A Comparative Study

Assessment of Physical and Physiological Profiles of Junior Female Players of Power and Endurance Events of North-East Region of India

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ABSTRACT

The aim of the present study was to find out the importance of various physical and physiological parameters of young female players of north-east region of India in both endurance and power games. The study was conducted on 80 young female athletes and divided into endurance athletes (Hockey players, n= 32; Football players, n=14) and power athletes (Weightlifting players, n=22. Wrestling players, n=12), respectively. All the subjects were selected from STC and SAG centres of Sports Authority of India, north-east region. They were evaluated for their decimal age, body height, weight, body fat % (BF %), resting heart rate (RHR), static strengths (handgrip strength and relative back strength), maximum oxygen uptake capacity and hemoglobin %. Body weight, BF%, RHR, VO_2max and static strengths were found to be significantly different ($p<0.01$) when compared among these groups except body height and hemoglobin % which were not found to be statistically significant. Coefficient of correlation further reveals that a significant relation of VO_2max and RHR with BF%, static strengths respectively. Again, the results further revealed that higher mean value of VO_2max and lower mean value of resting heart rate were observed in endurance group as compared to their power group counterparts which might be due to their nature of game and endurance based training programme; and as it was also indicated that the lower body weight and body fat%, in this group, may be the result of high training intensity. On the other hand, higher static strength in power athletes' group, as compared to endurance groups, may be due to the systematic strength training programme which was applied on them and which may be due to the development of significant muscular hypertrophy. Since such scientific study on female athletes of north east region of India are scanty, particularly the power and endurance game, the results of the present study could act as a reference standard for future comparison and also for monitoring the training regime in a scientific and systematic manner.

KEYWORDS

Endurance athletes, Power athletes, VO_2 max., Resting heart rate, Static strength, Hemoglobin%

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INTRODUCTION

Physical fitness is the fundamental necessity for excellence in any sport along with motor qualities such as speed, strength, endurance and flexibility. So, sports scientists and coaches nowadays are emphasizing more on improvement in player's conditioning by monitoring the physical fitness and physiological parameters of the players (Patel and Datta, 2014). Physiological parameters such as resting heart rate, body composition, maximum oxygen uptake (VO2max.) and hemoglobin has a significant effect on athletic performance; and as exercise can bring alteration in these profiles (Segal, 1996). Also, knowledge of different physical fitness characteristics such as body weight, body fat%, and static strengths of an athlete can determine the success in almost all sports and games (Manna et al. 2006). Baquet (2003) also reported that aerobic training aims to increase VO2 max; and also concluded that periodic monitoring of aerobic components of athletes, along with their physical performance, gives an opportunity to control and adapt training appropriately. This enables athletes to reach their peak performance.

The present study concentrates on evaluating and comparing different physical and physiological parameters of young Indian female athletes between power (Weightlifting and Wrestling) and endurance (Football and Hockey) events. In terms of the physical and physiological profiles and nature of the game, Hockey and Soccer are classified as high intensity, intermittent sports and players need technical, tactical and physical skills to succeed (Jennings et al, 2012) and hence they falls under the category of endurance group. On the other hand, the physical performance of players of power game incorporates overall static strength and power production, speed, agility, balance, stability, flexibility and the optimum level of endurance (Jovanovic et al, 2010). Wrestling and Weightlifting have undergone modifications and periodical changes which also influenced the methods of training. Power games require systematic resistance training to develop strength along with some endurance training to achieve success (Bishop et al, 1999). So, monitoring of physical and physiological profiles of power game athletes has also become absolute necessary (Raven et al, 1976).

Despite the world-wide popularity of these games, comparatively little scientific information is available concerning the physical and physiological characteristics of these group of athletes, especially in female athletes. As per literature, no such study was conducted on the basis endurance and power games, particularly in female athletes of north-east region of India, as this part of India is having lots of diversity in racial and geographical condition. Thus, the scientific study was undertaken to assess and evaluate the physical and physiological parameters on both endurance and power games of female athletes of northeast region of India and also to compare these parameters between the groups which can act as a reference standard for comparison and monitoring of the

training regime in sportspersons in these games as systematic manner.

METHODOLOGY

Subjects

The study was carried out on 80 young female athletes of different centres of Sports Authority of India (SAI) of north east region which include endurance athletes (Hockey players, n= 32, age= 15.7±1.40 years and Football players, n=14, age=15.9 ± 0.66 years) and power athletes (Weightlifting players n=22, age= 15.95 ± 0.62 years; Wrestling players, n=12, age= 16.2 ± 0.61 years). All these female athletes belonged to various centres viz. SAI Extension Centre, Thenzawl, Mizoram; SAI STC, NERC; SAI SAG, Khuman Lampak, Imphal, Manipur, under SAI, North East Regional Centre, Imphal. The selected subjects were having at least state level performers with minimum of 3-4 yrs of formal training history. The subjects were evaluated for various physical and physiological variables at Sports Science and Fitness Centre of Sports Authority of India, North East Regional Centre, Imphal. The players belonged to almost same socio-economic status, with similar dietary habits and undergoing training in same kind of environmental/ climatic condition. Hence, they were considered as homogeneous. Before commencement of test, all the subjects were clinically examined by the physicians, who are specialized in sports, medicine following standard procedure (SAI, National Sports Talent Contest Scheme, 1992). Prior to initial testing, a complete explanation of the purposes, procedures, potential risks and benefits of the tests were explained to all the subjects and a signed consent was obtained. The subjects who were found to be medically fit, healthy and without any history of hereditary and cardio respiratory diseases, were finally selected for the present study. The laboratory tests were performed at room temperature varying from 20oC – 22oC, with relative humidity varying between 50% and 60%. The field test was performed at temperature about 25oC, with relative humidity of maximum about 60% - 70%.

Training Regimen

The formulation and implementation of systematic training programme was made by the qualified coaches, with the guidance of scientific experts from Sport Science Faculty, SAI, NERC, Imphal and SAI, Kolkata. The training regimen was almost similar to both the groups of athletes except the skill training and was used to apply on an average 4 to 5 hours every day except Sunday and which comes about 30 hours in a week. There were two training sessions in a day i.e. morning session and evening session and both of which comprised physical training for one hour and skill training for about two hours. The physical training schedule includes different strength, speed and endurance training programme along

with flexibility exercises. Strength and endurance training was also applied by the qualified coaches, as per requirements. Warm up and cool down sessions before and after starting of the main practice were also included in the programme. Besides the technical and tactical training, the players were also provided with psychological or mental training sessions.

Measurements

The physical characteristics of the subjects including height (cm) and weight (kg) were measured by anthropometric rod and digital weighing machine, respectively, following standard procedures (Sodhi, 1991). The height was measured to nearest 0.1 cm and the weight was measured to nearest 0.1 kg. The decimal age of all the subjects were calculated from their date of birth was 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 standard procedures (Dey and Sinha, 1994). Later, absolute back strength was converted to the relative back strength dividing by individual's body weight. Body fat% were measured with the help of Bioelectrical Impedance Analysis (BIA) (Maltron Bioscan 920- 2, Made in UK) (Dey et al, 2015). Hemoglobin was also measured of the present subjects with the help of automated Hemoglobinometer (HemoCue 201+). Resting Heart Rate (RHR) was recorded by standard procedure.

Maximum aerobic capacity (VO2max) was assessed using an indirect method of multistage physical fitness test (Beep test) (Leger et al, 1982) from where VO2max 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 from the standard chart. The procedures and purpose of the above test was elaborately instructed to all the players. In a typical shuttle run test, the 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 marks the completion of a shuttle. The frequency of the "beep" sound increases progressively with every minute of the test and correspondingly the player increases her running speed accordingly. The player is warned verbally if she did not reach the end line in time once. The test is terminated when she i) could not follow the set pace of the "beeps" for two successful shuttles and/or ii) stops voluntarily. Typically, the scores in the test are expressed as levels and shuttles, which estimate a person's maximum oxygen

uptake capacity from the standard chart.

Statistical Analysis

Data were analyzed using the Statistical Program for Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, II, USA). Differences between groups for all variables according to their specific sports disciplines were calculated using a one-way analysis of variance (ANOVA) and Bonferroni's Post Hoc analysis. Pearson's Correlation coefficient was also done to find the relation between the physical and physiological parameters of the players. All values were expressed as descriptive statistics (mean ±SD). A confidence level at 95% ($p < 0.05$) was considered as significant.

RESULTS & DISCUSSION

The comparison of mean, standard deviation and level of significance of various physical and physiological parameters of junior female players of different sports groups were presented in Table 1. It was evident from the Table that body weight, body fat% were found to be significantly differed ($p<0.01$) when compared among the groups. Like body weight and body fat%, the static strength i.e., both the hand grip strengths and relative back strength were also differed significantly ($p<0.01$) when compared among these groups. Similar observation were also made in case of resting heart rate and maximum oxygen uptake when compared among the groups and the differences were found to be statistically significant ($p<0.01$). On the other hand, no such significant differences were observed in body height and hemoglobin percent % when compared among these sports groups.

Table-1: Comparison of mean, standard deviation (SD) and level of significance of various physical and physiological parameters of junior female athletes of northeast region of Ind

Parameters	Hockey n=32	Football n=14	Weightlifting n=22	Wrestling n=12	F value and level of significance
Age (years)	15.7±1.40	15.9±0.66	15.9±0.62	16.1±0.61	1.66 (N.S.)
Height (cm)	151.9±4.33	152.5±3.38	152.3±4.97	152.0±6.55	0.11(N.S.)
Weight (kg)	48.0±6.07	47.8±4.34	54.0±9.33	52.5±6.71	6.14**
Body Fat%	19.1±4.34	18.8±3.95	23.0±2.63	22.6±3.89	6.69**
Resting Heart Rate (beats/min)	63.3±2.84	64.5±1.73	68.2±2.45	67.5±2.14	21.67**
Right Hand Grip Strength (kg)	29.4±3.31	27.6±3.83	31.5±3.15	31.4±3.84	5.97**
Left Hand Grip Strength (kg)	26.0±3.34	27.5±3.03	30.2±3.06	30.0±3.28	9.37**
Relative Back Strength	1.21±0.19	1.19±0.18	1.39±0.27	1.80±0.41	15.62**
Hemoglobin (%)	11.4±1.29	12.1±1.23	12.5±0.94	12.0±1.72	2.48 (N.S.)
VO_2max. (ml/min /kg)	47.0±6.24	44.9±2.50	38.4±4.69	41.7±2.17	14.40**

*Level of Significance: **=p<0.01*= p<0.05, NS = Not significant*

Table 2 represented the Bonferroni's f-test for multiple comparisons of selected physical and physiological parameters of female athletes of northeast region of India. The Table depicts that the significant difference in body weight was observed when compared between Footballers vs wrestlers ($p<0.05$) and Hockey players v/s weightlifters ($p<0.01$); and other groups were found to be statistically insignificant. But, body fat % was found to be significantly differed when weightlifters were compared with Footballers ($p<0.05$) and Hockey players ($p<0.01$), respectively. It was also noted that resting heart rate significantly differed when compared between footballers vs weightlifters, footballers vs wrestlers, Hockey players vs weightlifters and Hockey players vs wrestlers, respectively, at the level of $p<0.01$. On the other hand both the hand grip strengths were showed significant difference in footballers vs weightlifters and Hockey players vs wrestlers, at the level of $p<0.01$. Relative back strength also depicted a significant difference when compared between footballers vs weightlifters, footballers vs wrestlers and Hockey players vs wrestlers ($p<0.01$), respectively.

Table-2: Bonferroni's F- test for multiple comparisons of selected physical and physiological profiles of junior female athletes of northeast region of India

Parameters	Football vs Hockey	Football vs Weightlifting	Football vs Wrestling	Hockey vs Weightlifting	Hockey vs Wrestling	Wrestling vs Weightlifting
Body Weight (kg)	ns	ns	1.96*	1.59**	ns	ns
Body Fat%	ns	1.30*	ns	1.05**	ns	ns
RHR (Beats/min)	ns	0.70**	0.57**	0.81**	0.69**	ns
HGSR(kg)	ns	1.19**	ns	1.18**	ns	ns
HGSL(kg)	ns	0.96**	ns	1.02**	ns	ns
RBS	ns	0.09**	0.10**	ns	0.09**	ns
VO_2max. (ml/min/kg)	ns	1.40**	ns	1.73**	1.72*	ns

***means p<0.01,*means= p<0.05, ns = Not significant; RHR: Resting Heart Rate; HGSR: Hand Grip Strength Right; HGSL: Hand Grip Strength Left; RBS: Relative Back Strength*

In case of VO_2 max, the post-hoc comparisons showed a significant difference in all the groups i.e., footballers vs weightlifters, Hockey players vs weightlifters and Hockey players v/s wrestlers, except footballers vs Hockey players and wrestlers vs weightlifters.

Coefficient of correlation between physical and physiological profiles of junior female athletes, of different sport disciplines, of northeast region of India are listed in Table 3. The Table reveals that VO_2max was found to be positively and significantly correlated with age and height in all groups except Hockey players. On the other hand, body weight and fat% were found to have significant positive and negative relation, respectively, with VO_2max in all the sports disciplines except Footballers. Both the hand grip

strength and relative back strength were positively and significant correlated with VO_2max except Football and Weightlifting where relations were not statistically significant. Resting heart rate was positively and significantly related with all the parameters except relative back strength which was only

Table-3: Coefficient of correlation between physical and physiological profiles of junior female athletes of different sport disciplines of northeast region of India.

	Age	Height	Weight	Body Fat%	Hand Grip Strength Right	Hand Grip Strength Left	Relative back Strength
Resting Heart Rate	Hockey .18 ns Football .53**** Weight Lifting .47**** Wrestling .48****	Hockey .42**** Football .24* Weight Lifting .64**** Wrestling .56****	Hockey .19 ns Football .58**** Weight Lifting .50**** Wrestling .34****	Hockey -.19 ns Football .63**** Weight Lifting .86**** Wrestling .57****	Hockey .29*** Football .16ns Weight Lifting .25* Wrestling .82****	Hockey .77**** Football .36*** Weight Lifting .36*** Wrestling .80****	Hockey .03 ns Football .13ns Weight Lifting .05ns Wrestling .30***
VO_2 max.	Hockey .15 ns Football .82**** Weight Lifting .56**** Wrestling .80****	Hockey .06 ns Football .78**** Weight Lifting .28** Wrestling .69*****	Hockey .23* Football .05ns Weight Lifting .28** Wrestling .68****	Hockey -.61 ns Football .17ns Weight Lifting -.29*** Wrestling -.76****	Hockey .26** Football .04ns Weight Lifting .33*** Wrestling .14ns	Hockey .70**** Football .11ns Weight Lifting .79**** Wrestling .11ns	Hockey .32*** Football .13ns Weight Lifting .22* Wrestling .69****

= 0.05; ** = 0.02 *= 0.01, ****= 0.001; ns = not significant;*

significant in Weightlifting group.

Table 4 represents the comparison of various physical and physiological parameters of present study with their female international counterparts. The Table reveals that body height and weight of the present players of both power and endurance groups were less as compared to their international female counterparts. Body fat% was found to be less in endurance group of the present study as compared to their power group and international counterparts except Turkish wrestlers who exhibited lowest body fat% among these groups.

In case of RHR both power and endurance groups, the present study was well comparable with their international counterparts except Ethiopian footballers who were found to be lowest in this component. It was evident from the Table that both right and left hand grip strength was highest in Turkish wrestlers as compared to other international counterparts, including the players of present study. Relative back strength of our present subjects showed lowest value as compared to their international counterparts, except the wrestler group, who was found with almost similar result as USA college athletes. Further, the higher VO2 max value was reported in Turkish wrestler and Ethiopian footballers as compared to other international counterparts, including present players. However, the VO2max of present Hockey players were more as compared to their Indian counterparts and even more than the New Zealand club Hockey representative and USA athletes,

Table-4: Comparison of different physical and physiological profiles of junior female athletes of North east region of India with their female international counterparts.

			Age (years)	Height (cm)	Weight (kg)	Body Fat %	RHR (beats/min)	HGSR (kg)	HGSL (kg)	RBS	VO2 Max. (ml/kg/min)
Ucan (2015) Turkish Hockey players			19.6 ± 0.8	162.1±4.8	56.0±6.1	21.9±5.3	-	32.3±4.02	29.0±2.35	-	-
Erkan (2015) Turkish Wrestlers players		AG15yrs	-	163.3±9.0	55.9±15.1	6.5±3.6	-	36.4±10.7	34.9±10	2.01±0.50	51.9±4.6
		AG16yrs	-	169.8±8.0	66.4±15.6	8.6±5.6		43.9±8.4	42.5±7.8	2.05±0.77	49.6±5.7
Bereded and Singh (2016) Ethiopian Football players U15yrs			-	-	-	-	65.02±7.65	-	-	-	49.78±2.46
Bereded and Singh (2016) Ethiopian Football players U17yrs			-	-	-	-	70±9.54	-	-	-	50.83±3.19
Keogh et. al. (2003) New Zealand Hockeyregional representative			19.4±1.0	164.7± 0.7	58.6±1.2	24.8±0.7	-	36.0±1.0	33.0±1.0	-	43.7±1.2
Keogh et. al. (2003) New Zealand Hockey club representative			20.3±1.5	163.5±1.1	56.2±0.5	27.4±0.8	-	34.0±1.0	24.0±1.0	-	38.9±1.3
Amanda et. al. (2011) USA College Athletes			19.7±1.8	166.4±5.6	62.5±4.9	21.6±4	-	34.6±3.19	33.4±2.86	1.8±0.24	46.1±3.3
Present Study	Endurance group	Hockey	15.7±1.4	151.9±4.33	48.0±6.07	19.1±4.34	63.25±2.84	29.4±3.31	26.0±3.34	1.21±0.19	47.03±6.24
		Football	15.9±0.66	152.5±3.38	47. 8±4.34	18.8±3.95	64.54±1.73	27.6±3.83	27.5±3.03	1.19±0.19	44.92±2.5
	Power group	Weightlifting	16.0±0.62	152.3±4.97	54.0±9.33	23.0±2.63	68.21±2.45	31.5±3.15	30.2±3.06	1.39±0.27	38.39±4.69
		Wrestling	16.2±0.61	152.0±6.55	52.5±6.71	22.6±3.89	67.5±2.14	31.4±3.84	30.0±3.28	1.80±0.41	41.72±2.17

RHR: Resting heart rate; HGSR: Hand grip strength right; HGSL: Hand grip strength left; RBS: Relative back strength

respectively.

Physical and physiological parameters can be possibly used to detect potentially talented athletes for a specific sports discipline. Mohammad et al, (2012) has observed that height and weight acts as an influencing parameter of physical performance. In the present study, weight of female athletes of power events group were having a significantly higher body weight as compared to their endurance group counterparts and this might be due to their physique is mesomorphic-endomorph in nature. The result further revealed that, body weight of international athletes were higher than the present athletes, the change is probably due to the development of muscles due to their higher chronological age (Table 4).

Many researchers reported that the BF% was inversely proportional to physical activity (PA). PA of an athlete is strongly related body composition of an individual thus higher physical activity results in lower BF% and higher free fat mass% (Bandyopadhyay and Chatterjee, 2003). So, less BF% might result in greater energy output and higher cardio-respiratory fitness (Chatterjee, et al, 2005). In the present study, endurance group of athletes both Hockey and Football were having significantly lower BF% as compared to their power group counterparts. Dey et al, (2015) reported that speed ability of an athlete depends on BF% thus higher BF% can be have deleterious effect on physical activity of an athlete. In the present study, endurance athletes group are having lower BF%

level than their international counterparts (except Turkish wrestlers= 9.5±5.8) and that might due to the more training effect resulting in more fitness. Whereas, both Weightlifting and Wrestling young Indian female athletes were found to have almost similar or lower BF% than their international counterparts. Also BF% in case of young female Indian endurance athletes of both Hockey and Football events was found to be significantly lower than power athletes counterparts of the present study. This might be due to more endurance based training regime of Hockey and Football players, resulting in higher PA and lower BF%.

The heart responds to strenuous training by becoming larger and more efficient as a pump and this phenomenon known as 'athlete's heart' (George et al, 2012). Athlete's heart is a specified condition when the size of left ventricle increases in response to repetitive work overload. Thus, to maintain the body's homeostasis, a decrease in the resting heart rate (RHR) is observed which is recovered by an increase in stroke volume (SV), resulting an increase in the 'end diastolic volume' (EDV) (Ogawa et al, 1992). In the present study, female athletes of Hockey and Football were reported to have significantly lower level of RHR ($p<0.01$) when compared to their power group and this low RHR was may be due to the increase in heart volume. But, the international endurance athletes are having higher RHR than all the athletes from the present study. This might be due to the fact that power group of athletes along with the endurance athletes from the present study were under more endurance based training regime than their international counterparts. Also Tate et al, (1994) reported that no significant change in RHR occurs with increase in age. Thus, higher age of international athletes might not be the reason behind their higher level of RHR.

In the present study, power female athletes were found to have significantly higher level of static strengths ($p<0.01$) than the endurance athletes. This improvement in the static strengths may be due to the muscle hypertrophy. But, athletes of the present study was found to have lower grip strength (both hands) and relative back strength (except young Indian female wrestlers= 1.80±0.41) than their international counterpart. Peltonen et al, (1998) observed same kind of result and indicate the fact that regular physical training, including systematic resistance training, enhances the trunk musculature hypertrophy and strength in power athletes. So, international athletes might have training with training regime which include more appropriate volume of resistance training and also may be due to their higher chronological age.

VO_2max is the highest rate of oxygen consumption of an individual during his all-out effort (Bacon et al, 2013). VO_2max could be regarded as a

better predictor of endurance exercise performance than lactate threshold (Marcell et al, 2003). In the present study, endurance group was found to have significantly higher level of VO_2max ($p<0.01$) than their 'power' counterparts and this may due to the increased stroke volume and cardiac output as reported by Ekabolam et al, (1968). International athletes were found to have similar or insignificantly higher level of VO_2max than their endurance counterpart. The result might be due to systematic endurance training programme.

In the present study, hemoglobin level were found to be at optimum level in all athletes; thus, that could be another reason behind the improved aerobic capacity of the present female Indian athletes. Percentage of fat was negatively correlated to VO_2 max, with the latter being a predictor of functionality in an individual, which means that an elderly individual, with levels of body fat above the normality guidelines, according to Bray's parameters (Bray et al, 1972) from 16 - 19% for men and 21 - 24% for women, will have difficulties in performing basic activities of daily life (Honglei and Xuguang, 2008), which worsens when making efforts that require greater vigor like physical exercise. VO_2max was positively associated to manual pressure strength, given that strength levels are generally related to functional capacity, as with aerobic capacity, including in elderly individuals (Skelton et al, 1995). This indicates that subjects with good levels of strength have greater ease to carry out activities that imply vigor and energy expenditure

CONCLUSION

Thus, the result revealed that higher mean value of VO_2max. and lower mean of RHR, in endurance group, might be due to their endurance based training, and also lower body weight and BF % may be of the same reason. Further, higher value of RBS and both handgrips in power athletes groups may be due to the systematic strength training programme, resulting in development of muscle hypertrophy and improving the static. So, the results of the present study can act as a frame of reference standard for comparison and monitoring the training regime in sportspersons, of both the groups, in a systematic manner; and also to help coaches with the information of physical and physiological status of the athletes.

ACKNOWLEDGMENT

The authors express their sincere gratitude to SAI, North East Regional Centre, Imphal, Manipur for providing an excellent opportunity to conduct the research.

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