Assessment of Various Physical and Physiological Profiles of Indian Junior Male and Female Athletes as Compared with Power and Endurance Events

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The aim of the present study was to find out the level of various physical and physiological profiles of Indian junior male and female athletes in intra disciplinary manner (event specific). The study was conducted on jumper and thrower (JT, n=28, male=10 & female=18), sprinter & short distance runner (SS, n=24, male=8 & female=16), middle & long distance runner (ML, n=22, male=7 & female=15) and pentathlon & heptathlon (PH, n=5, all female) to evaluate their height, weight, body fat percentage (BF%), resting heart rate (R-HR), handgrip strength, relative back strength (RBS), maximum oxygen uptake capacity (VO_2 max) and hemoglobin% (Hb%). Right hand grip strength (HGS-R) and Hb% were found to be significantly differed ($p<0.05$) in male athletes when compared among them. The significant difference in HGS-R and Hb%, in male, was observed between JT vs ML and SS vs ML, respectively; when Scheffe's f-test for multiple comparisons was applied. On the other hand HGS-R ($p<0.001$), HGS-L, RBS & Hb% ($p<0.05$) were found to be significantly different when compared among the female athletes, In case of female athletes, the significant difference in both HGS-R & RBS was observed in PH vs ML and both HGS-L & Hb% was observed in JT vs ML when Scheffe's f-test for multiple comparisons was applied. Coefficient of correlation clearly reveals that 'age & resting HR', 'age & VO_2max', 'BF% & VO_2max' and 'strength & VO_2max' were exhibiting a strong correlation with each other in both male and female athletes. But, the relations were found to be statistically significant on above parameters only in case female athletes. The results revealed that the higher value of static strengths in (both HGS-R & L) JT

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may be due to the heavy-resistance training being given to them; which might have developed muscular hypertrophy. Further, the higher value of RBS in female PH group may probably be due to the strength training which was applied to improve the core strength; as it is essential to perform such type of events (throwing, jumping and sprint). As such scientific studies on Indian male and female athletes comparing different athletic events are limited, the data of the present study could be a handy tool and can act as a frame of reference standard for monitoring of adaptation to training intensity, in players of both genders, as per their specific events, in a systematic manner.

KEY WORDS: Athletics, Jump-Throw, Sprint-Short distance runners, Middle & long distance runners, Pentathlon-Heptathlon, VO_2 max.

INTRODUCTION

Athletics is the most ancient sport as it includes running, jumping, throwing etc. Running is the most natural part of athletics and it includes sprinting, middle distance running, long distance running and hurdle running. These activities can be traced back from the ancient Greeks which have evolved over centuries to have reached to the modern track events (Segal, 1996). Jump events mainly include triple jump, long jump and high jump. Throwing events look after javelin and discus throws. Sprints include 100m, 200m, and 400m running races. Short distance running includes 100m and 400m hurdle. Although, the running distances vary, upper limit is usually 400m (Bangsbo, 2000). Middle & long distance running includes 800m, 1000m, 1500m, 3000m, 5000m and 5km But, if we talk about jump & throw events; then, these mainly includes triple jump, long jump and high jump; but, in case of pentathlon (5 events played) and heptathlon (6 events played) they have to play many events at a time.

Physiological parameters such as resting heart rate (RHR), maximum oxygen consumption (VO_2 max) and hemoglobin has a significant effect on athletic performance as exercise has the potential to alter body composition (Segal, 1996). Morphological characteristics of athletes such as height, weight, body fat% (BF%), grip & back strength can determine the success in particular sport events in various ways. The knowledge of these characteristics is necessary to establish their importance for the success in competitive sport, especially in athletics (Manna, Khanna & Dhara, 2006).This may vary according to their physical training regiments employed, the frequency of competition, the stage of competitive season, and so

on. It can help also in identifying strength and weakness of individual players, within the team (Moore et al, 1963). Already, many studies have been areported in different variables like resting heart rate (Ogawa et al., 1992; Hagberg, 1985; Tate et al, 1994), VO_2 max (Helgerud. et al, 2007; Ekabolam et al, 1968), hemoglobin (Mairbauri, 2013), but there is still limited scientific information available concerning the comparative study between morpho-physiological characteristics particularly among the Indian male and female athletes, participating in different athletic events. Thus, evaluating and comparing the RHR, VO_2 max and hemoglobin as physiological parameters and height, weight, BF%, hand grip strength (right and left), relative back strength, as physical parameters of these different athletes would provide new insight into the field of physical fitness.

As per literature, no such study has been undertaken so far to see the effect of systematic training program and inter disciplinary physical and physiological changes on Indian junior male and female athletes. Therefore, the present investigation on Indian junior male and female athletes were undertaken:i) to evaluate and compare the effects of systematic training programmes on different physical parameters (height, weight, BF%, handgrip strength & relative back strength) physiological parameters (resting heart rate, VO_2 max, hemoglobin%); ii) to observe the changing pattern in physical and physiological parameters, in respect to intra disciplinary manners in both genders; and iii) to evaluate the relation between physical and physiological parameters.

METHODOLOGY

Selection of Subject

The present study was carried out on 25 male athletes which includes jumper and thrower (JT) (n=10, mean age=17.7 ± 1.45 years), sprint and short distance runner (SS) (n=8, mean age=16.3 ± 1.78 years) and middle and long distance runner (ML) (n=7, mean age=17.5 ±2.16 years) and 54 female athletes which includes jumper and thrower (JT) (n=18, mean age=15.3 ± 1.56 years), sprint and short distance runner (SS) (n=16, mean age=15.9 ± 2.16 years), middle and long distance runner (ML) (n=15, mean age=16.2 ± 3.42 years) and Pentathlon and Heptathlon (PH) (n=5, mean age=18.3 ± 2.98 years). All the players belong to various schemes (viz., Centre of Excellence, Sports Training Centre & Special Area Games) of Sports Authority of India (SAI), Eastern region. The players of the present study were at least of state level performer with minimum of 2-3 yrs formal training history. All the subjects were evaluated for various physical and physiological variables at Human Performance Laboratory of Sports Authority of India, Kolkata. The players belonged to almost same socio-

economic status with similar dietary habits and got trained in same kind of environmental/ climatic condition. Athletes for a specific discipline were taking the same kind of training from the SAI trained coaches. Hence, they were considered as homogeneous. Before the commencement of test, all the subjects were clinically examined by the physicians of SAI, Kolkata, who are specialized in Sports Medicine, following standard procedure (SAI: National Sports Talent Contest Scheme, 1992). The subjects who were found to be medically fit, healthy and with no history of any hereditary and cardio respiratory diseases, were finally selected for the present study. The laboratory tests were performed at a room temperature varying from 23°C to 25°C with the relative humidity varying between 50 and 60%. The field test was performed at temperature about 30°C with relative humidity of maximum about 70-80%.

Training Regimen

Formulation and implementation of systematic training programme was done by the qualified coaches under the guidance of the scientific expert from Sport Science Department, SAI, Kolkata. The training regimen included practice interval of 4 to 5 hours every day excluding Sunday, which comes around 30 hours in a week. Both morning session and evening session comprised physical training for one hour and skill training for about two hours. The physical training schedule includes different strength and endurance training programme along with flexibility exercises. Strength and Endurance training was also applied according to their sports specific requirement. Warm up and cool down session, after and before starting the main practice, were also included in the programme. Apart from the technical and tactical training, the players were also provided psychological or mental training.

Measurements

The physical characteristics of the subjects, including height (cm) & weight (kg) ,were measured by anthropometric rod and digital weighing machine, respectively; followed by standard procedure (Sodhi, 1991). The decimal age of all the subjects were calculated from their date of birth recorded from original birth certificate, produced by them at the time of testing. Back strength and hand grip strength (both right and left hand) (kg) were measured by back and grip dynamometer (Senoh, Japan) following the standard procedure (Dey & Sinha, 1994). Body fat% was measured with the help of body composition analyzer (TANITA BF-350, Tokyo, Japan). Hemoglobin was measured from the present subjects with the help of automated Hemoglobinometer (MISSION Haemoglobin (Hb) Testing Kit, USA). Maximum aerobic power (VO_2max) was assessed to use an indirect method of multistage fitness test (Beep test) (Léger & Lambert, 1982) from

where VO_2 max was predicted. The test is a progressive shuttle run test for the prediction of aerobic fitness as well as to estimate a person's maximum oxygen uptake capacity (VO_2 max) from the standard chart. The procedures and purpose of the above test were elaborately instructed to all the players. Briefly, players ran back and forth between two lines, spaced 20-m apart, in time with the "beep" sounds from a compact disc (20-m Shuttle Run test CD). Each successful run of the 20-m distance was the completion of a shuttle. The "beep" sounded at a progressively increasing pace with every minute of the test and correspondingly the player must increase his/her running speed accordingly. The player was warned if he did not reach the end line in time once. The test was terminated when he/she i) could not follow the set pace of the "beeps" for two successfully shuttles and/or ii) stopped voluntarily. Typically, the scores in the test are expressed as levels and shuttles, which estimate a person's maximum oxygen uptake capacity (VO_2 max) from the standard chart.

Statistical Analysis

Differences between groups for all variables according to their specific sport disciplines were calculated using a one-way analysis of variance (ANOVA) and matrix of correlation coefficient. The data were analyzed using the Statistical Programme for the Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, Il, USA). All values are expressed as means ± standard deviation (SD). A confidence level at 95% ($p < 0.05$) was considered as significant.

RESULTS & DISCUSSION

Table-1: Mean, Standard deviation (SD) and level of significance of various anthropometric and physiological profiles of Indian junior male athletes.

Parameters	Jump & throw distance runner (N=10)	Sprint & short distance runner (N=8)	Middle and long (N=7)	Level of significance (F value)
Age (years)	17.7 ± 1.45	16.3 ± 1.78	17.5 ± 2.16	1.53 (N.S)
Height (cm)	170.9 ± 3.99	167.9 ± 5.25	167.0 ± 5.75	1.52 (N.S)
Weight (kg)	61.9 ± 4.34	61.1 ± 4.16	56.9 ± 7.67	1.94 (N.S)
Body Fat %	12.7 ± 2.22	13.0 ± 4.30	13.1 ± 3.99	0.03 (N.S)
Resting Heart Rate (beats/min)	61.4 ± 6.47	68.0 ± 8.94	64.6 ± 3.60	2.10 (N.S)
Right Handgrip strength (kg)	44.8 ± 5.37	42.2 ± 6.13	35.5 ± 5.31	5.81*
Left Handgrip strength (kg)	45.4 ± 7.00	41.9 ± 6.29	37.0 ± 6.27	3.34 (N.S)
Relative back strength	2.1 ± 0.20	2.0 ± 0.19	2.0 ± 0.20	1.18 (N.S.)
VO2 max (ml/min/kg)	50.9 ± 5.19	49.9 ± 4.70	55.5 ± 3.48	3.10 (N.S)
Haemoglobin (%)	13.4 ± 1.51	14.7 ± 1.77	12.1 ± 0.59	4.84*

**means P<0.05, N.S. - not significant*

Table-1(a) : Scheffe's f test for multiple comparisons of selected physical & physiological parameters of Indian junior male athletes

Parameters	JT vs SS	SS vs ML	JT vs ML	SS vs JT
Right Handgrip strength (kg)	NS	NS	9.31*	NS
Hb (%)	NS	2.60*	NS	NS

**means P<0.05, N.S. - not significant;JT: jump & throw, SS: sprint & short distance runner, ML: middle & long distance runner*

The comparison of various physical and physiological parameters between Indian junior male athletes of different intra-disciplinary groups is represented in Table 1. It was evidenced from the Table that hand grip strength-right (HGS-R) and hemoglobin% (Hb%) were found to be significantly higher ($p<0.05$) in male JT and in SS, respectively. On the other hand, VO_2 max was found to be higher in male ML although the result was statistically insignificant. Rest of the parameters like height, weight, hand grip strength-left (HGS-L) and relative back strength (RBS) were found to be slightly higher in male JT. Body fat% (BF%) & resting HR were found to be lowest in male JT although the result was statistically insignificant. Table 1 (a) represented the Scheffe's f-test for multiple comparisons of selected physical and physiological parameters of elite Indian male athletes of different athletic events. The Table depicted that the significant difference in HGS-R ($p<0.05$) and Hb% ($p<0.05$) was observed between JT vs ML and SS vs ML respectively.

Table-2 : Mean, Standard deviation (SD) and level of significance of various anthropometric and physiological profiles of Indian junior female athletes.

Parameters	Jump & throw (N=18)	Sprint & short distance runner (N=16)	Middle & long distance runner (N=15)	Pentathlon & heptathlon (N=5)	Level of significance (F value)
Age (years)	15.3 ± 1.56	15.9 ± 2.16	16.2 ± 3.42	18.3 ± 2.98	1.91 (N.S)
Height (cm)	160.1 ± 4.80	158.9 ± 6.08	155.7 ± 3.11	159.3± 1.48	2.68 (N.S)
Weight (kg)	51.5 ± 8.43	47.7 ± 6.26	45.9 ± 4.46	50.6± 5.95	2.15 (N.S)
Body Fat %	23.0 ± 5.52	20.9 ± 3.39	22.2 ± 5.70	22.5± 5.96	0.49 (N.S)
Resting Heart Rate (beats/min)	70.7 ± 4.70	68.7 ± 6.03	73.5 ± 9.15	65.2 ± 4.15	2.46 (N.S)
Right Handgrip strength (kg)	31.4 ± 4.53	29.1 ± 4.86	25.8 ± 3.41	33.1 ± 3.62	6.04**
Left Handgrip strength (kg)	30.4 ± 5.27	27.8 ± 4.29	24.2 ± 3.72	30.3 ± 4.53	5.66*
Relative back strength	1.6 ± 0.26	1.7 ± 0.27	1.6 ± 0.22	2.0 ± 0.19	3.72*
VO_2 max (ml/min/kg)	38.3 ± 6.11	41.3 ± 6.96	41.8 ± 8.02	39.9 ± 7.56	0.77 (N.S)
Haemoglobin (%)	12.8 ± 0.92	12.3 ± 1.38	11.4 ± 0.90	12.1 ± 0.26	4.02*

**means P<0.05, ** means p<0.01, N.S. - not significant*

Table-2 (a) : Scheffe's f test for multiple comparisons of selected physical& physiological parameters of Indian junior female athletes

Parameters	JT vs SS	JT vs ML	PH vs JT	SS vs ML	SS vs PH	PH vs ML
Right Handgrip strength (kg)	NS	NS	NS	NS	NS	7.29*
Left Handgrip strength (kg)	NS	6.22*	NS	NS	NS	NS
Relative back strength	NS	NS	NS	NS	NS	0.41*
Haemoglobin (%)	NS	1.38*	NS	NS	NS	NS

**means P<0.05, N.S. - not significant; JT: jump & throw, SS: sprint & short distance runner, ML: middle & long distance runner, PH: pentathlon & heptathlon*

The comparison of various physical and physiological parameters between Indian junior female athletes of different intra-disciplinary groups is represented in the Table 2. It was revealed that HGS-R ($p<0.01$) and RBS ($p<0.05$) were found to be significantly higher in PH group. HGS-L and Hb% ($p<0.05$) were found to be significantly higher in JT. Rest of the parameters were found to be changed in a statistically insignificant manner among intra-disciplinary groups of female athletes in which VO2max was likely to be higher in ML group and BF% & R-HR were found to be slightly lower in SS and PH group, respectively. Table 2 (a) represented the Scheffe's f-test for multiple comparisons of selected physical & physiological parameters of elite Indian female athletes. The table depicted that the significant difference in both HGS-R ($p<0.05$) & RBS ($p<0.05$) was observed in PH vs ML and both HGS-L ($p<0.05$) & Hb% ($p<0.05$) was observed in JT vs ML.

Table - 3 : Pearson Correlations between Physical & Physiological parameters of Indian junior male athletes sports persons of different athletic disciplines [jump & throw (JT, N=10); sprint & short distance runner (SS, N=8); middle & long distance runner (ML, N=7)]

	Age	Height	Weight	BF%	HGSR	HGSL	RBS
Resting HR	JT -0.054 SS -0.076 ML 0.115	JT -0.546 SS 0.085 ML 0.145	JT -0.524 SS 0.484 ML -0.335	JT 0.259 SS 0.354 ML -0.220	JT 0.028 SS 0.293 ML 0.018	JT -0.069 SS 0.157 ML 0.412	JT -0.214 SS -0.339 ML 0.442
VO_2 max	JT -0.216 SS 0.590 ML -0.349	JT 0.065 SS -0.270 ML -0.174	JT -0.041 SS -0.457 ML -0.135	JT -0.679 SS -0.352 ML 0.184	JT -0.018 SS -0.230 ML -0.203	JT -0.113 SS -0.336 ML -0.315	JT 0.701 SS 0.285 ML -0.301
Hb%	JT 0.561 SS -0.303 ML 0.359	JT 0.110 SS 0.026 ML 0.148	JT -0.554 SS 0.138 ML 0.037	JT -0.490 SS -0.371 ML -0.149	JT -0.277 SS 0.200 ML 0.460	JT -0.531 SS -0.125 ML 0.752	JT 0.026 SS -0.049 ML 0.586

**Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed),BF%= Body Fat %, HGSR=Handgrip strength Right, HGSL=Handgrip strength Left, RBS=Relative back strength, Resting HR=resting heart rate, Hb%=Haemoglobin %.*

Table 3 demonstrated the matrix of correlation coefficient between various physical and physiological parameters of Indian junior male athletes from various disciplines, where none of the parameters were found to be significantly related with each other.

Table-4 : Pearson Correlations between Physical & Physiological parameters of Indian junior female sports persons of different athletic disciplines [jump & throw (JT, N=18); sprint & short distance runner (SS, N=16); middle & long distance runner (ML, N=15); pentathlon & heptathlon (PH, N=5)]

	Age	Height	Weight	BF%	HGSR	HGSL	RBS
Resting HR	JT -0.291 SS -0.531* ML 0.604* PH -0.051	JT -0.283 SS -0.422 ML 0.285 PH 0.234	JT -0.452 SS -0.346 ML 0.466 PH -0.233	JT -0.280 SS 0.311 ML -0.555* PH -0.171	JT -0.292 SS -0.335 ML 0.444 PH 0.194	JT -0.459 SS -0.481 ML 0.530* PH 0.060	JT 0.338 SS -0.284 ML -0.184 PH -0.141
VO_2 max	JT -0.523* SS 0.316 ML 0.682** PH 0.572	JT -0.224 SS 0.208 ML -0.243 PH 0.956*	JT -0.452 SS 0.245 ML 0.138 PH 0.848	JT -0.765** SS -0.479 ML -0.546* PH -0.888	JT 0.155 SS -0.174 ML 0.242 PH 0.984*	JT 0.155 SS -0.031 ML 0.483 PH 0.979*	JT 0.436 SS -0.190 ML 0.068 PH 0.970*
Hb%	JT 0.101 SS 0.266 ML -0.178 PH -0.442	JT 0.283 SS 0.347 ML -0.205 PH 0.709	JT -0.106 SS 0.070 ML -0.789** PH 0.714	JT -0.183 SS -0.287 ML -0.380 PH -0.102	JT 0.158 SS 0.011 ML -0.047 PH 0.627	JT 0.148 SS 0.043 ML -0.168 PH 0.622	JT -0.049 SS -0.096 ML 0.311 PH 0.474

**Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed);*
BF%= Body Fat %, HGSR=Handgrip strength Right, HGSL=Handgrip strength Left, RBS=Relative back strength, Resting HR=resting heart rate, Hb%=Haemoglobin %.

Table 4 demonstrated the matrix of correlation coefficient between various physical and physiological parameters of Indian junior female athletes from various discipline. VO_2max was negatively and significantly correlated with age ($p<0.05$) & BF% ($p<0.01$) in Indian female JT. Age was negatively and significantly correlated with R-HR ($p<0.05$) in Indian female SS. For Indian female ML following results were observed: i) R-HR was positively and significantly correlated with Age ($p<0.05$) and HGS-L ($p<0.05$), ii) BF% was negatively and significantly correlated with R-HR ($p<0.05$) and VO_2 max ($p<0.05$), iii) Body weight was negatively and significantly correlated with Hb% ($p<0.01$), iv) Age was positively and significantly correlated with VO_2 max ($p<0.01$). The Height, HGSR, HGSL and RBS all four parameters were positively and significantly correlated with VO_2 max ($p<0.05$) in Indian female PH.

Table-5: Comparison of physical and physiological profiles of the Indian junior male & female athletes with their national and international counterparts

Teams		Age (yrs)	Height (cm)	Weight (kg)	Body fat %	HGS-R (kg)	HGS-L (kg)	RBS	VO2 max ($ml.kg^{-1}min^{-1}$)
Male									
Turkish athletes (Melekoglu et al., 2015), n=28		13.6 ± 0.48	162.0 ± 7.42	53.8 ± 7.60	16.0 ± 8.28	30.1 ± 7.56	28.0 ± 6.82	1.6 ± 0.5	--
College athletes, USA (Amanda et al., 2011), n=17		20.8 ± 1.1	182.0 ± 4.9	81.7 ± 11.0	8.5 ± 4.6	46.4 ± 4.56	46.0 ± 3.80	2.1 ± 0.22	53.1 ± 5.1
Present study	JT	17.7 ± 1.45	170.9 ± 3.99	61.9 ± 4.34	12.7 ± 2.22	44.8 ± 5.37	45.4 ± 7.00	2.1 ± 0.20	50.9 ± 5.19
	SS	16.3 ± 1.78	167.9 ± 5.25	61.1 ± 4.16	13.0 ± 4.30	42.2 ± 6.13	41.9 ± 6.29	2.0 ± 0.19	49.9 ± 4.70
	ML	17.5 ± 2.16	167.0 ± 5.75	56.9 ± 7.67	13.1 ± 3.99	35.5 ± 5.31	37.0 ± 6.27	2.0 ± 0.20	55.5 ± 3.48
Female									
College athletes, USA (Amanda et al., 2011), n=22		19.7 ± 1.8	166.4 ± 5.6	62.5 ± 4.9	21.6 ± 4.0	34.6 ± 3.19	33.4 ± 2.86	1.8 ± 0.24	46.1±3.3
Present study	JT	15.3 ± 1.56	160.1 ± 4.80	51.5 ± 8.43	23.0 ± 5.52	31.4 ± 4.53	30.4 ± 5.27	1.6 ± 0.26	38.3 ± 6.11
	SS	15.9 ± 2.16	158.9 ± 6.08	47.7 ± 6.26	20.9 ± 3.39	29.1 ± 4.86	27.8 ± 4.29	1.7 ± 0.27	41.3 ± 6.96
	ML	16.2 ± 3.42	155.7 ± 3.11	45.9 ± 4.46	22.2 ± 5.70	25.8 ± 3.41	24.2 ± 3.72	1.6 ± 0.22	41.8 ± 8.02
	PH	18.3 ± 2.98	159.3± 1.48	50.6± 5.95	22.5± 5.96	33.1 ± 3.62	30.3 ± 4.53	2.0 ± 0.19	39.9 ± 7.56

**Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed);*
BF%= Body Fat %, HGSR=Handgrip strength Right, HGSL=Handgrip strength Left, RBS=Relative back strength, Resting HR=resting heart rate, Hb%=Haemoglobin %.

Table 5 represents the comparison of various physical and physiological parameters of Indian junior male and female athletes with their international counterparts. Age, height, weight and strength parameters (HGS-R, HGS-L & RBS) were found to be lower in Turkish male athletes and found to be higher in USA male college athletes than Indian male athletes. BF% was found to be higher in Turkish male athletes and lower in USA male college athletes than Indian males. VO_2 max of USA males was found to be higher than Indian male JT, SS group but lower than ML group. Age, height, weight, HGS-R, HGS-L and VO_2max was found to be higher in USA female college athletes than present studied Indian females. BF% was found to be higher in USA female athletes than Indian female SS group but lower than other Indian female groups. RBS was found to be higher in USA females than Indian female JT, SS, ML groups but lower in case of PH group.

Anthropometric and physiological measurements may possibly be used to detect potentially successful athletes for a specific discipline in sports. Mohammad et al (2012) reported that the height and

weight as an influencing parameters of physical performance. In the present study, JT in both Indian junior males and females were found to be the taller and heavier. These taller players have got an advantage in terms of their jumping and throwing performance. In regard of the result, JT group was also reported to be the heavier as compared to their other counterparts; and this may be due to their more height and also they would tend to be mesomorphic-endomorph in nature. It was observed in Table 5 that the Turkish male players were younger and both USA males and females were older in age than the Indian athletes. Height and weight of both USA male and female athletes were found to be more and Turkish males were found to be less and the change is probably due to the development of muscles and training age along with their chronological age.

It has been established that the body composition has got a strong relationship with physical activity (PA) and PA indirectly shows the physical fitness level of an individual, i.e. higher PA levels resulted in lower BF% and higher in Fat Free Mass (FFM) (Bandyopadhyay & Chatterjee, 2003). It has also been reported by many researchers that BF % was inversely proportional with FFM and less the BF% greater the energy output and higher the cardio-respiratory fitness (Bandyopadhyay & Chatterjee, 2003; Chatterjee, Chatterjee & Bandyopadhyay., 2005). So, players with lower BF% were reported to be better in terms of cardio-respiratory fitness. So, it can be mentioned that the present 'SS' group among female athletes and 'JT' group among male athletes were also may be physically more fit as they were having less BF% as compare to their other counterparts. Dey et al, (2015) have reported that the speed ability of an athlete is one of the important factors of playing fitness and the disadvantage in respect to more body fat, which is having deleterious effects on physical fitness (PF). On the comparison of present study with their international counterpart, it has been observed that USA athletes are more trained and as a result they were more fit, as they have less BF% than Indians (expect SS in Indian female). Previous studies also depicts the almost similar result that physical fitness levels are positively correlated with age and negatively correlated with BF% (Bandyopadhyay & Chatterjee, 2003).

The heart responds to strenuous training by becoming larger and more effective as a pump. The chambers (particularly the left ventricle) increase in volume from a repetitive of overload stimulus such as endurance running whilst the walls of the heart thicken and may grow stronger as a result of a pressure stimulus. For maintaining homeostatic condition, a decrease in resting heart rate (R-HR) is recovered by an increase in stroke volume (SV) which reflects an increase in ventricular systolic

contraction and end diastolic volume (Ogawa et al, 1992). This fact is supported by the Frank-Starling mechanism as well. The increase in end diastolic volume is mainly reported in endurance athletes as they gone through maximum aerobic training. But, the similar result also found in case of Heptathlon and the athletes, exposed to the similar training protocol (Rodenheffer et al, 1984; Fleg et al, 1995). In the present study, R-HR was found to be lowest in male JT group and in females PH group, respectively. The present results corroborate the observations reported by the various researchers in case PH group only; but, decreased of R-HR in JT group is not clear. The mean age of a population is below 20 yrs. and the R-HR should have the decreasing tendency with increasing age and which is observed the group who undergone through proper endurance training as reported by Hagberg., 1985. In this context, all the correlations of present subjects were found o be positive except female ML group which showed a reversed value; and the reason is however not clear. On the other hand ,Tate et al (1994) reported that no significant change in R-HR occurs with increase in age.

The strength and stiffness of the connective tissue within the muscle and in the muscle tendons is of vital importance for the transfer of the tension, produced by the muscle fibers, to external forces. Improved muscle strength count as an advantage for better athletic performance because better muscular strengths may help in proper movements, generating speed etc. Handgrip strength (HGS) and relative back strength (RBS) are two main static strength parameters that can be measured easily in athletes. These static strengths are increased and maintained with proper strength training programme (Kallinen & Markku, 1995). In the present study, significant changes were observed in HGS-R, HGS-L & RBS in female athletes and only HGS-R in male athletes in JT group in both the cases. This improvement in static strengths may be due to the resistance training which leads to the muscular hypertrophy. Similar result was reported by Ikai and Fukunaga (1970), who found 23% increase in the cross-sectional area of elbow flexors after 100days of isometric training. Faigenbaum et al (1996) noted that participation in a short-term strength training program would increase the muscular strength even during the childhood and adolescent years. A positive correlation was found between HGS -R, HGS -L and RBS and this finding reveals the fact of improved core body balance along with increased in strengths. It has also been reported that improvement in handgrip and back strength reduce the chances of strength imbalance which indirectly decreases the occurrence of injury in athletes (Girardi et al, 2013). Peltonen et al (1998) indicated that regular physical training enhances

trunk musculature hypertrophy, strength and endurance in adolescents. Table 5 reveals that both USA male and female athletes were found to be superior (expect RBS in female) in static strength as compared to the present study ;and this may be due to their higher mean age.

VO_2max is the highest rate at which an individual can consume oxygen during exercise, limits the capacity to perform aerobic exercise (Bacon et al, 2013; Helgerud et al, 2007). It is considered to be one of the best indicators of cardiovascular fitness and has been shown to be a key determinant of endurance exercise performance (Jacobs et al, 2011) and was also a better predictor of endurance performance than the lactate threshold (Marcell et al, 2003). In the present study 'ML' was found to be superior in aerobic fitness as they have the higher VO_2max. Endurance training increases VO_2max by increasing the cardiac output, high stroke volume and an increase in A-V oxygen difference (Ekabolam. et al, 1968). Apart from this, enlargement of cardiac chambers, increased density of capillaries, increase in number of mitochondria and hypertrophy of muscle fibers all contribute to the increased VO_2max in endurance athletes (Brandon, 1995). In general the VO_2max of male athletes of all discipline (52.9 ± 3.6), ML (71.8 ± 5.0) and the VO_2max of female athletes of all discipline (52.9 ± 4.8), ML (59.2 ± 3.4) were found to be higher in each case when compared with present athletes (Joussellin et al, 1984). These differences in VO_2max of Indian athletes with their international counterpart may be due to proper implementation of endurance training programme.

In the present study, VO_2max was found to be positively correlated with age (ML: female). On the other hand it was negatively correlated with age (JT: female) & BF% (JT & ML: female), respectively. These findings were corroborated with the findings of Jackson et al, 1995 and they have indicated that the VO_2max was declines between 0.4-0.5 mL/kg/min (approx 1%) each year in adults but after the age of 25 it even raises. A recent study reported that if physical activity and body composition remain relatively stable over time, the expected increase in VO_2 max goes up till adult age;after that a declining trend occurs and the value is approximately 0.25 mL/kg/min (Kasch, et al, 1990). On the other hand, the observed value of VO_2 max in JT group was found to be contradictory but it may be quite possible as this type of activity doesn't depend on aerobic capacity.

Hemoglobin (Hb) is the primary protein that is found in the erythrocytes and carries oxygen through blood to all body tissues. Hemoglobin also contributes to the blood's buffering capacity and ATP, Nitric Oxide released

from red blood cells contributes to vasodilatation and improved blood flow to working muscle. Along with VO_2max, Hb is also an important parameter for assessing aerobic fitness of an athlete (Mairbauri, 2013). The result obtained in the present study indicates that all inter disciplinary groups of athletes have Hb% within the optimal range. However, Hb% was found to be significantly higher ($p<0.05$) in male SS and female JT groups than male and female ML groups, respectively. Trained athletes, particularly in endurance sports, have a decreased hematocrit, which is sometimes called "sports anemia." This is not anemia in a clinical sense, because athletes have in fact an increased in total mass of red blood cells and hemoglobin in circulation, relative to sedentary individuals. The slight decrease in hematocrit by training is brought about by an increased plasma volume (PV). Despite stimulated erythropoiesis, exercise can decrease the red blood cell mass by intravascular hemolysis mainly of senescent red blood cells, which is caused by mechanical rupture when red blood cells pass through capillaries in contracting muscles, and by compression of red cells such as in foot soles during running or in hand palms in weightlifters (Mairbauri, 2013).

CONCLUSION

To excel in sports, an athlete always need an appropriate physique for specific event. In the present study ,'Jump-throw' (JT) group was reported to have the better physique as they were taller, heavier & having more static strength than other groups and this is needed for the specific group as it includes power event. The study also identified 'Penta-hepta' (PH) as identical to JT in terms of strength parameters and marked JT & PH as least prone to injury, because they got higher values in static strengths. Result of VO_2max marked 'Middle & long distance runner' (ML) as the best group in terms of aerobic fitness. This fact also coincides with literature as runners of ML have got the maximum endurance training. The present study was limited in terms of evaluation of athletes' cardiac capacity as only resting HR can be taken in this regard. But the overall study marked JT (in males) & PH (in females) group as fittest. But, according to the comparative result, the training of these athletes was not sufficient/ systematic and need to be modified. The research also helps coaches to provide information and feedback about the level of athletes' physical status, their individual predisposing genetic factors as well as their adaptation to training intensity which can be adjusted in future for modifying training for athletes.

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