

LUNG TRANSFER FACTOR (TI) IN A GROUP OF YOUNG HEALTHY SUBJECTS

O. P. TANDON, SAVITA SINGH, P. GUPTA AND K. N. SHARMA

*Department of Physiology,
University College of Medical Sciences,
Ring Road, New Delhi - 110 029*

(Received on May 1, 1981)

Summary : Lung transfer factor (TI) was determined by employing single breath technique in fortyfive healthy young males, and twenty females. These subjects belonged to similar socio-economic and nutritional status and were non smokers. Morning value for TI in sitting posture was worked out by using Morgan's Pulmotest C while subjects were at physical and mental rest. Male subjects in the age group of (18-26) yrs (av. 21.0 yrs) and height 1.68 M and weight 58.5 kgs, showed TI of 30.6 ± 3.8 ml/CO/mm Hg/min and females of same age group, height 1.57 M and weight 49.1 kg, had TI values of 25.5 ± 6.2 ml CO/mm Hg/min.

Key words : lung transfer factor (TI)
helium equilibration

KCO (diffusion constant)
effective alveolar volume (VA)

INTRODUCTION

Studies on people of different ethnic origin living in similar environments reveal systematic variations in lung functions mainly confined to the vital capacity and forced expiratory volumes (5). In general, these indices along with maximum breathing capacity and peak expiratory flow are lower in people living in Indian and Africian subcontinents when compared with Europeans having similar age and body size (5). The transfer factor of the lungs (TI) which reflects the adequacy of the diffusion process (11), seems to be more stable and does not appear to exhibit ethnic variations (5). Using single breath technique, Cotes *et al*, (9), however, found that TI values were lower in the South Indians as compared to North Indians and the values of North Indian communities like Rajputs were quite comparable to the Western figures.

The present study is a preliminary report to work out the norms of lung function indices such as TI, VA (effective alveolar volume) and KCO (diffusion constant) in young healthy North Indian subjects from stratified population sample. It is hoped that the results should serve as a base for the future studies to work out nutritional correlates of cardiopulmonary indices in this sample of population having similar anthropometric but different socio-economic profiles.

MATERIALS AND METHODS

Sixty five subjects (forty five males and twenty females) belonging to similar socio-economic and nutritional status and in the age group of 18-26 yrs were selected for this study. They were moderately built (males: Ht. 1.68 M, wt. 58.5 kgs; and females: 1.57 M Ht., 49.1 kgs wt.). All the subjects were free from respiratory symptoms at the time of study and in the recent past. They were non-smokers, non-indulgent in drugs and had no history of respiratory allergy. The TI was determined in the sitting posture in the morning between 9-11 am, employing Morgan's Pulmo-test model C. This Model having controller, Analyser and Programmer units could be connected to automatic valve box for employing single breath technique for determining TI. The principal steps involved for working out TI are illustrated and described in Fig. 1. Essentially these consisted of (i) working out the amounts of CO in the alveolar gas at the beginning and the end of the period of breath holding, (ii) the duration of breath holding, and the (iii) alveolar volume during that time. The concentration of CO and Helium (He) in the inspired and expired gases was analysed by their respective analysers. A comparison was then made between the concentration of He and CO in the inspired gas and in the expired gas and calculation made to determine the effective alveolar volume (VA) and TI as follows :

$$\text{Transfer factor (TI) or DLCO} = \frac{\text{VA} \times 160 \times \text{Log}_{10} \frac{\text{CO insp.} \times \text{He exp.}}{\text{CO exp.} \times \text{He insp.}}}{t}$$

Where VA = Alveolar Volume at BTPS. t = Effective Breath Hold time in seconds. (Measured on the Pulmofunction unit automatically after 'wash in' (to mid point of gas sampling). 160 = standard adjustment factor : logs e to logs 10, sec to min vols per cent to partial pressure (at 760 mm Hg).

$$\text{Effective VA} = \frac{\text{Vol. insp.} \times \text{He insp.} \times \text{BTPS}}{\text{He exp.} \times 0.95}$$

BTPS can be found from the standard tables at temperatures taken from the Rotatherm Indicator at the time of the test. Another index called as diffusion constant (KCO) was also worked out. $\text{KCO} = \frac{\text{TI}}{\text{VA}}$ and average values obtained are given in Table. I.

VA

RESULTS

Figure 1 in the text shows the actual kymographic tracings of one of the subjects, upper panel showing normal spirometry and determination of FEV. The lower panel indicates the various procedural steps and the tracings obtained during the single breath test after programming the controller unit. The Table I also gives some of the physical parameters and the pulmonary functions. In the male subjects these indices were : FEV 3.8 ± 0.576 , LVA 5.37 ± 0.75 L, TI 30.6 ± 3.8 ml of CO/mm Hg/min; and in females 2.1 ± 0.46 L, 2.4 ± 1.03 L and 25.5 ± 6.2 ml of CO/mm Hg/min respectively.

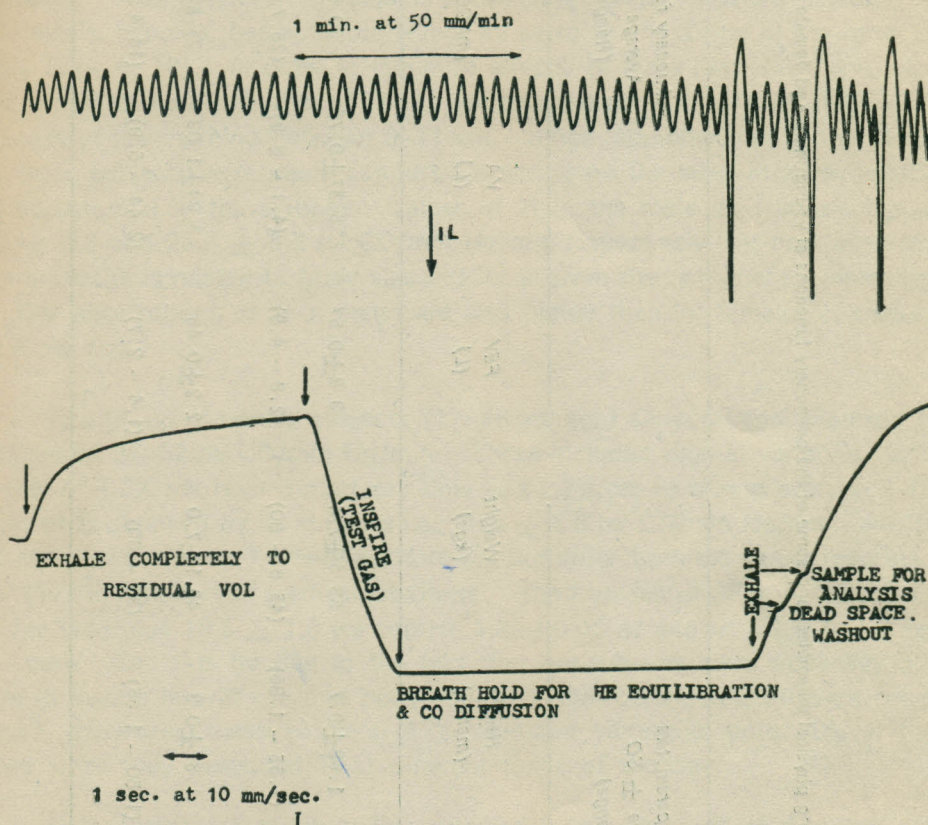


Fig. 1 : Upper panel : Kymographic tracings of one of the subjects, showing some of the normal respiratory excursions, including the Forced Expiratory Volume (FEV).

Lower panel : Procedural steps for Single breath technique using a mixture of Helium, Carbonmonoxide in air.

Calibrations : vertical for volume 1 cm = 1 L
horizontal for time : 50 mm/min or 10 mm/sec.

TABLE 1: Showing physical parameters and some of the pulmonary functions of young male and female subjects.

	Physical parameters				Pulmonary functions			
	Age (yrs)	Height (metres)	Weight (kgs)	FEV (L)	VA (L)	TI (ml CO/mm Hg/min)	KCO	
Males (n=45)	21.0±2.0 (18 - 26)	1.68±0.7 (1.55 - 1.85)	58.5±7.4 (45.6 - 80)	3.8±0.57 (2.8 - 4.9)	5.37±0.75 (4.1 - 6.9)	30.6±3.8 (25.7 - 38.5)	5.5±0.8 (4.1 - 7.5)	
Females (n=20)	20.3±1.08 (18 - 26)	1.57±0.3 (1.50 - 1.65)	49.1±7.0 (35 - 60)	2.2±0.46 (1.4 - 2.7)	3.94±1.03 (2.44 - 5.9)	25.5±6.2 (14.4 - 33.3)	6.3±2.2 (4.6 - 10.0)	

DISCUSSION

Measurement of the diffusing capacity of the lung (TI) is considered one of the most valuable tests of pulmonary function (11). Of all the methods employing CO, single breath technique has its own advantages particularly in the normal subjects. In this method the nature and magnitude of the interaction between uneven distribution of lung ventilation and perfusion, which affects TI, is least (4). There are normal physiological variations of TI with age, sex and body size (1, 10, 20). There are also many causes of variation in the transfer factor (TI) even in subjects with normal lungs. Posture, exercise, sympathetic tone, meals, hypoxia, haemoglobin levels, all seem to affect one or the other subdivisions of the TI (4, 8, 18). In order to minimise effects of these variables and also the interference due to diurnal rhythm of TI (3), we selected our subjects carefully and performed the study in the morning between 9–11 am. Since apprehension can enhance TI values (2), these subjects were made comfortable sitting on the stool in an airconditioned room and accustomed to the settings. Values of TI in the male and female subjects were : 30.6 ± 3.8 and 25.5 ± 6.2 ml CO/mm Hg/min respectively. It has been reported that TI in adult life is related to body size and for a given size is higher in men than in women (4). Our observations of TI in males are also higher than in females of similar age group and body size.

In a group of normal subjects (17–28 yrs age) Cinkotai and Thomson (3) reported TI values of 27–32 ml CO/mm Hg/min. These included diurnal variation in TI, falling at the rate of 1.2% per hour during day time and 2.2% per hr during evening. The morning values of TI obtained by us in males i.e., 30.6 ± 3.8 ml CO/mm Hg/min, are in agreement with the values reported by these authors (3) but differ from the values reported by Lawther *et al* (17) in a cohort of medical students. Their values of 38.6 ± 5.2 ml CO/mm Hg/min for TI for age 19.5 ± 1.6 yrs and Ht. 1.79 ± 0.05 M and wt. 72.1 ± 7.3 kg, are higher than ours. Can this be due to the fact that our subjects were ethnically different from theirs in having less height and body weight or they belonged to different socio-economic status? However, these workers (17) admitted variations upto 20% in their reported values since they measured TI at different times of the day.

In a sample of North Indian population, mostly civilians residing around Delhi, Cotes *et al.* (9) standardised TI and KCO values thus obtained by single breath technique in these subjects to Ht. 1.7 M and showed that values so worked out were similar to the ones as reported by others for European men of same age group (6, 7, 24). Our results for TI and KCO in male subjects are also comparable with theirs for north Indians.

Even among North Indians, some significant differences exist between highlanders and sea landers (13). The highlanders like Ladakhis had higher TI values. They further observed that TI in North Indian Rajput community resembled the European figures. We confirm their observations and further suggest that TI and KCO values in young adults belonging to Delhi are similar to their counterpart in Europe. This is based on the observation that values of TI reported in males and females as 33, 25 ml CO/mm Hg/min respectively in nomograms prepared for Western subjects of age group 20-25 yrs (6) are close to ours. This further favours the notion put forward by Cotes (5), that TI is one of the respiratory indices which do not appear to exhibit ethnic variations; for TI the smaller lung volume is associated with a lower value for Dm (diffusing capacity) of the alveolar capillary membrane but this is offset by the value of the blood in the alveolar capillaries being somewhat larger than in the Europeans. The anatomical basis for this difference is not yet established.

The values for FEV reported in the present study (Table I) are similar to those reported by other workers (14-16, 19, 23). However, when compared to white races of European descent, FEV and other ventilatory indices are lower (9, 17). Lower values for FEV as compared to Caucasians have also been reported in Chinese (12), Indians (7, 14-16, 19) and Nigerians (21).

In order to work out ethnic differences in lung indices Rossiter and Weill (22) suggested the application of certain scaling factors to determine the proportional differences of lung function in different races. They have found out that scaling factor of 1.132 should be used for the major lung volumes to account for the ethnic differences between Africans and Europeans. That may be true for Indians and other countries of South East Asia also. For TI and KCO, these authors feel that still smaller scaling factors might be required. Our observations suggest that these two indices are stable and do not seem to exhibit ethnic variations.

ACKNOWLEDGEMENTS

The authors acknowledge the secretarial help of Mr. M. Sundaram of Physiology Department.

REFERENCES

1. Burrows, B., J.E. Kasik, A.H. Niden and W.R. Barclay. Clinical usefulness of the single breath pulmonary diffusing capacity test. *Am. Rev. Respirat. Diseases*, **84** : 789-806, 1961.
2. Cinkotai, F.F., M. L. Thomson and A. R. Guyati. Effect of apprehension on pulmonary diffusing capacity in man. *J. Appl. Physiol.*, **21** : 534-538, 1966.

3. Cinkotai, F. F. and M. L. Thomson. Diurnal variation in pulmonary diffusing capacity for carbonmonoxide. *J. Appl. Physiol.*, **21** : 539-542, 1966.
4. Cotes, J.E. Lung Function, assessment and application in medicine, Third Edition, Balackwell Scientific Publications, Oxford London Edinburgh Melbourne, p. 233-234, 1975.
5. Cotes, J.E. Lung Function, assessment and application in medicine, Third Edition, Blackwell Scientific Publication Oxford London Edinburgh Melbourne, p. 356-360, 1975.
6. Cotes, J.E. Lung Function, assessment and application in medicine. Third Edition, Blackwell Scientific Publications. Oxford London Edinburgh Melbourne, p. 384, 1975.
7. Cotes, J. E. and M.S Malhotra. Differences in lung function between Indians and Europeans. *J. Physiol.*, **177** : 17-18, 1965.
8. Cotes, J.E., J.M. Dabbs, P.C. Elwood, A.M. Hall, A. McDonald and M.J. Saunders. Iron deficiency anaemia : its effect on TI for the lung (diffusing capacity) and ventilation and cardiac frequency during sub-maximal exercise. *Clinical Sci.*, **42** : 325-335, 1972.
9. Cotes, J.E., J.M. Dabbs, A.M. Hall, S.C. Lakhera, M.J. Saunders and M.S. Malhotra. Lung function of healthy men in India : Contributor roles of genetic and environmental factors. *Proc. R. Soc. Lond. B.*, **191** : 413-425, 1975.
10. Donevan, R. E., N. H. Palmer, C. J. Varvis and D. V. Bates. Influence of age on pulmonary diffusing capacity. *J. Appl. Physiol.*, **14** : 483-492, 1959.
11. Forster, R.E. Exchange of gases between alveolar air and pulmonary capillary blood : pulmonary diffusing capacity. *Physiol. Rev.*, **37** : 391-452, 1957.
12. Foster, J.H. A study of vital capacity of Chinese. *China Med. J.*, **38** : 285-294, 1924.
13. Guleria, J. S., J. N. Pande, P. K. Sethi and S. B. Roy. Pulmonary diffusing capacity at high altitude. *J. Appl. Physiol.*, **31** : 536-543, 1971.
14. Gupta, S., M. B. Puri and S. T. Singh. Pulmonary function tests in health. *J. Assoc. Physicians Ind.*, **23** : 247-254, 1975.
15. Jain, S.K. and T.J. Ramaiah. Normal standards of pulmonary function tests for healthy man 15-40 yrs old comparison of different regression equations (prediction formulae). *Ind. J. Med. Res.*, **57** : 1453-1466, 1969.
16. Kasliwal, R.M., V.S. Baldwa and P.H. Sharma. Ventilatory tests and Lung Volume studies in health. *J. Ind. Med. Assoc.*, **43** : 49-51, 1964.
17. Lawther, P.J., A.G. Brooks and R.E. Waller. Respiratory function measurements in a cohort of medical students. *Thorax*, **25** : 172-177, 1970.
18. Lewis, B.M., W.T. McElory, E.J. Hayford-Welsing and L.E. Samberg. The effects of body position, ganglionic blockade and nor-epinephrine on pulmonary capillary bed. *J. Clin. Invest.*, **39** : 1345-1352, 1960.
19. Mathur, K.S., D.K. Nigam and R.K. Garg. Pulmonary function studies in normal healthy person. *Ind. J. Chest Dis.*, **10** : 80-89, 1968.
20. McGrath, M. and M.L. Thomson. The effect of age, body size and lung volume change on alveolar-capillary permeability and diffusing capacity in man. *J. Physiol. (Lond.)*, **146** : 572-582, 1959.
21. Pearce, D.F. and E.A. Elebute. Ventilatory function in healthy adult Nigerians. *Clinical Sci.*, **41** : 203-211, 1971.
22. Rossiter, C.E. and H. Weill. Ethnic differences in lung function : evidence for proportional differences. *Intr. J. Epidem.*, **3** : 55-61, 1974.
23. Singh, H.D., D.L. Abraham and N.J. Antony. Expiratory flow rates and timed expiratory capacities in South Indian men. *J. Ind. Med. Assoc.*, **54** : 412-421, 1970.
24. Teculescu, D.B and D.C. Stanescu. Lung diffusing capacity, Normal values in male smokers using the breath holding technique. *Scand. J. Resp. Dis.*, **51** : 137-149, 1970.