PULMONARY FUNCTION OF INDIAN ATHLETES AND SPORTSMEN : COMPARISON WITH AMERICAN ATHLETES

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Summary : Studies were conducted to evaluate pulmonary functions in Indian athletes and sportsmen associated with different athletic events and games. It was found that swimmers were having significantly higher vital capacity (VC) and forced expiratry volume (FEV_1) values than all other athletic groups studied. Results have been discussed keeping in view the physiological, functional and structural demands in various events. Pulmomary function values of Indian athletes have also been compared with American athletes of standardized height for a better appraisal of athletic potentiality in our athletes. The importance of athletic training from childhood have been ascribed to be the reason for superior lung votumes and capacities in US athletes.

Key words : lung volumes pulmonary function athletic training

INTRODUCTION

It is well known that athletic training has a significant effect on respiratory functions (10, 11, 13, 17). Studies have confirmed that athletes have larger lung volumes and capacities than non-athletes of comparable age group. However, the lung function of Indian athletes have not been studied systematically so far. The purpose of the present study was, therefore (i) to investigate and report pulmonary function of Indian athletes involved in a variety of sports and (ii) to compare these values with the pulmonary function values available in literature for western athletes.

MATERIAL AND METHODS

Studies were conducted on national or state level athletes consisting of 10 foot ball players, 10 swimmers, 10 boxers, 9 track men, 7 wrestlers, 6 basketball players and 6 gymnasts. Swimmers and football players were from services whereas boxers, trackmen, wrestlers, basketball players and gymnasts were of national level. All these athletes were made familiar with the instruments and the techniques used. They were asked to report to laboratory in the morning after a light breakfast. Each of them was given half an hour rest before conducting pulmonary function test.

Lung volumes and capacities : each subject was given two trials and three test runs for each test and best of the three test readings was taken. Forced vital capacity (FVC), Forced Expiratory volume in Ist second (FEV_1), Expiratory reserve volume (ERV),

TABLE II : Ventilatory norms in Indian athletes.

S.No.	Parameters	Swimmers	Foot ballers	Boxers	Runners	Wrestlers	Basket ballers	Gymnasts	Error variance	L.S.D		
										5%	1%	0.1%
1.	VC (l)	5.58 ±0.05	4.91 ±0.12	4.19 ±0.26	4.31 ±0.18	4.88 ±0.27	4.24 ±0.12	3.96 ±0.13	0.2719	0.5239	0.6986	0.9127
2.	FVC (l)	5.52 ±0.07	4.93 ±0.11	4.17 ±0.24	4.31 ±0.28	4.92 ±0.27	4.22 ±0.13	3.98 ±0.14	0.2589	0.5112	0.6817	0.8906
3.	FEV_1(l)	4.43 ±0.11	4.05 ±0.11	3.53 ±0.2	3.62 ±0.09	3.92 ±0.22	3.34 ±0.11	3.52 ±0.11	0.1941	0.4427	0.5904	0.7712
4.	FEV_1%	80.16 ±1.47	82.17 ±1.22	84.46 ±1.76	84.58 ±2.30	79.66 ±0.92	83.56 ±1.34	83.83 ±2.02	23.4755	—	NS	—
5.	MVV (l/min)	174.46 ±5.27	161.68 ±4.34	167.78 ±8.29	173.54 ±7.81	160.21 ±5.25	157.71 ±7.26	160.59 ±7.21	374.0488	—	NS	—
6.	IC (l)	—	—	2.95 ±0.17	2.78 ±0.07	—	2.64 ±0.12	2.63 ±0.07	0.1344	—	NS	—
7.	ERV (l)			2.21 ±0.12	1.53 ±0.12	—	1.60 ±0.11	1.32 ±0.12	0.1149	—	NS	—
	N	10	10	10	9	7	6	6				

TABLE III : Ventilatory norms of Indian athletes standardized to a height of 170 cms.

S. No.	Parameters	Swimmers	Foot ballers	Boxers	Runners	Wrestlers	Basket ballers	Gymnasts	Error variance	L.S.D. 5%	L.S.D. 1%	L.S.D. 0.1%
1.	Vital capacity (1)	5.36 (3.04)	4.97 (2.90)	4.21 (2.40)	4.27 (2.47)	4.89 (2.59)	6.09 (2.36)	4.09 (2.36)	0.2038	0.4535	0.6048	0.7902
2.	FVC (1)	5.31 (3.01)	4.90 (2.91)	4.20 (2.39)	4.28 (2.47)	4.93 (2.61)	4.07 (2.35)	4.11 (2.42)	0.1943	0.4429	0.5906	0.7716
3.	FEV_1(1)	4.26 (2.41)	4.09 (2.39)	3.55 (2.02)	3.60 (2.07)	3.93 (2.08)	3.22 (1.86)	3.65 (2.14)	0.0373	0.1941	0.2589	0.3382
4.	FEV_1%	77.09	83.41	85.55	75.52	80.14	80.66	75.15	34.5090	5.9020	7.8711	10.2828
5.	MVV(1/min)	167.80 (95.33)	163.78 (95.66)	169.43 (95.42)	172.40 (99.73)	161.05 (89.02)	152.10 (88.10)	168.33 (87.92)	367.1077	19.2503	25.6728	33.5390
6.	Inspiratory capacity (1)	—	—	2.96 (1.71)	2.72 (1.60)	—	2.55 (2.15)	2.76 (2.09)	0.0495	0.2236	0.2983	0.3897
7.	Expiratory Resv. volume (1)	—	—	1.22 (0.69)	1.51 (0.87)	—	1.54 (0.88)	1.36 (0.80)	0.0544	0.2343	0.3125	0.4082

Lung function values in parentheses are per square metre of body surface area.

of 3.96 and 3.98 l respectively and a mean FEV_1 value of 3.52 l slightly higher than that of basket ball players mean FEV_1 value, 3.52 l.

The Table III shows lung function values of above mentioned athletic groups at a standardized height of 170 cms. A close look at the standardized values of lung functions in these groups reveals that even after eliminating the influence of height, if any, swimmers were still having highest mean values for VC, FVC and FEV_1, 5.36l, 5.31 l and 5.26 l respectively. It can be said that standardizing the lung function values to the same height did not change the trend much except small variations here and there.

The lung function values in American athletes vis-a-vis Indian athletes expressed per square metre of body surface area has been presented in Table IV. On appraisal of the table, it is observed that the mean vital capacity (1/m² BSA) was 3.54 l for American swimmers while it was only 3.04 litre for Indian swimmers. American runners were having a mean value of VC, 3.30 (l/m²BSA) while Indian runner were far behind them, having a mean VC, 2.47 (l/m²BSA). However, the Indian wrestlers did not differ much with their American counterparts in the vital capacity values. While former were having a mean VC 2.59 (l/m² BSA), the latter were slightly superior having a value of 2.77 (l/m² BSA). The American athletes possess much higher inspiratory capacity values in comparison to their Indian friends, the highest inspiratory capacity was found in American

TABLE IV : Ventilatory norms in Indian and American athletes standardized to HT-170 cms.

S.No.	Parameters	Athlete group	Swimmers	Footballers	Boxers	Runners	Wrestlers	Basket-ballers	Gymnasts
1.	VC (1)	Indian	5.36 (3.04)	4.97 (2.90)	4.21 (2.40)	4.27 (2.47)	4.89 (2.59)	4.09 (2.36)	4.09 (2.41)
		American	6.48 (3.54)	6.26 (3.12)	—	5.93 (3.30)	5.89 (2.77)	6.12 (3.22)	5.52 (3.11)
2.	IC (1)	Indian	—	—	2 96 (1.71)	2.75 (1.6C)	—	2.55 (1.49)	2.72 (1.61)
		American	4.55 (2.49)	4.51 (2.25)	—	3.94 (2.19)	—	4.08 (2.15)	3.72 (2.09)
3.	ERV (1)	Indian	—	—	1.22 (0.69	1.51 (0.87)	—	1.54 (088)	1.36 (0.80)
		American	1.93 (1.05)	1.75 (0.87)	—	1.99 (1.11)	—	2.04 (1.07)	1.80 (1.02)
4.	MVV(1/min)	Indian	167.80 (95.33)	163.79 (95.66)	169.43 (96.42)	172.40 (99.73)	161.05 (89.02)	152.10 (88.10)	166.33 (97.92)
		American	195.32 (106.65)	195.67 (97.65)	—	189.30 (105.29)	—	165.73 (87.30)	156.01 (93.69)

Lung function values in parentheses are per square metre of body surface area.

swimmers which was even higher than the vital capacity of some of the Indian groups studied.

DISCUSSION

The large metabolic demand of strenuous exercise requires an efficient O_2 transport system from the atmosphere to the active tissues. The results of the present study support the idea that physical training has a facilitative effect on the ventilatory function (15) and athletes have superior lung function values in comparison to non-athletes (8, 9, 11, 17). Vital capacity for swimmers, foot ballers and wrestlers and forced expiratory volume in 1st second for all the groups studied (except one) were all above the predicted normals in Indian soldiers by Verma *et al.* (18) and civil population by Jain and Ramiah (7). Maximum voluntary ventilation (MVV) seems to be significantly higher in comparison to its predicted normal value in Indians of similar age and height (7, 18). Inspiratory capacity (IC) and expiratory reserve volume (ERV) in the four subgroups studied viz. runners, boxers, basket ball players and gymnasts were found well within the range of values supposed to be possessed by young, healthy and active individuals of similar height and age (18).

To compare lung function values in Indian athletes among themselves, they were standardized to a height of 170 *cms*. When values thus obtained were analysed statistically, it was found that swimmers were having VC and FEV_1 values significantly higher than all other athletic groups.

It is of interest that swimmers had larger vital capacity and forced expiratory volume in Ist second in comparison to all other athletic groups studied. Higher values for lung volumes and flow rates in swimmers also have been reported in the literature by the previous workers (1, 2, 3, 6, 11). Astrand *et. al* (2) found that girl swimmers had higher values for VC and TLC in relation to height than a nonathletic reference group. Also, the mean values for VC and FEV_1 were found higher in swimmers of both sexes by Newman *et al.* (11). Andrew *et al.* (1) suggested that three years of competitive swim training produce large specimen with greater lung capacities than that might otherwise be anticipated.

It is of interest to speculate on the mechanisms whereby swim training affects lung volume measurements. As respiratory muscles including diaphragm of swimmers are required to develop greater pressures as a consequence of immersion during the respiratory cycle, this may lead to a functional improvement in these muscles. Also possibilities of alterations in elasticity of lung and chest wall or of ventilatory muscles can not be ruled out leading to an improvement in FVC and other lung functions of swimmers (16).

Actually, the respiratory response to swimming may be expected to be different from the response to many other types of man's activities for the following reasons :

1) Swimming is performed in horizontal position.
2) Ventilation is restricted.
3) External pressure is increased and
4) Heat conductance of water is higher than that of air.

The above mentioned factors in swimming can be anticipated to produce pulmonary function changes quite different than those observed in other sports activities. Further, the restricted ventilation experienced during swimming, leads the swimmers to face intermittent hypoxia and this may result in alveolar hyperplasia and thus increased VC and FVC (3). It will be of interest to report here that Cunningham *et al.* (4) found an increase in absolute lung weight, lung volume per unit body weight, total lung capacity and number of alveoli in rats maintained in an hypoxic condition from birth to 21 days. Also Fu (5) reported increased number of alveoli in rats exercise trained for the first three months of life.

Maximum voluntary ventilation (MVV) which depends both on the patency of air ways and tone of respiratory musculature was found highest in the runners and lowest in the Basketball players. The values for other athletic groups lie in between and are comparable. This finding supports the view expressed by Leith *et al.* (9). that endurance training increases the capacity for sustained ventilation and thus the maximum voluntary ventilation. The higher values of MVV, in all the groups of athletes in comparison to the predicted normal values for Indians (7, 18) is in accordance to the findings of Shapiro *et al.* (14) who observed that athletes had larger mean vital capacity and MVV.

However, on the basis of the comparison it can be said that boxing, basket-ball and gymnastics are less strenuous than swimming, football, running and wrestling and do not perhaps lead to much significant improvement in the lung function of the individuals involved.

When lung function values found in different subgroups of Indian athletes were compared with available lung function values in respective subgroups of American athletes (12), it was found that latter were better as far as pulmonary functions are concerned. The vital capacity in each group of American athletes seems significantly higher than their Indian counterparts, both when standardized to a height of 170 *cms* or when expressed as per square metre of body surface area. After examining the available inspiratory capacity and expiratory reserve volume values, it is felt that the former is more responsible for putting American Athletes on a higher vital capacity scale. Maximum voluntary ventilation values for American athletes again confirm their superiority over Indian athletes as far as pulmonary functions are involved. This superiority in pulmonary function in the American athletes may have occured due to prolonged athletic training from early childhood and adolescence besides the ethnic variations and over all dietry superiority, if any.

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