FUNCTIONAL CAPACITY AND BODY COMPOSITION OF DIFFERENT CLASSES OF INDIAN ATHLETES

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Smmary : Selected anthropometric characteristics, lung volumes and capacities, maximum O_2 uptake capacity, exercise ventilation and heart rate were determined on 25 top Indian athletes consisting of sprinters, middle and long-distance runners, throwers and jumpers. The trackmen and jumpers had a a higher lean body mass with a smaller fat content varying from 7.8 to 8.9% than the throwers who were tall and heavily built and had a fat content of 14.9% of their body weight. Mean vital capacity of the athletes were higher (28 ml/cm height) than the average values for Indians (18 ml/cm) while MBC values were same in the two. Middle-and long-distance runners had the highest and the throwers the lowest VO_2 max. values in terms of body weight and lean body mass. Similarly, trackmen had lower max. heart rate (181 beats/min) than the other groups of athletes. Jumpers and throwers had stronger leg muscle power, whereas throwers were strong in arm and shoulder muscle strength.

Key words : respiration sports exercise

INTRODUCTION

Performance in athletics is influenced by many factors such as aerobic and anaerobic capacity, muscular power, neuromuscular coordination, technique, tactics, motivation etc. The importance of each of these factors varies with different events e. g. the aerobic capacity is the dominant factor in endurance events like long distance running, walking and games, the anaerobic capacity in sprint running, short distance swimming, and the muscle power in throwing, wrestling, boxing etc. Various workers (2, 12, 30, 24, 13, 10, 7,9, 24, 18, 5 & 20) have studied these functions in top athletes and sportsmen of their countries. Attempts have also been made to corelate body size, shape and composition with the performance of swimmers, runners, skiers, weight lifters etc. (5,8,19,21,20 & 27). The authors have also conducted similar studies on top Indian athletes of different events and the results are presented in this paper

MATERIALS AND METHODS

Indian athletes undergoing preselection training for olympics were used as subjects. These included: 8 sprinters, 3 middle distance runners, 7 long distance runners and walkers, 3 jumpers and 4 throwers.

The followiug parameters were studied on them one hour after a light breakfast.

(a) *Lung volumes and Lung capacity*: Each subject was given two trials and three test runs for each test and the best of the three test readings was taken. The test consisted of:—

(i) Forced vital capacity (FVC)—forced expirator volume in first second (FEV_1) recorded in sitting position using a Goddart Pulmotest. (ii) Expiratory peak flow (EPF) in standing position with Wright's peak flowmeter (iii) Maximum voluntary ventilation (MVV) by making the subjects breathe through a Collins 2-way plastic 'J' valve into a meteorological balloon for 15 seconds at frequency of 60-80 per minute with maximal tidal volume maintained at that frequency.

(b) *Aerobic Capacity*: (i) Maximum oxygen intake capacity (VO_2max) which was determined by giving the graded exercise on bicycle ergometer according to Malhotra *et al.* (16). (ii) Maximum exercise ventilation (VE_{max}) attained during exercise on the bicycle ergometer using KM respirometer.

(c) *Cardiac frequency*: During submaximal and maximal exercises was recorded using E.C.G. machine.

(d) *Maximum blood lactate*: (Max LA) was estimated five minutes after the maximal exercise by the method of Barker and Summerson (4). Blood samples were collected from the prewarmed finger tip.

(e) *Muscle Power Capacity*: The explosive power of leg muscles was assessed from the distance covered in Jump & Reach and Standing Broad Jump and the arm & shoulder muscle strength from the work done (*kgm*) in Chin-up exercise (17).

(f) *Anthrapometry*: Anthropometric measurements consisted of height, weight, leg length, skinfold thickness, lean body mass and body fat content. Skinfold thicknesses at selected sites were recorded with a Lange's skinfold caliper and the body density and lean body mass were calculated by Pascale's method (22). Body density was converted into per cent body fat by using Brozek's formula (6).

RESULTS AND DISCUSSION

Anthropometric Difference:

Average values for age, height, weight. surface area and percentage of lean body mass and fat content for different types of athletes are presented in Table I. The average ages of various groups ranged from 24.3 to 28.0 years. As regards stature, the throwers were significantly taller than other classes of athletes. The tall stature of the throwers is an advantage for the throwing events since an object thrown from a higher level can travel farther in a trajectory before touching the ground (1), In body weight also, the throwers were the heaviest whilst the middle-distance runners were the lightest. The throwers' heavier stature and body weight resulted in their higher surface area.

TABLE I : Mean age, body dimensions and composition for different types of Indian athletes.*

	Sprinters	*Middle-distance runners*	*Long-distance runners and walkers*	*Jumpers*	*Throwers*	*Significance*
ge (Yrs)	24.6 ±3.46	28.0 ±2.65	27.0 ±3.87	24.3 ±3.06	24.3 ±4.03	
eight (m)	171.7 ±5.23	174.4 ±5.30	174.2 ±2.54	172.6 ±5.30	191.3 ±5.67	I Vs. V P<0.001 II Vs. V P<0.05 III Vs. V P<0.001 IV Vs. V P<0.01
Weight (kg)	62.8 ±6.71	58.8 ±10.79	62.1 ±5.71	64.7 ±0.76	100.1 ±13.32	I Vs. V P<0.01 II Vs. V P<0.01 III Vs. V P<0.01 IV Vs. V P<0.05 II Vs. IV P<0.05
Surface area (m^2)	1.72 ±0.09	1.70 ±0.17	1.73 ±0.11	1.81 ±0.04	2.37 ±0.07	I Vs. V P<0.001 II Vs. V P<0.01 III Vs. V P<0.001 IV Vs. V P<0.001
Fat (%)	7.77 ±1.22	8.10 ±1.93	8.37 ±0.94	8.90 ±1.22	14.96 ±1.67	I Vs. V P<0.001 II Vs. V P<0.01 III Vs. V P<0.001 IV Vs. V P<0.01
LBM(%)	92.33 ±1.23	91.90 ±1.93	91.10 ±1.21	91.10 ±1.22	84.11 ±3.24	II Vs. V P<0.05 IV Vs. V P<0.04

Values are Mean ± S.D.

In respect of body composition, the throwers had highest body fat (14.96%) and the lowest lean body mass (84.11%). The long-distanee runners and walkers had the lowest fat (7.77%) and highest lean body mass (92.23%). The other types of athletes were in between these two. Although the throwers had lower lean body mass when expressed as per cent of body weight, in absolute values it was 84.2 *kg* against 57.3 *kg* for the long-distance runners. It is thus apparent that the throwers are not only heavily built with higher fat content, but are also more muscular. Throwers should be massive and heavy, since in all throwing events the thrust given to the object thrown depends not only on the rapidity with which the athletes limbs move but also on his mass. When an object is thrown upwards and forwards, an equal and opposite reactive force is exerted on the athlete as in recoiling of a gun. The effect of this reactive force is less if the athlete is heavier (29).

Lung values and Capacities:

Values on various lung functions are presented in Table II. The mean vital capacity in the throwers, again, was higher (5.61 l.) than the other athletes (4.36 to 4.46 l.) This was

mostly due to the throwers' greater height and bigger lungs. When vital capacity was expressed as *ml/cm* of height, there was no significant difference between the various groups. However, the mean values of the vital capacity of these athletes, ranging from 24.8-30.7 *ml/cm* of height, was much higher than the average value of 18 *ml/cm* reported by Rao *et al.* (23) on Indian subjects of sedentary habits. In an earlier work (16), we did not find any significant difference in vital capacity in top Indian runners (26 *ml/cm*). and in moderately trained Indian soldiers (24 *ml/cm*). Regular physical training in athletes and soldiers had resulted in higher values of vital capacity than in the sedentary subjects of Rao *et al.* (23). Increased vital capacity by training, has also been reported by Stuart & Collings (28) and Novak *et al.* (19).

Table II : Mean lung volume and capacities of top Indian athletes.*

	Sprinters	*Middle-distance runners*	*Long-distance runners and walkers*	*Jumpers*	*Throwers*	*Significance*
Vital Capacity : Litres	4.40 ±0.881	4.36 ±1.121	4.38 ±0.527	4.46 ±0.555	5.61 ±0.608	I Vs. V P<0.05 III Vs. V P<0.01
ml./cm of ht.	25.2 ±4.08	24.6 ±5.71	24.8 ±3.07	26.4 ±3.91	30.7 ±3.59	III Vs. V P<0.05 III Vs. V P<0.05
FEV_1	3.55 ±0.47	3.63 ±0.52	3.54 ±0.70	4.07 ±0.42	4.79 ±0.65	I Vs. V P<0.01 III Vs. V P<0.05
$\frac{FEV_1 x100}{VC}$	81.20 ±4.19	84.20 ±8.66	82.20 ±5.06	86.60 ±3.41	80.83 ±5.39	—
MBC (Litres)	170.3 ±23.18	160.7 ±37.12	149.3 ±12.50	170.0 ±16.55	170.8 ±26.50	—
Expiratory Peak Flow rate (LBTPS/min)	598 ±78.1	652 ±62.1	593 ±51.8	667 ±40.7	810 ±14.1	I Vs. V P<0.001 II Vs. V P<0.05 III Vs. V P<0.001 IV Vs. V P<0.05

Values are Meen ± S. D.

The maximal breathing capacity (MBC) in different classes of athletes showed no significant difference. Grimby and Soderholm (14) have also reported that the MBC bears littte relation to the level of trainiug, and Stuart and Collings (28) found no difference in MBC between athletes and non-athletes. Our earlier study (16) also confirmed this observation. Expiratory peak flow was higher in all groups of athletes as compared to sedentary persons (15) and. amongst the athletes, the throwers had the highest value. The FEV_1 per cent varied from 80% to 86% tn the various groups of athletes which are within the range commonly considered as normal.

ximal oxygen consumption:

The mean $\dot{V}O_2$ max values ranged between 2.90 to 3.90 *l/min;* the lowest being in jumpers the highest in throwers. However, when the $\dot{V}O_2$ max was expressed in relation to dy weight, the highest values were obtained for middle and long-distance runners, (55.2 & 2 *ml/kg*) and the lowest for throwers and jumpers, (38.9 & 44.8 *ml/kg* respectively). Similar ferences were obtained when $\dot{V}O_2$ max values were expressed in relation to L.B.M.

Maximal oxygen consumption values (Table III) obtained on moderately trained n-athlete Indian soldiers of comparable age have been found to range between 42.3 to 7 *ml/min/kg* (26, 11 & 17). Thus, the trackmen had higher values than the throwers, d the jumpers had similar values as the trained soldiers. But the values are much lower than se of the world-class Olympic runners (2, 25 and 9).

TABLE III : Maximal oxygen uptake data*

	Sprinters	*Middle-distance runners*	*Long-distance runners and walkers*	*Jumpers*	*Throwers*	*Significance*
ximal oxygen uptake L/Min	3.19 ±0.481	3.29 ±0.926	3.27 ±0.334	2.90 ±0.483	3.90 ±0.340	I Vs. V P<0.05 III Vs. V P<0.05 IV Vs. V P<0.05
Ml/Min/Kg (Body wt.)	51.1 ±4.45	55.2 ±7.65	54.2 ±5.55	44.8 ±7.11	38.9 ±2.61	I Vs. V P<0.001 III Vs. V P<0.001
Ml/Min/Kg (LBM)	58.7 ±5.64	60.1 ±8.32	55.8 ±5.09	49.2 ±7.80	45.20 ±2.30	I Vs. V P<0.001 III Vs. V P<0.01
E. Max. BTPS/min)	104.5 ±17.21	98.4 ±23.45	104.9 ±17.02	93.5 ±18.56	133.2 ±2.40	I V. V P<0.01 III Vs. V P<0.01
Maximum Heart Rate	181.3 ±9.35	183.0 ±2.69	184.8 ±8.11	187.3 ±3.20	184.0 ±5.66	—
Maximum Lactic Acid	84.0 ±8.83	117.0 ±17.40	115.6 ±15.85	109.1 ±16.35	99.6 ±11.80	I Vs. II P<0.01 I Vs. III P<0.001 I Vs. IV P<0.05 I Vs. V P<0.05

*Values are Mean ± S.D.

The maximum exercise ventilation (VE_{max}) had the highest value in throwers (133.2 l/min) followed by sprinters and long-distance runners (105 l/min), whilst the jumpers had the lowest value (93.5 l/min). All these values are much lower than those seen in Olympic athletes (7 & 25). The mean maximum heart rate varied from 181 to 187 beats per minute which is lower than the reported values for non-athletic subjects of the same age group (16). Athletes,

especially those who take part in endurance events, have a lower maximum heart rate (16,13 & 18), in these studies, the long-distance runners and the walkers were found to have the lowest value of 181 beats per minute.

Agility, explosive power of leg muscles and arm and shoulder muscle strength:

The distance covered in Standing Broad Jump test which is indicative of the explosive power of the leg muscles, and, the Chin-up test representing arm and shoulder muscle strength, are shown in Table 4. The sprinters, jumpers, and throwers show more agility, explosive power of leg muscles and arm muscle strength than the middle and long-distance runners and walkers. It is well, known that ability to sprint and jump depends upon having powerful leg muscles. Even for the throwing events, the explosive power of leg muscles is very important for providing the propelling force necesssary for the events. Similarly, greater arm muscle strength is a definite advantage for the throwers.

TABLE IV : Explosive power of legs and arm muscle strength*

	Sprinters	*Middle-distance runners*	*Long-distance runners and walkers*	*Jumpers*	*Throwers*	*Significance*	
Height reached in Jump & Reach Test (cm)	36.0 ± 10.4	42.0 ± 2.5	37.0 ± 4.8	63.0 ± 7.8	63.0 ± 6.4	I Vs. III II Vs. IV II Vs. V III Vs. IV III Vs. V	P<0.001 P<0.05 P<0.01 P<0.001 P<0.001
Distance cleared in in Standing broad Jump (cm)	267.0 ± 14.1	214.0 ± 18.6	214.0 ± 15.4	260.0 ± 20.4	275.0 ± 9.8	I Vs. II II Vs. IV II Vs. IV II Vs. V III Vs. IV III Vs. V	P<0.001 P<0.001 P<0.05 P<0.01 P<0.01 P<0.001
Work in Chin-up test (kgm)	206.0 ± 65.6	146.3 ± 31.1	107.0 ± 21.2	208.0 ± 34.4	240.0 ± 23.1	I Vs. III II Vs. V II Vs. III III Vs. IV III Vs. V	P<0.01 P<0.01 P<0.05 P<0.001 P<0.001

*Values are Mean ± S.D.

It is thus seen that, between the various groups of athletes, throwers were tall in stature and heavily built. They also had higher agility and arm and shoulder muscle strength. The runners on the other hand, were lightly built and had higher aerobic capacity.

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