MAXIMAL EXPIRATORY FLOW-VOLUME LOOP IN SOUTHERN INDIAN COLLEGE SPORTSMEN

K. V. KUPPU RAO AND V. K. VIJAYAN

Cardio-Pulmonary Medicine Unit,
Tuberculosis Research Centre,
Indian Council of Medical Research, Madras - 600 031

(Received on November 11, 1987)

Summary : Flow volume loops using computerised pulmonary function testing equipment were analysed in twenty sportsmen of Loyola College, Madras. There was no significant difference in mean P. E. F. R. ($P>0.2$) and $\dot{V}E$ 25% ($P>0.2$) in sportsmen, comparad to Indian or American normals. On the other hand, the mean $\dot{V}E$ 50% ($P<0.05$) and $\dot{V}E$ 75% ($P<0.001$) were significantly higher in sportsmen compared to Indian values, but was similar to those reported in American normals ($P>0.1$). Inspiratory flow rates were similar to those reported in Indians. Our results show that there is an increase in maximal expiratory flow rates at lower lung volumes in Southern Indian College Sportsmen compared to Indian normals.

Key words : Max expiratory flow sportsmen $\dot{V}E$ max

INTRODUCTION

Flow volume loop is a graphic recording of the maximum flow rates at all lung volumes and is recorded during a maximal forced expiratory and inspiratory manoeuvre. It is one of the easiest ventilatory function tests which can be utilised to screen patients with various pulmonary diseases (1). Eventhough characteristic abnormalities in the pattern of Flow-volume loops in various pulmonary diseases have been described (2, 3), there is paucity of data on flow-volume loops in Indian literature.

The maximal expiratory flow volume curve is used for early diagnosis of ventilatory abnormalities, especially small airways disease (4). This is superior to peak expiratory flow rate (PEFR) or forced expiratory volume 1 second (FEV_1) in that it provides complete information during the forced vital capacity (FVC) manouvre. According to Jordanoglou and Pride (5, 6), several factors such as respiratory muscle contratile power, elastic recoil of lung tissue, and airways resistance influence the maximal flow volume curve. Thus, the study of flow-volume loop may be useful in the evaluation of ventilatory adaption during athletic training.

The present study is therefore undertaken to record the maximal expiratory flow volume loop in South Indian college sportsmen and also to understand whether there are any differences in flow rates at different lung volumes in sportsmen, compred to normal.

MATERIAL AND METHODS

Twenty sportsmen of Loyola College, Madras, who were active participants of various games and athletics such as foot ball, basket ball and running conducted at Inter-University and Inter-State competitions were studied. All of them were non-smokers. Subjects were selected for study after an evaluation, which included a medical history and a 12-lead electrocardiogram. Maximal flow volume spirogram tests were carried out using Morgan Transfer test Model C. The instrument is provided with dedicated computer and X-Y recorder for recording Flow-Volume curve. The instrument has a resolution of 50 *ml* in measuring lung volumes; and 1 cm equals 1 liter. The resolution of flow rates is 0.1 liter per second. The results are printed out after correction to BTPS. Best of three well attempted efforts is utilised for analysis of the data.

We had undertaken pulmonary function studies in 249 normal Southern Indian subjects and the regression equations obtained from this study was utilised to obtain the predicted values of various parameters such as spirometry and expiratory flow rates in the study (in preparation). The predicted values of Inspiratory flow rates were obtained from those reported by Patel *et al.* (12). The measured values are considerd normal if within $\pm 15\%$ predicted (2).

RESULTS

Physical characteristics of the subjects are as shown in Table I. Mean age of the sportsman is 19.8 ± 0.24 years, Hight 172.1 ± 1.6 centimeters and Weight 57.0 ± 2.1 kilograms.

TABLE I : Physical characteristics.

Parameter	*Mean±S.E.M.*
Age (years)	19.8±0.24
Height (*cm*)	172.1±1.6
Weight (*kg*)	57.0±2.1

Table II shows the lung volumes measured during Forced Expiratory volume tests. Mean Forced vital capacity of the sportsmen was 4.06±0.13 liters, mean Forced Expiratory volume in 1 second 3.54±0 12 liters, mean $FEV_1\%$ 88.7±1.4 and mean Maximal Voluntary Ventilation 152.7±5.4 litres per min.

Mean values of forced expiratory flow rates are shown in Table III and the classification of expiratory flow rates based on predicted values of South Indian population is given in Table V.

TABLE II : Lung volumes (BTPS).

Parameter	*Mean±S.E.M.*
F.V.C. L)	4.06±0.13
F.E.V.$_1$ (L)	3.54±0.12
F.E.V.$_1$ (%)	88.7±1.4
M.V.V. (L/M)	152.7±5.4

TABLE III : Mean Expiratory flow rates in sportsmen.

Parameter	*PEFR*	*FMF*	$\dot{V}$ *Emax 25%*	$\dot{V}$ *Emax 50%*	$\dot{V}_E$ *max 75%*
Sportsmen (Mean±S.E. (L/S)	7.89±0.29	5.09±0.24	7.12±0.29	5.18±0.27	2.87±0.24
% Predicted (South Indian)	102.5	114.2	107.0	110.7	134.2
% Predicted Udwadia *et al.* (14)	97.9	134.5	—	118.5	146.3
% Predicted Patel *et al.* (12)	94.4	—	—	113.8	126.0
% Predicted American (7)	73.7	111.0	—	101.4	115.0

TABLE IV : Inspiratory Flow Rates.

Parameter	*Mean±SEM*	% *Predicted (Patel et al.) (12)*
Peak Inspiratory Flow Rate (L/S)	4.91±0.28	89.7
Inspiratory Flow 25% (L/S)	4.48±0.23	89.9
Inspiratory Flow 50% (L/S)	4.45±0.40	82.4
Inspiratory Flow 75% (L/S)	3.88±0.35	88.3

TABLE V : Classification of Expiratory Flow Rates.

Parameter	*PEFR*	*FMF*	$\dot{V}_E$ *max 25%*	$\dot{V}_E$ *max 50%*	$\dot{V}_E$ *max 75%*
% *Predicted*					
<85%	3	3	2	3	3
85-115%	12	10	13	8	6
>115%	5	7	5	9	11

PEFR and $\dot{V}_E$ *max* 25% : Twelve sportsmen had normal PEFR (85-115% predicted) and 5 had increased flow rates (>115% predicted). $\dot{V}$Emax 25% was increased in 5, and 13 had normal flow rates. PEFR and $\dot{V}$Emax 25% were not significantly different from normal South Indian population (P>0.2). This was true when compared to those reported by Udwadia *et al.* (14) (P>0.2) and Patel *et al.* (12) (P>0.1) from Indian subjects and Knudson *et al.* (7) from American subjects (P>0.2).

$\dot{V}$Emax 50% *and $\dot{V}$Emax* 75% *:* Eight sportsmen had normal $\dot{V}$Emax 50%, 9 had increased flow rate and 3 had low flow rate. On the other hand, 11 sportsmen had $\dot{V}$Emax 75% more than 115% predicted indicating that the airways are patent even at very low lung volumes (Table V). When average maximal flow volume loop is plotted, it falls on the right side of the predicted normal graph for normal South Indian population (Fig. 1), indicating that for a given volume the flow rate is higher in sportsmen compared to South Indian population. There was no significant difference in the mean values of VEmax 50% (P>0.1); however, the mean $\dot{V}$E max 75% were significantly higher (P<0.01). On the other hand, $\dot{V}$E max 50% and $\dot{V}$Emax 75% were significantly higher in sportsmen compared to the predicted values of

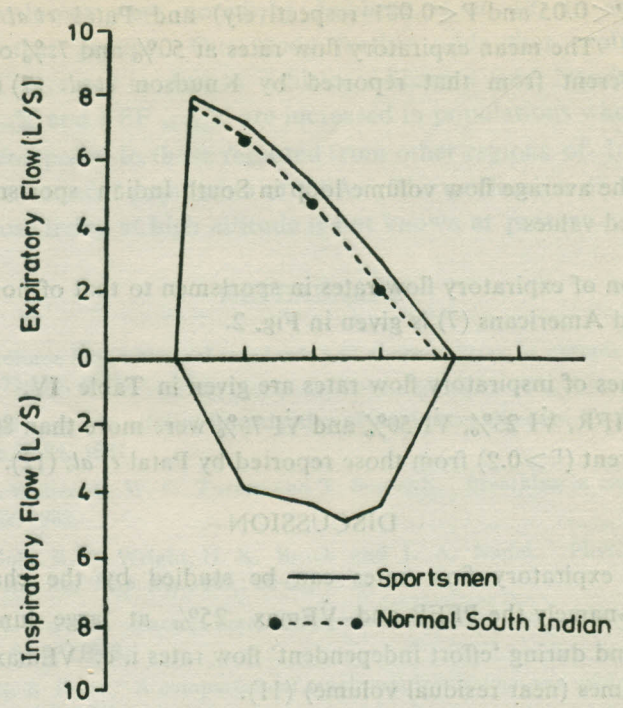

Fig. 1 : Flow volume loop in sportsmen compared to normal South Indians.

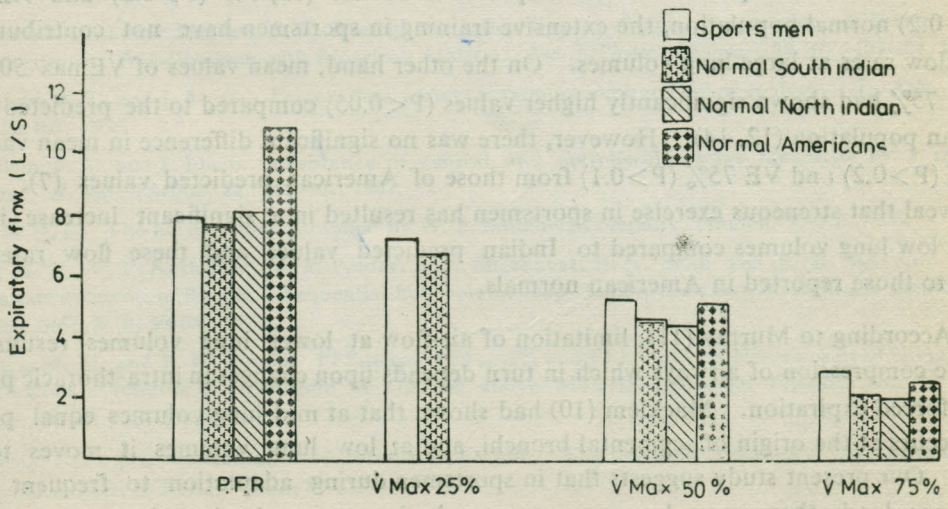

Fig. 2 : Expirtory flow rates in sportsmen compared to normal South Indians, North Indians and Americans.

Udwadia *et al.* (14) ($P<0.05$ and $P<0.001$ respectively) and Patal *et al.* (12) ($P<0.05$ and $P<0.05$ respectively). The mean expiratory flow rates at 50% and 75% of vital capacity were not significantly different from that reported by Knudson *et al.* (7) ($P>0.2$ and $P>0.1$ respectively).

Fig. 1 shows the average flow volume loop in South Indian sportsmen compared with South Indian predicted values.

The comparison of expiratory flow rates in sportsmen to that of normal South Indians, North Indian (14) and Americans (7) is given in Fig. 2.

The mean values of inspiratory flow rates are given in Table IV. The mean percent predicted values of PIFR, $\dot{V}I$ 25%, $\dot{V}I$ 50% and $\dot{V}I$ 75% were more than 80% and these were not significantly different ($P>0.2$) from those reported by Patal *et al.* (12).

DISCUSSION

The maximal expiratory flow rates can be studied by the changes during 'effort dependent' flow rates-namely the PEFR and $\dot{V}E$max 25% at large lung volumes (around total lung capacity) and during 'effort independent' flow rates i. e. $\dot{V}E$max 50% and $\dot{V}E$max 75% at low lung volumes (near residual volume) (11).

As the mean values of PEFR and $\dot{V}E$max 25% in sportsmen were not significantly different from the mean predicted values reported in Indian (12, 14) ($P>0.2$) and American (7) ($P>0.2$) normal population, the extensive training in sportsmen have not contributed for higher flow rates at large lung volumes. On the other hand, mean values of $\dot{V}E$max 50% and $\dot{V}E$max 75% had shown significantly higher values ($P<0.05$) compared to the predicted values of Indian population (12, 14). However, there was no significant difference in mean values of $\dot{V}E$ 50% ($P>0.2$) and $\dot{V}E$ 75% ($P>0.1$) from those of American predicted values (7). These data reveal that streneous exercise in sportsmen has resulted in a significant increase in flow rates at low lung volumes compared to Indian predicted values and these flow rates were similar to those reported in American normals.

According to Murray (11), limitation of air-flow at lower lung volumes results from dynamic compression of airways which in turn depends upon changes in intra-thoracic pressure during forced expiration. Macklem (10) had shown that at mid-lung volumes equal pressure point occurs at the origin of segmental bronchi, and at low lung volumes it moves towards alveoli. Our present study suggests that in sportsmen during adaptation to frequent higher ventilatory load, there may be some structural changes such that there may be less compression of airways at lower lung volumes.

Larger lung volumes were noted by Lakhera *et al.* (8) in swimmers, sportsmen, boxers, runners and other groups. Our study further adds that expiratory flow rates at low lung volumes are increased in Indian athletes. Sharma and Nanda (13) reported that $FEF_{200-1200}$, $FEF_{25-75\%}$ and $FEF_{75-85\%}$ are increased in populations who live in Simla (150 Metres above MSL) compared to those reported from other regions of India and these flow rates are comparable to normal population of USA. The mechanism of increased flow rates in atheletes and in those living at high altitude is not known at present.

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