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PEAK EXPIRATORY FLOW RATES IN ELDERLY INDIANS

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Abstract : Peak expiratory flow rates were measured in 124 normal elderly men (55-85 yr) using the Wright's peak flow meter. In the < 60 yrs age group (n = 32; mean age 57.7 yr) the PEFR was 431 ± 13 lpm, while for the group > 60 yr (mean age 69.0 ± 6.0; n = 92), the PEFR value was 373 ± 11 lpm. These values are similar to those reported in other Indian studies, suggesting that the ethnic variations amongst Indian subjects do not affect the PEFR. However, the reported values are lower than those observed in Europeans, but greater than those of Chinese. The PEFR regressed at a rate of 4.47 lpm/year increase in age, but is positively correlated to the subjects' height (cm), and their FVC and FEV1. The smokers had a significantly higher PEFR as compared with the non-smokers. This finding was contrary to what was expected.

Key words : age lung function PFR

INTRODUCTION

Lung function studies in elderly Indians are as such sparse, and envelope mostly the standard lung volumes and capacities (1,2,3). We have obseved that the airway dilatation produced with a therapeutic dose of salbutamol is less in the healthy elderly men, as compared with healthy young men (4). However, very little information is available on the peak expiratory flow rates [*PEFR; litres/min (lpm)*] in elderly Indians. This test for pulmonary function is relatively simple to adminster, and is fairly repeatable (5,6). Age reduces the ventilatory capacity of the lung/chest wall system (7), and is thus expected to affect the PEFR. We report here our findings of PEFR in 124 elderly Indian male subjects in the age group of 55-85 years.

METHODS

Of the 127 elderly males examined for their overall lung functions (8), we were able to measure PEFR in 124. Informed consent was obtained in all. Subjects with a history of cough, sputum and breathlessness were excluded from the study. A thorough clinical examination (ECG and X-Ray chest whereever indicated) determined the suitability of the subject for inclusion in the study. The subjects were subdivided in to 5 subgroups as per their ages, (Table I). 33 of our subjects were smokers (mean age 63.1 yr ± 7.2 SD; ht. 163.2±5.9 cm), and 91 non-smokers (mean age 66.8±7.2 SD; ht. 161.6±6.4 cm).

The PEFR test was adminstered as per the standard method recommended by Wright and Mckerrow (5), by using Wright's peak flow meter (Air Med. UK; ser. no. W 36677). This equipment was calibrated against on older well used one (Air Med, U.K. ser. no. 12021). For this 10 males (laboratory staff; mean age 37.8 yr) performed the PEFR tests with both the instruments. The PEFRs obtained were 548 ± 21 lpm (old instrument) and 545 ± 20 lpm (new instrument), the values being not significantly different ($p > 0.05$). Our elderly subjects were trained to perform the PEFR manouevre, before they gave at least 3 satisfactory efforts which could be included for analysis as per the standard practice (9). 3 successful forced expirograms were also recorded on a Goddart water seal spirometer in order to measure the

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forced vital capacity and the forced expiratory volume 1 sec (FVC, FEV1) in 113 of the subjects (8). From these records, FEF 25%-75% FVC were also measured for 30 smokers and 33 non-smokers, in order to calculate the airflow during the expulsion of the middle 50% of the FVC, which gives a good indication of airflow through the small airways (9).

Statistics: The data was treated on a Hindustan Computer (Busy Bee, PC) using a LOTUS 123 programme in order to obtain the mean and ± SE values for the PEFR (1pm) for the various age groups. The inter-group means were compared using ANOVAR to obtain the F ratio. A regression coefficient was obtained to determine the relationship of the PEFR to (i) age; (ii) height (cm); (iii) FVC; and (iv) FEV1. A multiple regression for the height and age dependency of the PEFR was also calculated. The level of significance was determined at a P value of < 0.05.

The PEFR was also measured in (i) 44 male medical students (mean age 18.2 ± 0.9 (SD) yr; ht. 171.8 ± 5.7 cm); (ii) 10 young men (24.4 ± 2.4 yr; 170.6 ± 5.1 cm); (iii) 10 Service athletes (26.0 ± 3.2 yr; 170.0 ± 6.0 cm), and (iv) 10 laboratory staff (males) (37.8 ± 5.8 yr; 172.0 ± 6.7 cm). However, this data was not included for statistical analysis as the aim was to generally demonstrate the effects of age on PEFR.

RESULTS

The PEFR values for the various age groups are given in Table I. ANOVAR revealed a significant inter group difference ($P < 0.05$). The PEFR decreased with age at a rate of 4.47 1pm/yr increase

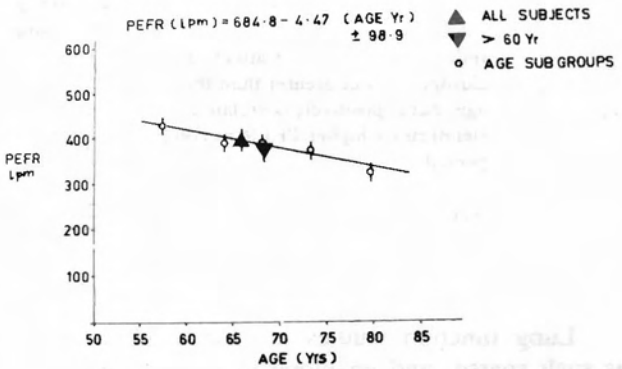

Fig. 1: Depicts the age dependency of the PEFR. The vertical bars on symbols are the SE of the means.

TABLE I : Depicts the physical characterics of 124 elderly male subjects (mean and SD) and the Peak expiratory flow rates (mean and SE) (lit per min). The bracketed figures indicate the age range.

	n	*Age* *yrs*	*height* *cm*	*wt* *kg*	*PEFR* *lpm*
Gp.	1 32	57.7±2.3 (55-60)	164.1±5.4	54.3±8.9	430.8±13.3
Gp.	2 37	64.2±1.4 (>60–65)	161.1±6.6	52.0±8.8	378.8±18.0
Gp	3 30	68.8±1.5 (>65–70)	162.5±1.7	53.2±9.3	385.8±22.2
Gp	4 13	73.5±1.7 (>70-75)	158.3±5.3	46.5±5.8	372.5±27.1
Gp	5 12	80.0±3.0 (>75-85)	161.0±5.6	50.0±8.7	313.5±26.0
All	124	66.1±5.4 (55-85)	161.9±6.3	52.2±8.9	389.8± 9.3
>60	92	69.0±6.0 (>60–85)	61.2±6.5	51.5±8.9	372.8±10.8

TABLE II : Depicts the regression relationships of PEFR to i) age, ii) height, iii) FVC), iv) FEV1, v) age/height.

PEFR (l pm)=				
i)	684.8 − 4.7	×	age ± 98.9 (SE);	r = 0.30 P<0.05.
ii)	−1009 + 8.6	×	ht (cm)±86.8 (SE);	r = 0.53 P<0.01.
iii)	98.9 + 100.8	×	FVC (1)±75.8 (SE);	r = 0.69 P<0.01.
iv)	94.1 + 140.9	×	FEVI (1)±66.4 (SE);	r = 0.77 P<0.01.
v)	−663.4 − 3.37	×	Age + 7.86 ht (cm)± 84;	r = 0.6

in age (PEFF = 684.79 − 4.47 Age (yr) ± 98.9 (SE) 1pm); (Table II; Fig 1). The relationship of the height, FVC and the FEV1 to PEFR is given in Table II. The combined effect of age and height on the variable under study was PEFR (1pm) = − 663.4 − 3.37 × age (yr) + 7.86 × ht (cm) ± 84.0. Fig. 2 depicts this relationship in a graphical form. The 33 smokers had a PEFR of 405.6 ± 15.5

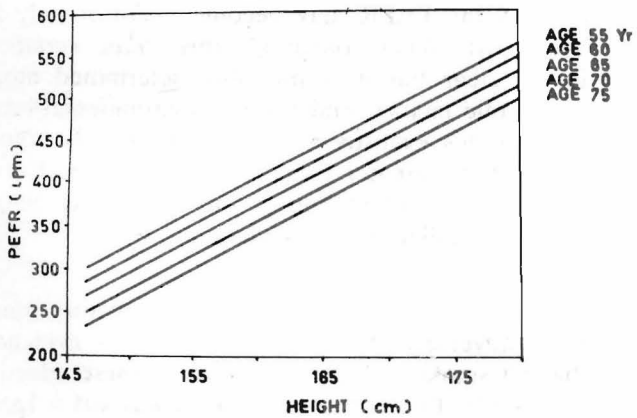

Fig. 2: Depicts the height and age dependence of the PEFR of the elderly subjects studied. Refer the multiple regresion equation in Table II.

TABLE III: Depicts the PEFR values for young subjects.

	Age	*n*	*sex*	*PEFR*
1)	18.3 ± 0.13	44	M	587.0 ± 10.10
2)	24.4 ± 0.8	10	M	541.0 ± 37.0
3)	25.5 ± 0.9	10	M	586.6 ± 16.0 (athletes)
4)	37.8 ± 1.8	10	M	548.0 ± 21.4

(SE) which was significantly greater ($p < 0.05$; unpaired t test) than the PEFR of the non-smokers (380.8 ± 11.2 1pm). The mean FEVI of the smokers was slightly higher (2.33 1) as against that for the non-smokers (2.25 1). Table III depicts the PEFRs of the young subjects.

DISCUSSION

In this paper, we have given the due consideration to a useful ventilatory variable which has been generally ignored in other studies on ventilatory functions of the aged (1,2,3). The PEFR may not be able to detect an early deterioration in ventilatory capacity as the FEV1% is thought to do (10) but this is a test which a relatively easy to adminster, and is fairly repeatable (5), and therefore can be used for a bedside assessment of elderly patients with respiratory problems, or by anaesthetists while evaluating patients. It is also a useful tool for carrying out ventilation function surveys. A reduction in the PEFR of the elderly is expected because this variable is dependent upon expiratory muscle effort, lung elastic recoil and airway size (11)-factors which are known to reduce with advancing age (7). PEFR studies in this country have mostly been concerned with young subjects (12, 13, 14, 15,). Malik (14) in his study had about 20 subjects who were above the age of 55 years, and of these, only 7 were more than 60 yr of age. Their mean PEFR was 396 1pm, which is close to the value of 402.9 1pm in our subjects in the same age range (calculated from data in table I; Gps 1 and 2.) All of Malik's subjects were North Indians, while a majority of our subjects were from Maharashtra (ethnically dissimilar). In Kamath et al's (12) study there were 48 subjects (mean age of 64.7) in their PEFR series, and a mean PEFR value of 452 1pm was observed in these. Singh and Peri (15) have reported extensively on PEFRs of South Indians, but have studied only 38 males in the > 60 yrs group (mean age 64.9 yr; mean PEFR 431 1pm). The mean values that

have been obtained in the present study are not very different from these reported by other workers, suggesting that at least on this subcontinent, ethnic variations do not reflect upon the PEFRs. Other studies on lung functions in Indians (16,17) chose to measure the FEF 200-1200 as an index of flow rate, rather than the PEFR. Further, Jain and Ramiah's data (16) pertains to subjects upto 40 yrs of age, while Mathur's series (17) includes a very small number of elderly subjects in whom PEFR was not measured. Goel et al (13) measured extensively pulmonary functions of healthy Indian soldiers (including their PEFR) but their oldest subjects were 42 yr of age.

Peak flow rates in elderly subjects as observed in the present study regressed at 4.47 lpm/year increase in age (Fig. 1 and Table II). This was very close to that reported by Tinker (6) (4.64 lpm/yr) for his British subjects in the age range of 20-60 years. The constant in this study was 768 lpm while in our study it is 684.8 lpm, which may be a reflection of the ethnically higher PEFR in European subjects. Tinker also suggested that as the relationship given by his age vs PEFR regression was quite linear, it may be justifiable to extend this line beyond the range reported. However, he has not taken into account the fact that most ventilatory functions increase with age upto about 25-30 years, and then start to decline (7,9). Bradford-Hill (18) recommends that a regression line must not be extended beyond the range of the observations on which it is based, without sufficient justification. We would therefore be wary of using our regression equation (Fig. 1 Table II) to predict PEFRs outside the range of 55-85 years.

The peak flow rate in our study was positively and significantly correlated to (i) the height; (ii) FVC; and (ii) FEV1 (Table II). This has been reported in Nigerian males (mean age 34.9 yr; range 30-59 yrs (19), and for Caucasian males (20). But elderly subjects in both the studies were too few in number. The Nigerians had a PEFR of 405 lpm in the age group 55-59 as against 517 lpm reported in Europeans for the same age group (6). Our values of 430.8 lpm for this age group (Table I) is closer to that measured in the Africans, and similar to those reported by Singh (15) and Kamath (12). This small difference between Indians and Africans may be attributed to slight variations in methodology, even though both the studies were carried out in expert hands, using standard prescribed technique, and standard equipment (Wright's Peak Flow meter); and to the subject motivation and co-operation. However, the much larger PEFRs in Tinker's study (6) and the much lower values amongst the elderly Chinese from Hongkong (21), can be explained on the basis of *ethnic variation*. Patrick and Patel (22) did not find a difference in the PEFRs of their British, Indian and Afro-Carribean children, but the FVC and FEV1s of their British children were significantly higher. This may suggest that ethnic difference in the PEFR may become manifest only in adulthood. What constitutes this *ethnic variation* is not clear but it is probably determined more by genetic factors, and not by environmental ones (23). In his exaustive review, Patrick (23) points out that the greater thoracic volume of the Europeans is a manifestation of this genetically determined so called ethnic variation.

Smoking is thought to affect ventilatory functions adversely (9,11,23). But there is evidence that all smokers do not succumb to these adverse effects (7). PEFR of our smokers was 405.6 lpm, and was significantly greater ($P < 0.05$; unpaired t test) than that of the non-smokers' PEFR (380.8 lpm). Taking into consideration the regression rate of-4.47 lpm/year of age, the non-smokers (3.7 yr older) should have had a PEFR which is lower by 16.5 lpm and not 24.8 lpm as observed. The fact that smoking had not affected PEFR of our elderly subjects may be explained either that smoking may not affect adversely ventilatory functions of all subjects (7); or that PEFR is +vely correlated to FEV1 and height (Table II and 18,19). The FEV1 and the ht of our smokers was slightly greater than that of the non-smokers. The PEFR may not be considered as a very sensitive index of ventilatory function derangement (10), but this factor is of no consequence as we have found that the FVC, FEV1 and the FEV1% of smokers and

non-smokers was not significantly different (8). However, the deterioration in this variable in the smokers may manifest itself as a greater regression/yr at a later age. It is also suggested that the higher PEFR of smokers is a reflection of a compensatory manifestation of greater ventilatory effort in this group, whose small airways damage may not have reached significant proportion. When the damage to their ventilatory system increses, it is likely to manifest itself as lowered PEFR, as well as lowered airflow in the small airways. To support this hypothesis, we found that the 33 non-smokers had a FEF 25-75% value of 114.2 1pm, while 30 of the smokers had a value of 107.3 1pm ($P > 0.05$). It may be hypothetised that the small airways function deterioration of such subjects will be accompanied at a later stage with lowered PEFRs. However, this needs further elucidation. There are other studies which have failed to observe deleterious effect of smoking on PEFR (19). Perhaps the number of smokers is too small to enable us to come to any final conclusion.

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REFERENCES

1. Pathak JD, Mehrotra PP, Joshi SV, Shah AH. Pulmonary functions of the elderly Indian subjects. Trends of decline with age. *Indian J. Physiol and Phamac* 1989, 33: 157-62.
2. Bhargawa RP, Mishra SM, Gupta NK. Ventilatory tests and lung volume in np. *Indian J Physiol Pharmac* 1973; 17: 266-72.
3. Meenakshi S. Spirometric data in Indian subjects 60-80 yrs. *Indian J Physiol Pharmac* 1984; 28: 58-62.
4. Sodhi PS, Dikshit MB. Broncholidilator response of normal elderly males to salbutamol aerosol. *Med J Armed Forces India* 1990; 46: 200-206.
5. Wright BM, McKerrow CB. Maximum forced expiratory flow as a measure of ventilatory capacity. *British Med J* 1959; 2: 1041-47.
6. Tinker CM. Peak expiratory flow measured by the Wright's peak flow meter. *British Med J* 1961; 1: 1365-66.
7. Culver BH, Butler J. Alterations in pulmonary function: In Principles of Geriatric Medicine ed. Andes R, Bierman EL and Hazzard WR. McGraw-Hill Book Co. Ltd. (Lond.) 1985. Chap. 26. pp 280-87.
8. Dikshit MB, Jog NV, Prasad BAK et al. Lung functions in elderly Indian males. 1991: (in print).
9. Cotes JE. Lung function : Assessment and application in Medicine 4th Ed. Blackwell Sci. Pubs. Oxford. 1979.
10. Balchum OJ, Felton JS, Jamison JN et al. A survey for chronic respiratory disease in an industrial city. *Amer Reve Resp Dis* 1962; 86: 675-85.
11. Woolcock AJ, Colman MH, Blackburn CRB. Factors affecting normal values for venytilatory lung function. *Amer Rev Resp Dis* 1972; 106: 692-707.
12. Kamat SR, Thiruvengadam KV, Rao TL. A study of pulmonary function amongst Indians and assesment of the Wright's peak flow meter in relation to spirometry in field use. *Amer Rev Resp Dis* 1967; 96: 707-16.
13. Goel BR, Venkatraman C, Rastogi SK, Lakhera SC, Gautam RK. Normal standards and prediction of lung function tests in Indian Armed Forces personnel. *Med J Armed Forces India* 1984; 40: 151-56.
14. Malik SK, Jindal SK, Jindal V, Bansal S. Peak expiratory flow rates in healthy adults. *Ind J Chest Dis* 1975; 19: 166-71.
15. Singh HD, Peri S. Peak flow rate in South Indian adults *Indian J Physiol Pharmac* 1979; 23: 315-20.
16. Jain SK, Ramiah TJ. Normal standards of pulmonary function tests for healthy Indian men, 15-40 years old; comparison of different regression equations (prediction formulae). *Ind J Med Res* 1969; 57: 1453-66.
17. Mathur KS, Nigam DK, and Garg RK. Pulmonary function studies in normal healthy persons. *Indian J Chest Res* 1968; 10: 80-89.
18. Bradford-hill A. A Short Text Book of Medical statistics. *ELBS, Lond.* 1977.
19. Elebute EA, Femi- Pearse D. Peak expiratory flow rate in Nigeria. anthropometric determinants and usefulness in assessment of ventilatory function. *Thorax* 1971; 26: 597-601.
20. Leiner GC, Abramowitz S, Small MJ, Stenby VB, Lewis WA. Peak expiratory flow rate. Standard values for normal subjects. Use as a clinical test of ventilatory function. *Amer Rev Resp Dis* 1963; 88: 644-51.
21. Woo J, Pang J. Spirometry in healthy elderly Chinese. *Thorax* 1988; 43: 617-20.
22. Patrick JM, Patel A. Ethnic differences in the growth of lung function in children: a cross sectional study in inner city: Nottingham. *Annals Human Bio* 1986; 13: 307-15.
23. Patrick JM. Ventilatory capacity in tropical populations in Variations in Working Capacity in Tropical Populations Ed. Collins KJ and Roberts Df. Camb Univ Press Camb 1986.