhibited an increase with increasing TBF ( $r=0.4216$ ,  $P<0.0001$ ) and increase with increasing PEFR (Fig. 5,  $r=0.3951$ ,  $P<0.0001$ ). It was higher in passive smokers.

## Discussion

As it has become quite clear that the children belonging to lower socioeconomic status are exposed to more hazardous indoor environment due to passive smoking and use of less efficient and more smoke-producing fuels. Along with larger fraction unvaccinated children, all these factors may be responsible for favouring the underdevelopment associated with various respiratory disorders amongst them<sup>1,3,15</sup>.

The TBF has also been assessed by Burnin and Womensley<sup>23</sup>, however, they calculated it in older age group from the body fat density presuming the later to be uniform in the whole body. Faridi et al<sup>15</sup> have used a method similar to our and their results were slightly lower than ours possibly because they carried out

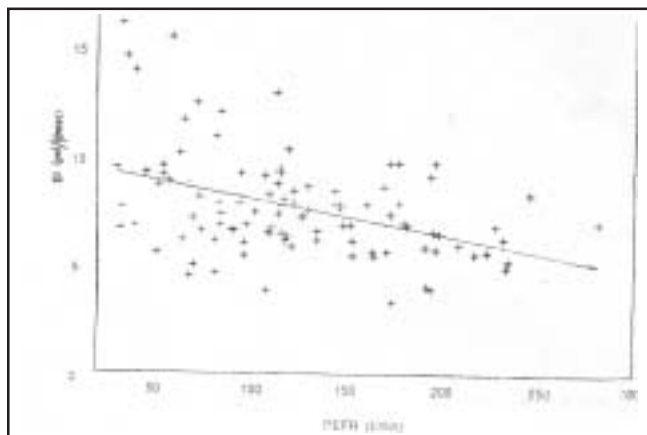


Fig. 5: Scatterogram showing EI (Empey index) in relation with PEFR (peak expiratory flow rate). Regression equation :  $EI = (-0.0185 \times PEFR) + 10.35$ ;  $r=-0.3951$ ;  $P<0.0001$ .

their study in malnourished children only. On assessing Body Mass Index (BMI) the results are further supported by showing more malnourished children in group II as compared with group I.

Ong et al<sup>14</sup> show that lung function normalized for sitting height and stature correlated significantly with indices of nutrition in both sexes. The pulmonary function values reflect better results in children living in less polluted areas, and these are supported by many other workers as they have reported from the children belonging to health environment<sup>1,4,5,17,18,22</sup>. The linear increase in PEFR values with increase in age, ht, wt and BSA has also been reported in study carried out in mildly malnourished Senegalese children<sup>24</sup>. The rate of increase in PEFR also seems to be enhanced with increasing age<sup>25</sup>. Smokers of the family are exposing the children to passive smoking and may cause a decrement in their pulmonary function values.

The EI is an important pulmonary function since a value of it above 10ml/L/min is suggestive of narrowing of upper airways<sup>22</sup>. Our study reveals that as the Nutritional and respiratory conditions improve, the EI value decreases depicting its significance. There are reports on similar trends by others<sup>1-7</sup>.

Though we have tried to explain and provide suitable reasoning for our results and their correlation with other factors worked out by us, but to draw a conclusion we suggest to continue such studies involving more number of such children belong to various socioeconomic status.

## References

1. Shen S, Qin S, Shang J, Liu Y, Yang X, Deng Y et al. Indoor air pollution and pulmonary function in children. *Biomed Environ Sci* 1992;5(2):136-141.
2. Menon P, Rando RJ, Stankus RP, Salvaggio JE, Lehrer SB. Passive cigarette smoke-challenge studies: increase in bronchial hyperactivity. *J Allergy Clin Immunol* 1992;89(2):560-566.
3. Goren AI, Hellmann S. Passive smoking among school children in Israel. *Environ Health Perspect* 1991;96:203-211.
4. Xu XP, Dockey DW, Wang LH. Effects of pollution on adult pulmonary function. *Arch Environ Health* 1991;46(4):198-206.
5. Azizi BH, Henry RL. Effects of indoor air pollution on lung function of primary school in Kuala Lumpur. *Paediatr Pulmonol* 1990;9(1):24-29.
6. Schmitzberger R, Rhomberg K, Buchele H, Puchegger R,

- Schmitzberger Natzmer D, Kemmler G et al. Effects of air pollution on the respiratory tract of children. *Paediatr Pulmonol* 1993;15(2):68-74.
7. Koening JQ, Larson TV, Hanley QS, Rebolledo V, Dumler K, Checkoway H et al. Pulmonary function changes in children associated with the fine parculate matter. *Environ Res* 1993;63(1):26-36.
  8. Goren AI, Goldsmith JR, Hellmann S, Brenner S. Follow up of school children in vicinity of coal fired powder plant in Israel. *Environ Health Pespect* 1991;94:101-105.
  9. Hock G, Fischer P, Brunkreef B, Lebert F, Hofchreuder P, Mennen MG. Acute effects of ambient ozone on pulmonary function of children in the netherlands. *Am Rev respir Dis* 1993; 147(1):111-117.
  10. Niepsul G, Niepsul K, Oklek K, Kozielski J, Krzywlecki A, Zlora D et al. Chronic bronchitis and efficiency of lung ventilation in workers of the "Zawadzkie" foundry. *Med Pr* 1993; 44(1):1-8.
  11. Sharma PP, Gupta P, Deshpande R, Gupta P. Lung function values in healthy children (10-15 years). *Indian J Pediatr* 1997;64(1):85-91.
  12. Raj Kapoor, Mahajan KK, Mahajan A. Ventilatory lung function test in school children of 6-13 years. *Indian J Chest Dis Allied Sci* 1997;39(2):97-105.
  13. Kapil U, Bali P. Nutritional status of pre-school children of urban communities in Delhi. *Indian Pediatr* 1989;26(4):338-42.
  14. Ong TJ, Mehta A, Ogston S, Mukhpadhyay S. Prediction of lung function in the inadequately nourished. *Arch Dis Child* 1998;79(1):18-21.
  15. Faridi MMA, Gupta P, Prakash A. Lung function in malnourished children (age 5-11 years). *J Indian Paediatr* 1995;32(1):35-42.
  16. Mahajan KK, Maini BK, Mahajan SK, Srivastava SC, Chander S. Pulmonary functions and their correlation with anthropometric parameters in young adults of Haryana (India). *Indian J Physiol Pharmacol* 1978;22(1):87-92.
  17. Singh HD, Prabhakaran S. Pulmonary function studies (A preliminary note). *J Indian Med Assic* 1957;29:269-272.
  18. Jain SK, Ramiah T. Lung volumes and mechanics of breathing in healthy boys (7-17 years old). *Indian J Chest Dis* 1968;10:63-68.
  19. Bhattacharya AK, Bannerjee S. Vital Capacity in children and young adults of India. *Indian J Med Rs.* 1966;54:62-71.
  20. Keele CA, Nell E, Joels N, editors, Safason Wright's applied physiology 13th ed. Oxford: Oxford University Press, 1982;213.
  21. Ghai OP. Nutrition and nutritional disorders. In Ghai OP, editor. *Essential Paediatrics*, Ed. 3, New Delhi. Interprint 1993;42-57.
  22. Empey DW. Assessment of upper airways obstruction. *BMJ*1972;3:503-505.
  23. Durnin JVCA, Womensley J. Body fat assessed from total body density and its estimation from skinfold thickness. *Br J Nutr* 1974;32:77-97.
  24. Beneflee E. Physical activity and anthropometric and functional characteristics of mildly malnourished Senegalese children. *Ann Trop Paediatr* 1992;12(1):55-66.
  25. Ware JH, Dockery DW, Louis TA, Xu XP, Ferrts BG Jr, Speizer FE. Longitudinal and cross sectional estimates of pulmonary function decline in never-smoking adults. *Am J Epidemiol* 1990;132(4):685-700.

**When gram-ve Pathogens hit 'hard,  
Patient Becomes truly fragile**

**In Such Critical Conditions  
Patient Requires Stable Power**

**GLENMARK** PROUDLY INTRODUCES

**TREZAM** 500mg/1gm/2gm Inj.  
(AZTREONAM)

***Stable Power for Critical Care***

**Glenmark Pharmaceutical Ltd.**