Assessment of Body Composition and Physical Fitness Components of University Level Indian Female Team Game Players

Sarita Tyagi [a], Vanaik Anil K. [a], Wasuja Monika [a], Deepak S. [b]
[a] Associate Professors, IGIPESS (University of Delhi), Vikaspuri, New Delhi, India
[b] Research Student, IGIPESS (University of Delhi), Vikaspuri, New Delhi, India

Abstract

The present study was carried out to assess the status of University level team game players belonging to Volleyball, Basketball, Handball and Hockey with respect to anthropometric measurements, body composition components and physical fitness parameters. A total of 40 female team game players in the age range of 18 to 22 years were chosen from Volleyball, Basketball, Handball and Hockey. Ten female University level players were selected for each game from various colleges of Delhi University, India. In a**nthropometry, height and weight were measured and BMI was computed. Body Composition Components were measured using BODYSTAT machine based on bioelectric impedance method.** Among Physical fitness variables, Cardio-vascular Endurance was assessed using **HARVARD STEP TEST**, Abdominal Strength was tested by Sit-ups (1 min) and Agility was measured by 4X10m Shuttle Run. **Data was treated for** descriptive statistics (mean ± standard deviation), One way analysis of variance (ANOVA) and Pearson's correlation coefficients (r) and significance was tested at 5% level of probability ($p<0.05$). The findings of the study indicated that handball players were the shortest, basketball players were the tallest among all games studied. The mean BMI values of volleyball, hockey and basketball players were almost similar and slightly higher than handball players. The mean Waist to hip ratio values were **0.89±0.08 which were** higher than the normal (0.85) values for all the game players. However, distribution according to BMI classification placed highest percentage (67.5%) of these players in normal category with highest percentage of players with normal BMI for hockey players. The lowest mean FFM (**39.50±2.72 kg)** was in handball players and highest mean FFM (**41.10±6.04 kg)** was in basketball players. Similarly mean body fat% values of handball players (**28.35±7.09 %)** were minimum as compared to the other team game players. No significant differences were observed in any of the body composition components among team game players. ANOVA revealed significant differences in Sit-ups and Physical Efficiency Index (PEI) among four groups however, no significant difference was observed for agility. Post Hoc Scheffe's test revealed the significant difference owing to differences in PEI of Hockey and Basketball players. The mean Sit-up count was highest in Handball players (37±5.20) and the lowest in basketball players (26±11.61). Shuttle run timing was comparable in three games volleyball, handball and basketball and slightly higher in hockey players. As far as computed Physical Efficiency Index is concerned the best performance was of hockey players (**65.40±7.12)**. Physical efficiency of majority of players across all teams was below average. The significant and negative correlation was seen in sit-ups with weight ($p<0.05$). PEI however did not show any significant relationship with body composition parameters. A positive and significant correlation of agility with FFM ($p<0.01$) was seen stressing the fact that there is a need to plan training programmes to improve body composition parameters like

increasing FFM and decreasing BF% along with training specific physical fitness parameters in order to exhibit the best potential of University team game athletes.
KEY WORDS: Physical fitness, body composition, Team games, shuttle run, sit-ups, physical efficiency index, cardio-respiratory fitness, abdominal strength, agility, fat free mass, body fat percent.

INTRODUCTION

The physical components of athletes largely determine their performance at all levels. Physical characteristics in turn are determined by genetics, nutritional status and training of the sportspersons. Body composition is a factor that can influence athletic performance and has a bearing upon bio-motor abilities like endurance, strength, speed, agility and flexibility. Body composition is an important component which can improve maximal work capacity by affecting training-based alterations and some physiological parameters (Venkata et al, 2004). Uppal and Chib (2001) in their study while working with volleyball players concluded that explosive strength of the legs and agility were important motor components for predicting performance in the game. To be successful in team games such as volleyball, handball, hockey and basketball, players need to develop strength, endurance, speed, agility, and neuro-muscular skills which can be enhanced by improving body composition variables through a proper conditioning programme.

Uppal and Sharma (2002) in their study found out that leg power and agility are the two important motor fitness components for predicting Badminton performance. Investigations undertaken by Shaker (1981), Ellena (1960), Dahl (1973), Atkinson (1977), Lamba (1980), Mishra (1983) and Amusa and Onyewadume (1987) in sports other than cricket have concluded that physical / motor fitness components play an important role in different games and sports and they have a direct relevance to performance. The findings of various other studies have shown that certain anthropometric and body composition characteristics are advantageous to the team game players, including greater height, greater mass (Kovaleski et al 1980), and greater upper body strength (Fry et al., 1991) and lower body fat percent (Fleck et al, 1985). The female volleyball and basketball players, having large FFM have shown excellent aerobic and anaerobic work capacities (Tsunawake et al, 2003). Manchado et al. (2013) reviewed performance factors in women's handball team- physical and physiological aspects and concluded that players that had a higher skill level were taller and had higher fat-free mass; players who were more aerobically resistant were at an advantage in international level women team handball. Regular monitoring of body composition and physical fitness variables are therefore, essential to assess any fluctuations in diet and training schedules. Proper evaluation of these parameters gives an insight into their present status and any deficit or alterations can be rectified for better health and performances. Research on body composition and physical fitness parameters of Indian female team game players is limited. Thus, this study was carried out on Indian female university level, team game players to assess the body composition components and their selected physical fitness parameters.

OBJECTIVE OF THE STUDY

The present study was carried out to assess the status of University level Indian female team game players belonging to Volleyball, Basketball, Handball and Hockey games with respect to anthropometric, body composition and physical fitness parameters.

MATERIAL AND METHODS

Sample Selection

A total of 40 female team game players in the age range of 18 to 22 years were chosen from Volleyball (19.7 ± 1.4 years), Basketball (19.4 ± 1.2 years), Handball (19.8 ± 1.3 years) and Hockey (19.3 ± 0.9 years) games as subjects for the study. Only those players who had played their respective game for at least three consecutive years and followed the criterion of minimum participation at the University level in their respective game were selected**.** The subjects were taken from various colleges of Delhi University, India and their selection was done employing purposive sampling technique.

Data Collection

The general information related to duration of participation in sports, number of hours of training, health profile etc. was obtained using a self-designed, pretested and finalized questionnaire. **Anthropometric components measured included body weight** taken using electronic weighing scale, **Height** measured using anthropometric rod. Body Mass Index (BMI) was computed with weight (kg) and height (m) values using standard formula {BMI= Weight (kg)/height (m^2)}. Body Composition components including Body Fat percent (BF%), Fat Free Mass (FFM), Muscle Mass (MM), Bone Mass (BM), Protein (P) and Fat Mass (FM) other components were measured using Body Composition Analyzer (BODYSTAT) which was based on the principle of bioelectrical impedance. Among Physical fitness variables, Cardio-vascular Endurance, Abdominal Strength and Agility were studied. **Cardiovascular endurance was measured using HARVARD STEP TEST (**Brouha, 1943) and physical fitness through Physical Efficiency Index (PEI) was calculated by the following formula:

$$\text{Physical Efficiency Index} = \frac{\text{Duration of exercise period in seconds x100}}{\text{2 x Sum of three pulse counts after exercise}}$$

Abdominal Strength was measured by Sit Up Test (one Minute) and agility was measured by (4X10m) Shuttle Run.

Statistical Analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. Percentages were computed and One way analysis of variance (ANOVA) was tested for the comparisons of data among players of different team games studied. Pearson's correlation coefficients were computed to establish the relationships among various variables measured. Data were analyzed using SPSS

(Statistical Package for Social Science) version 22.0. A 5% level of probability was used to indicate statistical significance ($p<0.05$).

RESULTS

The analysis of data pertaining to different variables chosen in the study is presented in the following tables.

Table 1 shows that Basketball players had mean body weight of 60.6±13.9 kg followed by volleyball players 58.6±1.42 kg and hockey players had mean body weight of 58.5±7.18 kg and handball players 52.3±8.58 kg. The handball players were shortest among all groups, basketball players were the tallest. The mean BMI values of volleyball, hockey and basketball players were almost similar and slightly higher than handball players.

TABLE 1: ANTHROPOMETERIC DATA OF FEMALE TEAM GAME PLAYERS (MEAN ± S.D.)

VARIABLES	VOLLEYBALL (n=10)	HANDBALL (n=10)	HOCKEY (n=10)	BASKET BALL (n=10)	TOTAL (n=40)
WEIGHT (kg)	58.6±1.42 (47.2-81.9)	52.3±8.58 (43.3 -69.4)	58.5±7.18 (48.8-75.2)	60.6±13.90 (43.6-84.2)	57.5±10.67 (43.30 -84.20)
HEIGHT (cms)	162.35±5.011 (156-172)	156.70 ±4.16 (149-163)	162.0±5.47 (155.5-173.5)	164.30±8.96 (154-184)	161.34±6.59 (149-184)
BODY MASS INDEX (BMI) (kg/m2)	22.06 ± 4.301 (18.3-30.1)	21.26±3.54 (17.1 -28.50)	22.38±2.83 (18.52-28.60)	22.12±4.90 (15.50-30.20)	21.95±3.84 (15.50-30.20)
WAIST HIP RATIO (WHR)	0.88± 0.08 (0.79 - 1.03)	0.88±0.06 (0.82-1.03)	0.90±0.05 (0.79-1.0)	0.88 ±0.11 (0.66-1.05)	0.89±0.08 (0.66-1.05)

*** Figures in parentheses ( ) represent range**

The mean Waist to hip ratio values were 0.89±0.08. WHR is used as a measurement of obesity, which in turn is a possible indicator of other more serious health conditions. The WHO states that waist–hip ratio which is indicative of fat distribution in abdominal area and hip region, above 0.90 for males and above 0.85 for females poses high health risks (WHO, 2011). In the present study, WHR showed higher than normal (0.85) mean values for all the game players. However, distribution according to BMI classification presented in table 2, highest percentage (67.5%) of these players were placed in normal category with highest percentage of players with normal BMI for hockey players. Underweight category also had 15% of total players.

TABLE 2. BODY MASS INDEX (kg/m^2) (FEMALE TEAM GAME PLAYERS) (MEAN ± SD)

STANDARD VALUE	VOLLEYBALL (n=10)	HANDBALL(n=10)	HOCKEY (n=10)	BASKETBALL (n=10)	TOTAL (n=40)
<18.5 Underweight	2 (20%)	2 (20%)	0	2 (20%)	6 (15%)

18.5 – 24.9 Normal	5 (50%)	7 (70%)	9 (90%)	6 (60%)	27 (67.5%)
25.0-29.9 Overweight	2 (20%)	1 (10%)	1 (10%)	2 (20%)	6 (15%)
30.0-34.9 Obese Grade I	1 (10%)	0	0	0	1 (2.5%)
35.0-40.0 Obese Grade II	0	0	0	0	0
Above 40.0 Obese Grade III	0	0	0	0	0

TABLE 3. WAIST HIP RATIO(FEMALE TEAM GAME PLAYERS) (MEAN ± SD)

STANDARDS	VOLLEY BALL (n=10)	HANDBALL(n=10)	HOCKEY (n=10)	BASKET BALL(n=10)	TOTAL (n=40)
BELOW NORMAL (< 0.85)	3 (30%)	3 (30%)	2 (20%)	4 (40%)	12 (30%)
NORMAL (0.85)	1 (10%)	2 (20%)	1 (10%)	1 (10%)	5 (12.5%)
ABOVE NORMAL (> 0.85)	6 (60%)	5 (50%)	7 (70%)	5 (50%)	23 (57.5%)

According to table 3, WHR was above normal (>0.85) for 57.5% of total subjects indicating more than half of the subjects having more fat in the abdominal area than in the gluteus region.

TABLE 4 : BODY COMPOSITION OF FEMALE TEAM GAME PLAYERS (MEAN ± SD)

VARIABLES	VOLLEYBALL (n=10)	HANDBALL (n=10)	HOCKEY (n=10)	BASKET BALL(n=10)	TOTAL (n=40)
FAT FREE MASS (KG)	**40.51 ± 4.30 (34.9-49)**	**36.75± 3.66 (33.6-45.1)**	**39.50±2.72 (36.6-46.2)**	**41.10±6.04 (33.1-49.4)**	**39.46±4.51 (33.10-49.40)**
FAT (KG)	**18.07±7.59 (11.7-32.8)**	**15.56±5.68 (9.3-28.2)**	**18.63±4.79 (12.1-29)**	**18.55±9.42 (3.4-34.9)**	**17.70±6.94 (3.40-34.90)**
MUSCLE MASS (KG)	**38.01±4.72 (32.4-48.5)**	**34.2±3.47 (31.2-42.1)**	**37.36±2.60 (34.1-43.2)**	**39.26±5.55 (30.7-46.2)**	**37.21±4.50 (30.7-48.5)**
BONE (KG)	**2.77±0.24 (2.44-3.20)**	**2.54±0.196 (2.37-2.99)**	**2.74±0.164 (2.54-3.05)**	**2.82±0.313 (2.35-3.22)**	**2.722±0.25 (2.35-3.22)**
PROTEIN (gm)	**8.01±0.73 (7.1-.9.5)**	**7.53±0.776 (6.9-9.3)**	**8.23±0.571 (7.5-9.5)**	**8.65±1.21 (6.8-10.2)**	**8.10±0.92 (6.8-10.2)**
BODY FAT (%)	**30.51±6.41 (23-40)**	**28.35±7.09 (15-41)**	**31.35±4.52 (24-39)**	**29.02±9.67 (7-41)**	**29.64±6.97 (7.2-41.4)**

*** Figures in parentheses ( ) represent range**

Table 4 describes the body composition profile of female team game players. It clearly shows the lowest mean FFM (39.50±2.72 kg) in handball players and highest mean FFM (41.10±6.04 kg) in basketball players. Similarly mean body fat% values of handball players (28.35±7.09 %) were minimum as compared to the other team game players. According to BMI classification, maximum number of subjects (70%) falling in normal category were from Handball game. They were the shortest and lightest among four team

games studied. No significant differences were observed in any of the body composition components among team game players.

The physical fitness parameters assessed in the present study included sit-ups for abdominal strength, Harvard step test for cardio-respiratory endurance and shuttle run for agility. ANOVA revealed significant differences in Sit-ups and Physical Efficiency Index (PEI) among four groups however, no significant differences in shuttle run was found among players of four team games studied (Table 5).

TABLE-5- ANOVA- Physical Fitness Parameters

		Sum of Squares	Df	Mean Square	F	Sig.
SIT-UPS(NO./MIN)	Between Groups	632.100	3	210.700	3.170	.036*
	Within Groups	2393.000	36	66.472		
	Total	3025.100	39			
SHUTTLE RUN(SEC)	Between Groups	.463	3	.154	.206	.891
	Within Groups	26.913	36	.748		
	Total	27.375	39			
PHYSICAL EFFICIENCY INDEX	Between Groups	1029.874	3	343.291	4.692	.007**
	Within Groups	2634.016	36	73.167		
	Total	3663.890	39			

*Significant at 0.05; **Significant at 0.01

Post Hoc Scheffe's test revealed the significant difference owing to differences in PEI of Hockey and Basketball players. Table 6(a) shows that the mean Sit-up count was highest in Handball players (37±5.20) and the lowest in basketball players (26±11.61). Basketball players had low mean values because two subjects showed very low results (Table 6 b). Shuttle run timing was comparable in three games volleyball, handball and basketball and slightly higher in hockey players. As far as computed Physical Efficiency Index is concerned the best performance was of hockey players (65.40±7.12). Basketball players (51.38±5.31) revealed the poorest performance in the Harvard Step test.

TABLE 6 (a) : PHYSICAL FITNESS PARAMETERS OF FEMALE TEAM GAME PLAYERS (MEAN ± SD)

VARIABLES	VOLLEY BALL (n=10)	HANDBAL L(n=10)	HOCKEY (n=10)	BASKET BALL(n=10)	TOTAL (n=40)
SIT UPS(NO./MIN)	30±9.05 (13-41)	37±5.20 (30-46)	28±4.67 (21-38)	26±11.61 ** (4-36)	30 ±8.81 (4-46)
SHUTTLE RUN(SEC)	11.73±0.84 (10.57-12.97)	11.87±1.12 (10.66-14.6) Ṁ	12.03±0.63 (11.05-12.86)	11.91±0.78 (10.62-13.40)	11.89±0.838 (11-15)
PHYSICAL	59.49±12.87	61.04±6.92	65.40±7.12	51.38±5.31	59.33±9.69

EFFICENCY INDEX	**(49.18-85.71)**	**(52.32-73.7)**	**(53.25-76.2)**	**(43.06-59.60)**	**(43.06-85.71)**

*** Figures in parentheses ( ) represent range**

TABLE 6 (b): UNIVARIATE STATISTICS**

	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
SIT-UPS NO.MIN	**40**	**30.3500**	**8.80719**	**0**	**.0**	**2**	**0**

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Table 7 shows that Physical efficiency of majority of players across all teams was below average indicating need to emphasize more on training focused on enhancing aerobic power of these players. With below average or poor aerobic capacity players cannot sustain energy till the end of the match and has detrimental effects on their performance.

TABLE 7: PHYSICAL EFFICIENCY INDEX (FEMALE TEAM GAME PLAYERS)

PHYSICAL EFFICENCY INDEX (PEI)	**VOLLEY BALL (n=10)**	**HAND BALL(n=10)**	**HOCKEY (n=10)**	**BASKET BALL(n=10)**	**TOTAL (n=40)**
Excellent >96	0	0	0	0	0
Good 83-96	1 (10%)	0	0	0	1 (2.5%)
Average 68-82	1 (10%)	2 (20%)	4 (40%)	0	7 (17.5%)
Below average 54-67	3 (30%)	6 (60%)	5 (50%)	3 (30%)	17 (42.5%)
Poor <54	5 (50%)	2 (20%)	1 (10%)	7 (70%)	15 (37.5%)

TABLE 8: CORRELATIONS OF BODY COMPOSITION AND PHYSICAL FITNESS PARAMETERS

		WEIGHT (KG)	HEIGHT(CMS)	BODY MASS INDEX	WAIST HIP RATIO	BODY FAT(%)	FAT FREE MASS(KG)
SIT-UPS(NO./MIN)	Pearson Correlation	-.462**	-.314*	-.347*	-.234	-.238	-.326*
	Sig. (2-tailed)	.003	.048	.028	.147	.139	.040
	N	40	40	40	40	40	40
SHUTTLE RUN(SEC)	Pearson Correlation	.467**	.125	.426**	.330*	.346*	.432**

	Sig. (2-tailed)	.002	.442	.006	.038	.029	.005
	N	40	40	40	40	40	40
PHYSICAL EFFICIENCY INDEX	Pearson Correlation	-.059	-.187	.011	.132	.144	-.136
	Sig. (2-tailed)	.717	.247	.948	.417	.377	.401
	N	40	40	40	40	40	40

*Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

Table 8 revealed the correlation of body composition and physical fitness parameters. The significant negative correlation was seen in sit-up with weight and Fat Free Mass (FFM) ($p<0.05$), positive and significant correlation of shuttle run with FFM ($p<0.01$). PEI however did show any significant relationship with body composition parameters.

DISCUSSION

The present study was carried out to assess the body composition and physical parameters of the University level team game female players studying in the University of Delhi, India. Players of four team games in the age range of 17-22 years were studied including volleyball, handball, hockey and basketball.

Basketball players were found to be heavier than all other team players and they were the tallest also and this is desirable characteristic for this game for the purpose of longer reach. Koley et al (2010) studied anthropometric and physiological characteristics on Indian inter-university volleyball players and showed that female volleyball players had mean height of 159.67±5.85 cm and mean weight of 49.96± 7.51 kg. BMI 19.62 ±2.79. In comparison to these values, the players of the present study were taller but had higher mean body weight hence, higher BMI.

Handball players had the least mean body weight and were the shortest among all the groups and for this reason their mean BMI values were lowest as compared to the other team games studied. In the present study, although distribution according to BMI classification showed highest percentage (67.5%) of these players in normal category however, the mean Waist to hip ratio values placed almost 58% of the subject having above 0.85 value indicating adiposity in the abdominal region. Despite normal BMI higher WHR may lead to health problems as age advances and also have adverse effects on the performance of athletes. Underweight category also had 15% of total players signifying high health risks for these women. Low energy intakes are associated with endocrine malfunctioning in women leading to female athletic triad.

The assessment of body composition parameters of the team game female athletes of the present study revealed the lowest mean FFM (**39.50±2.72 kg)** in handball players and highest mean FFM (**41.10±6.04 kg)** in basketball players. Similarly mean body fat% values of handball players (**28.35±7.09 %)** were minimum as compared to the other team game players. Mala et al (2015) reported mean FFM of elite female team game players of Prague, Czech Republic, as 57.81 ± 4.53kg of Volleyball players, 60.30 ± 5.42 kg of Basketball players and 56.95 ± 5.34 kg in Handball players. Similarly the mean body fat percent values have been reported to be 19.77 ± 1.77%, 21.22 ± 1.66% and 21.43 ±

2.48% for volleyball, basketball and handball players respectively. In comparison to these values the mean FFM values in the present study are lower and BF% values are higher. Similarly, according to Jeukendrup and Gleeson (2010) the desirable percentage of body fat percent for female volleyball players is 20-27% while for basketball players it is 16-25% for better performance. In the present study, mean BF% of volleyball players was 30.51±6.41% and for basketball players it was 29.02±9.67% . Higher FFM and lower BF% is directly associated with higher strength and aerobic capacity hence, better performance (Koley et al, 2010). For speed and agility, athletes body muscle and perimeters are of importance and the most important negative anthropometric factor is amount of body fat (Armstrong and Welsman, 2001, Mercier et al, 1992). In the present study, the significant and negative correlation was seen in sit-up with weight ($p<0.05$), clearly indicating higher the weight lower is the performance in sit-ups. PEI however did show any significant relationship with body composition parameters.

The mean Sit-up count was highest in Handball players (37±5.20) and the lowest in basketball players (26±11.61). The reason for low mean sit-up count in basketball players was that two basketball players could not perform well and gave very low results signifying poor core strength and the need to include exercises to strengthen this area in their conditioning programmes. Basketball players need strong core muscles -- including both the abdominals and obliques -- to support all of the games fast-paced, twisting and turning movements.

Shuttle run timing was comparable in three games volleyball, handball and basketball and slightly higher in hockey players. As far as computed Physical Efficiency Index is concerned the best performance was of hockey players It is desirable to have good cardio-respiratory fitness in hockey players which was apparent in the present study. Basketball players (**51.38±5.31)** revealed the poorest performance in the Harvard Step test. High level of cardio-respiratory endurance is a prerequisite for good performance in team game sports. Physical efficiency of majority of players across all teams was below average indicating need to emphasize more on training focused on enhancing aerobic power of these players. With below average or poor aerobic capacity players cannot sustain energy till the end of the match and has detrimental effects on their performance. Bhowmick (2001) investigated the motor fitness status of BKSP cricket players. The motor fitness components selected were speed (50m dash), agility (4x10m shuttle run), endurance (600m run and 12-minute run) and strength (standing broad jump, vertical jump, push-ups and bent knee sit-ups). He concluded that the overall motor fitness status of the players was good. The findings of the present study were contrary to the findings to the reported Indian study.

In the present study, a positive and significant correlation of shuttle run with FFM ($p<0.01$) and negative and significant correlation of sit-ups and weight was seen stressing the fact that there is a need to plan training programmes to improve body composition parameters like increasing FFM and decreasing BF% along with training specific physical fitness parameters in order to exhibit the best potential of female University team game athletes.

Acknowledgements : This work was supported by the University of Delhi, India, under Innovation Project-IGPE-301.

REFERENCES

Amusa Lateef O. and Onyewadume Ignatius (1987). A profile of the University of Ibadon male swimmers. NIS Scientific Journal,; 10:35-42.

Armstrong N, Welsman JR. (2001). Peak oxygen uptake in relation to growth and maturation in 11- to 17-year-old humans. Eur J Appl Physiol. Oct;85(6):546-51

Atkinson James R. (1973) Predicting performance in tennis, badminton and handball from certain physical traits. Completed Research in Health, Physical Education and Recreation,; 8:63.

Brouha L, Graybiel A, Heath CW (1943). Step test: Simple method of measuring physical fitness for hard muscular work in adult man. Rev Canad Biol.;2:86-92.

Bhowmick S. (2001). Performance related fitness of BKSP boys participating in team games. Bangladesh Journal of Sports Science, 2: 73-77.

Dahl Donald F. (1977). The relationship of jump shooting ability in Basketball to selected measure traits. Completed Research in Health, Physical Education and Recreation,; 19: 24.

Ellena Jack Duane (1960). Relationship of physiological factors to football performance. Completed Research in Health, Physical Education and Recreation,; 2:26.

Fry A, Kraemer WJ, Weseman C, Conroy B, Gordon S , Hoffman J, Maresh C. (1991). The effects of an off-season strength and conditioning program on starters and non-starters in women's intercollegiate volleyball. Journal of Applied Sport Science Research. 5:174-181.

Fleck S, Case S, Puhl J, Van-Handle P (1985). Physical and physiological characteristics of elite women volleyball players. Canadian Journal of Applied Sport Science.; 10:122-126.

Jeukendrup Asker and Michael Gleeson (2010). Normal ranges of body weight and body fat. Sport Nutrition, Second Edition Human Kinetics..

Koley S, Singh J, Sandhu JS (2010). Anthropometric and physiological characteristics on Indian inter-university volleyball players. J. Hum. Sport Exerc. Vol. 5, No. 3, pp. 389-399.

Kovaleski J, Parr R, Hornak J, Roitman J. (1980). Athletic profile of women college volleyball players. The Physician and Sports Medicine. 8(2):112-116.

Lamba Manmohan Kaur. (1980) Comparative study of selected physical fitness components and physiological parameters of offensive and defensive hockey players of college level. Unpublished Master`s Thesis, Jiwaji University, Gwaliar.

Mala L, Maly T, Zahalka F, Bunc V, Kaplan A, Jebavy R, Tuma M. (2015). Body composition of elite female players in five different sports games. J Hum Kinet. Apr 7;45:207-15, 2015.

Manchado C, Tortosa-Martínez J, Vila H, Ferragut C, Platen P. (2013). Performance factors in women's team handball: physical and physiological aspects--a review. J Strength Cond Res. Jun;27(6):1708-19. doi: 10.1519/JSC.0b013e3182891535.

Mercier B, Mercier J, Granier P, Le Gallais D, Prefaut (1992). Maximal anaerobic power: relationship to anthropometric characteristics during growth. Int J Sports Med 13(1): 21-26.

Mishra Laljee. (1983)Relationship of selected physical and physiological variables to performance in 50–meter front crawl swimming. Unpublished Master`s Thesis, Jiwaji University, Gwaliar,.

Shaker Mohan Chadra (1981). Comparison of selected physical fitness components of football and basketball players. Unpublished Master`s Thesis, Jiwaji University, Gwaliar,.

Tsunawake N, Tahara Y, Moji K, Muraki S, Minowa K, Yukawa K. (2003). Body composition and physical fitness of female volleyball and basketball players of the Japan inter-high school championship teams. J Physiol Anthropol Appl Human Sci. Jul;22(4):195-201.

Uppal A. K. and Chib S. S. (2001). Psychomotor variables as predictors of volleyball playing ability. Bangladesh Journal of Sports Science, , 2: 115-120.

Uppal A. K. and Sharma G. K. (2002). Relationship f selected motor components and physique characteristics to badminton playing ability. Bangladesh Journal of Sports Science, 1: 46-50.

Venkata, R. Y., Surya, K. M. V. L., Sudhakar, R. S., & Balakrishna, N. (2004). Effect of changes in body composition profile on VO2max and maximal work performance in athletes. Journal of Exercise Physiology, 7: 34–39.

WHO, 2011 http://whqlibdoc.who.int/publications/2011/9789241501491_eng.pdf