Variation in Physical Activity and Maturation on Selected Physical & Physiological Profiles of Indian Junior Female Volleyball & Table Tennis Players

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ABSTRACT

Changes in specific physical and physiological parameters are difficult to assess, with reference to maturation or physical activity levels. The aim of the present study was to evaluate and establish the relations of various physical and physiological profiles of the junior female Volleyball and Table Tennis players (Eastern region of India), of different age groups with reference to growth and development.

The study was carried out on female Table Tennis (92) and Volleyball players (80), respectively, having the age group ranging from 12 to 18 years and above. Volleyball players of all the age groups, in the present study, were found to be significantly (p<0.01 & p<0.05) bigger in size as compared to their Table Tennis counterparts. Volleyball players were also having significantly (p<0.01 & p<0.05) higher value in back and hand grip strength and trunk flexibility. Like other parameters, explosive power of lower limbs (vertical jump) was also found to be more in Volleyball players, when compared with Table Tennis players of the same age group. But, the value was found to be significantly higher (p<0.05) in Volleyball players only at 16-18 yrs age. On the other hand, Table Tennis players showed a significantly higher body fat percentage as compared to their Volleyball counterparts; and the difference was significant (p<0.05) only at the age group of >18 yrs. No such significant difference was observed in maximal O2 uptake capacity, in any of the age group, when compared between the groups, though Volleyball girls dominated over their Table Tennis counterparts. However, all the physical and physiological variables were found to be increased, with increase in age in both the groups. The improvement in muscular strength and cardio-respiratory endurance, in respect to maturation, went linearly as they grew/matured. It is well established that the physical activity is one of the responsible factors, which helps to improve the different physiological parameters, along with growth and development. But, it is difficult to assess whether changes are the results of maturation or the physical activity, as they performed regularly. So, from the above discussion, it may be concluded that like growth and development the regular physical activity has also got an influence on various physiological profiles; particularly the component of strength and endurance.

KEYWORDS

Female players, Maturation, Physical activity, Physiological profiles.

INTRODUCTION

In present day, the increase in women participation in competitive sports is

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reflected in the growing popularity of women Soccer, Hockey, Volleyball, Table Tennis, Athletics etc. As women of all ages become increasingly active and successful in their sports endeavours, they deserve to achieve the full measure of their sporting potential.

The athletes, particularly the female athletes in different sports, exhibit characteristics of body composition and shape that are related to the sport/events. Relative body fat varies with physical activity level as well as with age (Leake & Carter, 1991). The physiological changes which resulted from exercise and training may shift in the same direction as those, which occur due to maturation, or even they may change in the opposite direction. For example, the improvement of peak aerobic power was due to both maturation and physical training. Similarly, decrease in oxygen cost of moving is also caused by both maturation and physical training (Armstrong & Weisman, 1994). It has been also been reported that, the improvement in motor abilities are associated with the periodic acceleration of changes in adolescents of females (Loko et al, 2000). Again, muscular strength with respect to the maturing female grows stronger as they mature making it difficult to assess whether changes are the result of maturation or physical activity levels (Grodjinovssky & Bar-Or, 1984).

Volleyball has been described as an "interval" sport with the requirement of both aerobic and anaerobic components. At higher skill levels, technical performance may be limited by physical characteristics, e.g. physical fitness, and performance characteristics, such as speed and explosive power of lower limbs (Smith et al, 1992). For both male and female players, modern Volleyball is characterized by a very high outreach above the net and great ball velocity at jump service and spiking. A very quick reaction and high agility are also required in order to able the control such balls on serve reception, especially in the field of defense. Many authors consider motor abilities, agility and explosive strength, along with pronounced longitudinal skeleton dimensionality, as the major characteristics for successful Volleyball performance (Katic et al, 2006; Milic et al, 2008; Rajic et al, 2004). The sport such as Volleyball, competitive success and efficiency of the game, largely depend on physical fitness levels (Ercolessi, 1999; Marques et al, 2008; Smith et al, 1992). On the other hand, Table Tennis is not only a sports branch which is so popular but also has little points of view. At high levels of play, the sport demands excellent fitness: players require aerobic capacity, agility, strength, speed and precision. It is also a technical sport, requiring good motor coordination, the development of sophisticated racquet movements and adequate anthropometrical requirement and biomechanical development.

However, as per literature, studies on

different physical and physiological parameters of Indian junior female athletes; in particularly Table Tennis and Volleyball are found to be scanty. So, this is insufficient to conclude the variations in specific physical and physiological parameters in various age group of the different games mainly Volleyball and Table Tennis. Therefore, the present study was conducted to:

1. Evaluate the various physical and physiological profiles of the Indian jr. female Volleyball and Table Tennis players of different age groups, with reference to growth and development.

2. To correlate the above parameters of these female athletes with physical activity and according to their age and games.

METHODOLOGY

Selection of subjects

The present study was carried out on 92 female Table Tennis players and 80 Volleyball players of four different age groups (12-14 yrs, 14-16 yrs; 16-18 yrs; Above 18 yrs; n= 23 and 20, in each group, respectively) of Table Tennis and Volleyball players, respectively. All the players were selected from various Sub-centre of Sports Authority of India (SAI), Eastern Region and including the players who trained in SAI, N.S. Eastern Center, Kolkata. The girls who played at least in the state level (in their respective category and games) were included for the study. All the players were evaluated for various anthropometric and physiological variables at Human Performance Laboratory of Sports Authority of India, Kolkata. They belonged to almost same socio-economic status, having similar dietary habits, and were having training in same kind of climatic condition. Hence, the subjects were considered as homogeneous. Before the commence-ment of test, all the players were clinically examined by the physicians of SAI, Kolkata, who are specialized in Sports Medicine, following standard procedure (SAI Manual, 1992). Prior to initial testing, a complete explanation of the purposes, procedures and potential risks and benefits of the tests were explained to all the players and a signed consent was obtained from them. The players, 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.

Training Regimen

The formulation and implementation of systematic training programme was done by the qualified coaches, with the guidance of the scientific expert from Sport Science Department, SAI, Kolkata. The training regimen was almost common to both the games of the present study, 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 sessions in a day i. e. morning session and afternoon session and both of which comprised of physical

training for at least one hour and skill training for about two hours. The physical training schedule included different strength and endurance training programme along with flexibility exercises. Strength and endurance training was also given, according to their sports specific requirement. Warm up and cool down session, after and before starting of the main practice, were also included in the programme. Besides the technical and tactical training, the players were also provided psychological or mental training session.

Measurement procedure
Measurement of Physical & Physiological Variable

The physical characteristics of the subjects including height (cm) and 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. Skin fold thickness   was recorded using Harpenden skin fold calliper at the site of biceps, triceps, subscapular and suprailliac (Eston et al, 1995).   Body density was calculated using the equation of Siri (1961) and percent Body fat (BF %) was calculated using the formula of Durnin and Womersley (1974). Back and hand grip strength (right and left) were measured by back and grip dynamometer (Senoh,

Japan) following the standard procedure (Johnson and Nelson, 1988). The hip and back flexion as well as extension of the hamstring muscles of the leg was evaluated by modified Sit-and-Reach Test using a 'Flexometer' (Lafayette Instrumental co, USA) following the standard procedure (Johnson & Nelson, 1988). Explosive power of lower limbs i.e., the power of the legs in jumping vertically upwards (VJ), was measured by using the standard method of Verduci (1980). Maximum aerobic power (VO_2 max) was assessed using an indirect method of multistage fitness test (Bleep test) (Leger et al, 1988) 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 20m apart, in time with the "beep" sounds from a compact disc (20m Shuttle Run test CD). Each successful run of the 20m distance was the completion of a shuttle.   The "beep" sounded at a progressively increasing pace with every level of the test and correspondingly the player was to increase his/her running speed accordingly. The player was warned if he/she 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 successive 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 female Table Tennis and Volleyball players for all variables according to their different age groups were calculated using a one-way analysis of variance (ANOVA). The data were analyzed using the Statistical Programme for the Social Sciences (SPSS) version 21.0 for Windows (SPSS Inc., Chicago, Il, USA). All values are expressed as means ± Standard Deviation (SD). A confidence level at 5% ($p < 0.05$) was considered as significant. Matrix of correlation coefficient of various physical and physiological parameters of women Table Tennis and Volleyball players of different age groups were also applied to analyze the collected data.

RESULTS & DISCUSSION

The comparison of various physical and physiological parameters between woman Table Tennis and Volleyball players of different age groups were presented in Table I. It is evident from the Table that height showed a significantly ($p<0.01$ & $p<0.05$) higher mean values in Volleyball players than their Table Tennis counterparts in all age groups. But, in body weight no such significant difference was observed when compared between the groups and different age groups of Table Tennis and Volleyball players, except 12-14 years age group. Body fat was found to be lower in Volleyball players as compared to the Table Tennis players; and was found to be significant ($p<0.05$) only in age group >18 years. Similarly, both back and hand grip strength (L) were also found to be significantly higher ($p<0.01$ & $p<0.05$ respectively) in Volleyball players than the Table Tennis players, in all age groups. Whereas, right hand grip strength was found to be significantly higher in Volleyball players than the Table Tennis players, only in age groups 12-14 and 16-18 years, respectively. Like back strength, the trunk flexibility was also found to be significantly higher ($p<0.05$) in Volleyball players when compared with their Table Tennis counterparts, in all age groups, except >18 years age groups. Vertical jump was found to be significantly higher ($p<0.05$) in Volleyball players when compared with Table Tennis players only in age group 16-18 years. On the other hand VO_2 max has not showed any such significant changes while comparing both Volleyball and Table Tennis players, of all age groups, though the Volleyball players had higher mean values than Table Tennis players, in all age groups.

Table 1 further represented the various physical and physiological parameters of woman Table Tennis players, of different age groups. The

difference in height and weight was found to be gradually and significantly ($p<0.01$) increased with the increase in age when compared among the groups. But, no such gradual and significant change was observed in case of body fat percent when compared among the different age groups. Like height and body weight, the static strength (hand grip strength of both right & left hand and back strength) of the players were also found to be gradually and significantly increased with the increase in age. The players of >18 years age group demonstrated the maximum increment in mean value in back strength as compared to other age groups. Almost similar trend was also noted in case of right and left hand grip strength. Again, mean values of trunk flexibility showed a gradual increment from 12 years to above 18 years of age; but, the difference was found to be statistically insignificant. On the other hand significant differences in vertical jump ($p<0.01$) and VO_2 max ($p<0.05$) were observed when compared among the groups. It was also evident from the table that a gradual improvement was observed in vertical jump test and VO_2 max. However, the minimum improvement was noted in vertical jump and VO_2 max only in the 14-16 years and 16-18 years of age group.

The various physical and physiological parameters of woman Volleyball players of different age groups are also depicted in Table I. The difference in height was found to be gradually and

significantly ($p<0.05$) increased with the increments in age when compared among the groups. But no such gradual and significant change was observed in case of body fat percent when compared among the different age groups. Like height, hand grip strength of both right and left hand of the Volleyball players were found to be significantly and gradually increased with the increase in age of all age groups. Other parameters like back strength, trunk flexibility and vertical jump test although showed a gradual increment among Volleyball players from 12 years to above 18 years of age; but, all the changes were found to be statistically insignificant. On the other hand a gradual and significant increment ($p<0.01$) in VO_2 max was observed when compared among different age groups.

Table 2 demonstrated the matrix of correlation coefficient of various physical and physiological parameters of women Table Tennis and Volleyball players of 12 – 14 years age group. It was evident from the Table that age is positively and significantly related with right hand grip strength, back strength and vertical jump test of Table Tennis players of 12-14 years age group. But, the other parameters were not found to be correlated significantly with age though the relation was found to be positive. A significant positive relation of body height was also noted with all the static strength and body weight but significant negative correlation was noted with VO_2 max. However, rest of

Table-1 : Comparison of various physical and physiological parameters of women Table Tennis (T) and Volleyball players (V) of different age groups

Variables	12-14 years age group			14-16 years age group			16-18 years age group			>18 years age group			Level of significance
	Table Tennis (n = 23)	Volleyball (n = 20)	Level of Significance	Table Tennis (n = 23)	Volleyball (n = 20)	Level of Significance	Table Tennis (n = 23)	Volleyball (n = 20)	Level of Significance	Table Tennis (n = 23)	Volleyball (n = 20)	Level of Significance	
Age (yrs)	12.8 ± 0.55	13.5 ± 0.44	NS	14.8 ± 0.55	15.0 ± 0.68	NS	16.9 ± 0.58	17.1 ± 0.57	NS	21.5 ± 2.82	19.6 ± 1.32	*	T^{**}, V^{**}
Height(cm)	142.9 ± 3.94	147.7 ± 7.06	**	148.0 ± 3.32	154.8 ± 4.32	*	150.5 ± 10.11	157.8 ± 5.50	**	151.3 ± 3.32	157.9 ± 5.50	**	T^{**}, V^{*}
Weight(Kg)	43.6 ± 9.02	49.4 ± 5.53	*	52.6 ± 8.17	50.0 ± 6.16	NS	53.5 ± 7.03	52.2 ± 5.35	NS	54.5 ± 7.86	55.7 ± 6.04	NS	T^{**}, V^{NS}
Body fat %	16.5 ± 4.09	15.5 ± 3.29	NS	20.3 ± 5.28	19.0 ± 4.01	NS	20.8 ± 5.74	19.8 ± 8.02	NS	22.0 ± 6.31	19.6 ± 6.75	*	T^{NS}, V^{NS}
Grip Strength-R (kg)	16.6 ± 4.46	18.9 ± 3.60	*	20.2 ± 5.13	21.6 ± 5.09	NS	22.2 ± 3.86	24.9 ± 4.94	**	22.4 ± 5.26	25.0 ± 4.75	NS	T^{*}, V^{*}
Grip Strength-L (kg)	14.1 ± 3.93	17.9 ± 3.90	*	16.5 ± 4.59	22.5 ± 5.78	**	18.6 ± 6.63	24.2 ± 6.47	**	20.1 ± 5.29	25.9 ± 6.75	*	T^{*}, V^{**}
Back strength (kg)	70.8 ± 7.99	75.3 ± 7.06	**	75.6 ± 9.17	78.5 ± 7.27	*	78.8 ± 8.82	82.7 ± 8.08	*	79.2 ± 7.69	82.7 ± 8.51	*	T^{**}, V^{NS}
Trunk flexibility (cm)	6.5 ± 3.76	8.0 ± 5.86	*	6.8 ± 4.36	8.6 ± 6.35	*	6.8 ± 5.48	8.7 ± 4.66	*	7.0 ± 4.47	8.7 ± 6.25	*	T^{NS}, V^{NS}
Vertical jump (cm)	26.0 ± 2.51	27.7 ± 4.98	NS	29.8 ± 4.75	29.4 ± 6.86	NS	29.9 ± 4.76	32.2 ± 8.01	*	33.3 ± 5.92	33.8 ± 7.57	NS	T^{**}, V^{NS}
VO2 max (ml/kg/min)	37.2 ± 3.48	39.4 ± 3.75	NS	42.3 ± 3.69	43.9 ± 3.82	NS	43.9 ± 4.48	44.6 ± 5.42	NS	46.2 ± 3.68	47.9 ± 4.58	NS	T^{*}, V^{**}

Values are (mean ± sd); **P< 0.01,* P< 0.05, NS= Not Significant.

Comparisons between Female Table Tennis and Volleyball players of different age groups by one way ANOVA

Comparisons among different age groups of female Table Tennis players (T) and female Volleyball players (V) by one way ANOVA

Table-2 : Matrix of Correlation Coefficient of various physical and physiological parameters of women Table Tennis players (T) and Volleyball players (V) of 12–14 years age group.

	age	ht	wt	fat%	grip-r	grip-l	b.st	flex	Ver-j	VO$_2$
age		T 0.236(NS) V -0.349(NS)	T 0.226(NS) V -0.182(NS)	T 0.274(NS) V 0.035(NS)	T 0.461* V 0.048(NS)	T 0.217(NS) V 0.032(NS)	T 0.549* V 0.082(NS)	T 0.055(NS) V 0.394(NS)	T 0.488* V 0.197(NS)	T 0.069(NS) V 0.114(NS)
ht			T 0.758* V -0.096(NS)	T 0.055(NS) V -0.481*	T 0.704* V 0.242(NS)	T 0.627* V 0.200(NS)	T 0.581* V 0.006(NS)	T -0.014(NS) V -0.305(NS)	T 0.131(NS) V 0.003(NS)	T -0.521* V -0.011(NS)
wt				T 0.381(NS) V 0.323(NS)	T 0.744* V 0.616*	T 0.745* V 0.630*	T 0.505* V 0.401(NS)	T -0.163(NS) V -0.062(NS)	T 0.231(NS) V -0.211(NS)	T -0.397(NS) V 0.240(NS)
fat%					T 0.110(NS) V -0.028(NS)	T 0.150(NS) V 0.156(NS)	T 0.230(NS) V 0.435(NS)	T 0.062(NS) V 0.244(NS)	T -0.534* V -0.023(NS)	T 0.162(NS) V 0.401(NS)
grip-r						T 0.822* V 0.829*	T 0.544* V 0.688*	T -0.236(NS) V 0.060(NS)	T 0.101(NS) V -0.353(NS)	T -0.291(NS) V 0.488*
grip-l							T 0.309(NS) V 0.707*	T -0.210(NS) V -0.019(NS)	T 0.167(NS) V -0.272(NS)	T -0.323(NS) V 0.559*
b.st								T 0.052(NS) V 0.091(NS)	T 0.325(NS) V -0.345(NS)	T -0.230(NS) V 0.728*
flex									T 0.300(NS) V -0.234(NS)	T 0.006(NS) V 0.082(NS)
ver-j										T 0.084(NS) V 0.024(NS)

**P< 0.01, * P< 0.05, NS= Not Significant.

the parameters were not significantly related with body height. Almost similar observations were made in case of body weight with others parameter like body height. As expected a significant negative correlation was observed in body fat percent with standing vertical jump ability in women Table Tennis players of 12-14 years age group. In women Volleyball players of same age group, it was observed that age is positively and insignificantly related with all the parameters like height, weight, fat percent, static strength, flexibility, vertical jump test and VO_2 max. A significant negative correlation of body height was noted with body fat percent and all other parameters though the relations were found to be statistically insignificant. Almost similar observations were also made in case of body weight with others parameter like body height except static strength which was found to be positively and significantly related with body weight. As expected a significant positive correlation was also observed in hand grip strength, back strength and VO_2 max in the Volleyball players of 12-14 years age group.

Table 3 demonstrated the matrix of correlation coefficient of various physical and physiological parameters of women Table Tennis and Volleyball players of 14 – 16 years age group. It was evident from the Table that age was positively and significantly related with right and left hand grip strength and back strength of Table Tennis players of

14-16 years age group. A significant positive relation of body height was noted with body weight and right hand grip strength. But rests of the parameters were not significantly related with body height. As expected a significant positive correlation was observed in body weight with body fat percent in the Table Tennis players. It was also evident from the Table that age was positively and significantly related with left hand grip strength, vertical jump and trunk flexibility but negatively and significantly related with body fat percent of Volleyball players of 14-16 years age group. A significant positive relation of body height was noted with the back strength. But, rest of the parameters were not significantly related with body height. Almost similar observations were also made in case of body weight with others parameter like body height. However, body weight was positively and significantly related with body fat percent.

Table 4 demonstrated the matrix of correlation coefficient of various physical and physiological parameters of women Table Tennis and Volleyball players of 16 – 18 years age group. It was evident from the Table that age was positively and significantly related with body height of Table Tennis players of 16-18 years age group. Body height was not significantly related with any of the parameters as studied. However, body weight was found to be positively and significantly related with static strength and trunk flexibility. As expected a

Table 3 : Matrix of Correlation Coefficient of Various physiological parameters of women Table Tennis player (T) and Volleyball player (V) of 14-16 year age group.

	age	ht	wt	fat%	grip-r	grip-l	b.st	flex	ver-j	VO$_2$
age		T 0.043(NS) V 0.066(NS)	T 0.132(NS) V -0.382(NS)	T -0.194(NS) V -0.474*	T 0.533* V 0.402(NS)	T 0.528* V 0.541*	T 0.521* V 0.366(NS)	T 0.104(NS) V 0.444*	T 0.145(NS) V 0.462*	T -0.025(NS) V 0.162(NS)
ht			T 0.523* V 0.251(NS)	T 0.049(NS) V 0.002(NS)	T 0.488* V 0.315(NS)	T -0.160(NS) V 0.087(NS)	T -0.235(NS) V 0.456*	T -0.329(NS) V -0.321(NS)	T -0.252(NS) V 0.249(NS)	T -0.090(NS) V 0.075(NS)
wt				T 0.693* V 0.747*	T 0.407* V -0.058(NS)	T -0.204(NS) V -0.092(NS)	T 0.254(NS) V -0.019(NS)	T 0.013(NS) V -0.360(NS)	T -0.305(NS) V -0.147(NS)	T -0.123(NS) V -0.375(NS)
fat%					T 0.044(NS) V -0.205(NS)	T 0.049(NS) V -0.320(NS)	T 0.019(NS) V -0.236(NS)	T 0.115(NS) V -0.309(NS)	T -0.235(NS) V -0.265(NS)	T -0.003(NS) V -0.015(NS)
grip-r						T 0.711* V 0.639*	T 0.633* V 0.399(NS)	T -0.091(NS) V 0.341(NS)	T -0.241(NS) V 0.509*	T -0.087(NS) V 0.041(NS)
grip-l							T 0.608* V 0.644*	T 0.050(NS) V 0.207(NS)	T -0.126(NS) V 0.177(NS)	T -0.326(NS) V 0.052(NS)
b.st								T 0.04^2(NS) V -0.184(NS)	T 0.317(NS) V 0.137(NS)	T -0.235(NS) V -0.005(NS)
flex									T 0.372(NS) V 0.226(NS)	T -0.401(NS) V 0.072(NS)
ver-j										T 0.100(NS) V 0.310(NS)

**P< 0.01, * P< 0.05, NS= Not Significant.

Table- 4: Matrix of Correlation Coefficient of various physical and physiological parameters of women Table Tennis players (T) and Volleyball players (V) of 16 -18 years age group.

	age	ht	wt	fat%	grip-r	grip-l	b.st	flex	ver-j	VO$_2$
age		T 0.505* V -0.175(NS)	T 0.339(NS) V -0.368(NS)	T 0.148(NS) V -0.359(NS)	T 0.110(NS) V -0.069(NS)	T -0.028(NS) V -0.039(NS)	T 0.289(NS) V -0.202(NS)	T 0.111(NS) V -0.131(NS)	T 0.036(NS) V 0.536*	T 0.074(NS) V -0.080(NS)
ht			T 0.124(NS) V 0.395(NS)	T -0.425(NS) V -0.384(NS)	T 0.218(NS) V 0.314(NS)	T 0.002(NS) V 0.244(NS)	T 0.417(NS) V 0.671*	T -0.126(NS) V 0.022(NS)	T -0.089(NS) V 0.075(NS)	T 0.171(NS) V 0.390(NS)
wt				T 0.286(NS) V 0.367(NS)	T 0.503* V 0.459*	T 0.270(NS) V 0.545*	T 0.536* V 0.556*	T 0.497* V -0.271(NS)	T -0.216(NS) V -0.016(NS)	T -0.171(NS) V 0.274(NS)
fat%					T -0.200(NS) V -0.044(NS)	T -0.243(NS) V 0.077(NS)	T 0.033(NS) V -0.179(NS)	T 0.317(NS) V -0.169(NS)	T -0.040(NS) V -0.363(NS)	T -0.488* V -0.260(NS)
grip-r						T 0.606* V 0.883*	T -0.034(NS) V 0.658*	T 0.473* V 0.000(NS)	T 0.076(NS) V 0.269(NS)	T -0.160(NS) V 0.519*
grip-l							T -0.101(NS) V 0.644*	V -0.062(NS)	T 0.182(NS) V 0.395(NS)	T 0.172(NS) V 0.528*
b.st								T 0.102(NS) V -0.028(NS)	T -0.117(NS) V 0.183(NS)	T -0.055(NS) V 0.544*
flex									T -0.220(NS) V 0.046(NS)	T -0.050(NS) V 0.076(NS)
ver-j										T 0.039(NS) V 0.192(NS)

**P< 0.01, * P< 0.05, NS= Not Significant.

significant negative correlation was observed in case of body fat percent with VO$_2$ max in the Table Tennis players. It was also evident from the same Table that age was positively and significantly related with vertical jump of Volleyball players of 16-18 years age group. A significant positive relation of body height was noted with the back strength. But, rest of the parameters were not significantly related with body height. However, body weight was positively and significantly related with all the static strength. As expected a significant positive correlation was observed in VO$_2$ max with all the static strength.

Table 5 demonstrated the matrix of correlation coefficient of various physical and physiological parameters of women Table Tennis and Volleyball players of >18 years age group. A significant positive relation of body height was noted with all the static strength (except right grip strength) and body weight. But, rest of the parameters was not significantly related with body height. On the other hand, body weight was found to be positively and significantly correlated with body fat% and left hand grip strength. As expected a significant positive correlation was observed in back strength and trunk flexibility with standing vertical jump in women Table Tennis players of >18 years age group. For the women Volleyball players of same age group, it has been observed that the age was positively and significantly related with

body weight. A significant positive correlation of body weight was noted with body fat percent and left grip strength. Almost similar observations were also made in case of grip strength with others parameter like back strength and standing vertical jump. As expected a significant positive correlation was observed in flexibility with standing vertical jump and VO$_2$ max in the Volleyball players of >18 years age group.

The present study reveals that most of the anthropometric and physiological profiles were found to be higher in Volleyball girls as compared to their Table Tennis counterparts, in almost all the age groups. Volleyball is the game of high intensity exercises interspersed with rest period. The technical demands of the game and the tactical system employed have led to the players adopting a specific role during the game. The game requires mainly height, explosive nature of block and spike jump along with good back and shoulder strength.

On the other hand Table Tennis players' pre-requisites are quite different as Volleyball players. The prerequisite of Table Tennis players are agility, good reflexes, strength and power of the shoulder and upper limbs etc. Height is not the prime pre-requisite for Table Tennis players as Volleyballers needed. But unique types of body size and proportion may constitute important pre-requisite for successful participation in Table Tennis.

Table -5 : Matrix of Correlation Coefficient of various physical and physiological parameters of women Table Tennis players (T) and Volleyball players (V) of >players (V) of > 18 years age group.

	age	ht	wt	fat%	grip-r	grip-l	b.st	flex	ver-j	VO₂
age		T 0.120(NS) V -0.208(NS)	T 0.127(NS) V -0.482*	T 0.027(NS) V -0.368(NS)	T 0.025(NS) V -0.152(NS)	T 0.075(NS) V -0.169(NS)	T 0.051(NS) V 0.146(NS)	T -0.296(NS) V -0.324(NS)	T -0.078(NS) V 0.175(NS)	T -0.098(NS) V -0.316(NS)
ht			T 0.582* V 0.412(NS)	T 0.405(NS) V -0.138(NS)	T 0.351(NS) V 0.407(NS)	T 0.541* V 0.394(NS)	T 0.461* V 0.062(NS)	T -0.362(NS) V 0.282(NS)	T -0.010(NS) V 0.214(NS)	T -0.139(NS) V 0.367(NS)
wt				T 0.829* V 0.472*	T 0.290(NS) V 0.421(NS)	T 0.554* V 0.513*	T 0.330(NS) V 0.072(NS)	T -0.123(NS) V 0.388(NS)	T 0.066(NS) V 0.376(NS)	T -0.147(NS) V 0.423(NS)
fat%					T -0.041(NS) V -0.162(NS)	T 0.396(NS) V -0.135(NS)	T 0.234(NS) V -0.083(NS)	T 0.018(NS) V 0.187(NS)	T 0.100(NS) V -0.180(NS)	T -0.268(NS) V 0.144(NS)
grip-r						T 0.283(NS) V 0.914*	T 0.646* V 0.381(NS)	T 0.160(NS) V 0.338(NS)	T 0.346(NS) V 0.613*	T -0.008(NS) V 0.349(NS)
grip-l							T 0.627* V 0.480*	T -0.191(NS) V 0.397(NS)	T 0.239(NS) V 0.594*	T 0.284(NS) V 0.424(NS)
b.st								T 0.041(NS) V 0.102(NS)	T 0.445* V 0.311(NS)	T 0.080(NS) V 0.381(NS)
flex									T 0.581* V 0.550*	T -0.111(NS) V 0.512*
ver-j										T 0.037(NS) V 0.318(NS)

**P< 0.01, * P< 0.05, NS= Not Significant.*

In the present study, the height, strength of the upper body and explosive power of the lower limbs of the Volleyball girls were higher as compared to the Table Tennis girls of all age groups. Recent research on elite male Volleyball players has illustrated the development of the trend towards an increase in height. The obvious advantage of possessing such an impressive height arises from the fact that Volleyball is played over a net at height of 2.43m for men and 2.24 m for women. The higher above the net a player can reach, the more likely he or she is to successfully block or spike past an opponent. The shorter the player, the higher he has to jump in order to play successfully in this aerial zone. Indeed, if the players were too short they might then not be physically able to reach the necessary heights, despite having a good vertical jumping ability (Reilly et al, 1990, Dey & Sinha, 1994). However, the present study revealed that the body weight of female Volleyball players of 12-14 years and >18 years groups were significantly more in comparison to the Table Tennis players of the same age groups and which might be disadvantageous for them in attaining a good jumping height as they have to lift a greater weight.

In the present study, the Volleyball players had significantly higher mean values of back strength, hand grip strength (both right and left) and flexibility than their Table Tennis counterparts of all age groups, indicating biomechanical advantages of the games. In fact, jumping and landing require great amount of back strength in Volleyball players, along with smashing. Strong back muscles help to lift the body in jumping as well as proper landing. To avoid game specific injuries and greater success in the game, the estimation of back strength is essential (Koley et al 2013; Unierzyski, 1995).

Standing vertical jump was found to be more in Volleyball players, in all the ages, as compared to their Table Tennis counterparts and also increased linearly with increase in age in both the sports disciplines. The ability to generate vertical height is of importance in top class Volleyball players. As previously mentioned, the elite male Volleyball players are required to play at a height 330 cm above the ground level (i.e. 87 cm above net height) whereas elite female players are required to play at a height of 300 cm above the ground (i.e. 76 cm above net height) (Reilly et al, 1990).

The vertical jump shows negative correlation with total body fat percentage, in both the Table Tennis and Volleyball players. Fleck et al (1985) have examined some physical and physiological characteristics relating to success in women Volleyball, and highlighted the power (as indicated by VJ) as the crucial physiological characteristics along with low percentage of body fat are the most important physical characteristics. The facts also confirm the present findings.

The results of the present study seems reasonable in view of the fact that both sports involve explosive jumping actions where any excess of body weight carried in the form of fat would lead to a lowered jumping capability.

Malina (1980) reported that the girls achieve strength at about ages 10-11 yrs. Following this, the girls increase in strength at ages 11 through 17 yrs. A women's strength would continue to increase until full maturity occurs at about the age of 30 years. The present study also corroborated with the study as reported by Malina. On the other hand Blimkie (1989) found that maturation related strength increases at a linear rate for most of the girls until about age 14 years. Beyond that point, the rate of increment slows down and for girls may actually decrease.

Maximum oxygen uptake capacity (VO_2 max) was found to be more, although insignificant, in Volleyball players in all the ages as compared to their Table Tennis counterparts and also increased linearly with increase in age in both the sports discipline. Table Tennis and Volleyball can be considered moderately stressful aerobic sports with the element of anaerobic energy involvement. In fact, Volleyball is an intermittent sport. It also requires players to participate in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Kunstlinger, et al, 1987; Viitasalo et al, 1987). The high intensity bouts of exercise, coupled with total duration of the match requires players to have well-developed aerobic and anaerobic alactic (ATP-CP) energy systems (Polglaze & Dawson, 1992; Viitasalo et al, 1987). As a result, Volleyball players require well-developed speed, agility, upper-body and lower body muscular power, and maximal aerobic power (VO2max). On the other hand, Table Tennis is characterized by consecutive series of fast and powerful hits against a lightweight ball. This has an alternating aerobic-anaerobic requirement, caused by short and intermittent efforts and incomplete recoveries (Carrasco et al, 2010). So, based on the nature of the game the training for these sports should be including activities promoting endurance ability as well as those develops explosive power and agility.

In their studies on females of different ages Armstrong and Weisman, (1994) reported that the general pattern of change in absolute aerobic power ($l.min^{-1}$) for girls increases with growth prior to adolescence; but, in the absence of systematic exercise, it steadily declines into adulthood. As reported a decrease in absolute aerobic power in adolescent girls is generally occurs at 13-15 yrs of age. Despite the apparent decrease in aerobic power in females of 13-15 years of age the overall rate of increase in treadmill, the absolute aerobic power for females between the ages of 8 and 16 was approximately 1-2l. The present study also corroborated with the findings as reported by Armstrong and Weisman (1994).

CONCLUSION

The physiological changes which result from exercise and training may shift in the same direction as those, which occur due to maturation, or they may change in the opposite direction. For example, peak anaerobic power increases due to both maturation and physical training. Similarly, decreases in oxygen cost of breathing are also caused by both maturation and physical training. With respect to biochemical changes in the opposite direction, the body's ability to use oxygen (i.e., anaerobic threshold, percent VO_2max) decreases due to maturation but increased due to training. On the other hand, muscular strength with respect to the maturing female grows stronger as they mature, making it difficult to assess whether changes are the result of maturation or physical activity levels. However, the results of the present study may be useful for the trainer to formulate the systematic and scientific training programme to enhance sport performance as well as for future comparison.

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