

## Physical Fitness and Performance Indicators of Indian Female Volleyball Players: the Need for individual Data

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### Abstract

The performances of Indian female volleyball teams (mini to senior levels) are poor at the Asian as well as in the international levels. This has become a challenge to the volleyball coaches, physical educationists and sports scientists of India. Though efforts are being made to improve the performance of Indian female volleyball players of different levels however, very little success has been achieved so far in this regard due to fact that in India the emphasis during selection of teams in different levels has been based on only in skills and tactics without much consideration of physical fitness and performance indicators of volleyball players. In this respect the researcher realizes the importance of physical fitness and performance indicators in the game of volleyball and undertaken this topic.

The present study was aimed to assess the physical fitness indicators i.e. strength, speed, power, agility, flexibility and muscular endurance and the performance indicators i.e. height, weight, grip strength (left + right), back strength, block jump and spike jump of Indian talented sub-junior female volleyball players and to compare the results with age matched Control Group. Also, compare the findings of the Indian talented sub-junior female volleyball players with that of their international standards from available literatures and to make some suggestions for the improvement of their performance level in international standard. The study was carried out in twenty (20) Indian talented sub-junior female volleyball players aged between 13 to 16 years and twenty (20) ages matched female Control Group. Physical fitness indicators of volleyball game namely strength, speed, power, agility, flexibility, muscular endurance and performance indicators namely height, weight, grip strength (left + right), back strength, block jump and spike jump were measured by their respective standard tests. Data was analyzed using Independent Sample 't' test by using SPSS, (Version 20.0) software. The level of significance chosen was 0.05.

The results of t-test revealed that all physical fitness and performance indicators of Indian talented sub-junior female volleyball players were statistically significant in compared to their age matched Control Group but when values of the each physical fitness and performance indicators were compared to the international standards, the Indian talented sub-junior female volleyball players were behind the recommended norms for the elite international female sub-junior volleyball players. The Indian sub-junior female volleyball players have more advantages in strength, speed, power, agility, flexibility, muscular endurance, height, weight, grip strength (left + right), back strength, block jump and spike jump of physical fitness and performance indicators respectively in compared to their age matched Control Group.

**Keywords:** Physical Fitness, Performance indicators, strength, speed, power, agility, flexibility, muscular endurance, grip strength, back strength, block jump, spike jump.

### INTRODUCTION

Millions of people play volleyball across the world. In many countries, it has been ranked as one of the top level competitive sport. During a volleyball match players are involved in various

performance movements such as; defensive and offensive jumps, blocks, spikes and sprints where power, strength, agility, and speed are required (Gabbett & Georgieff, 2006). Volleyball is a team sport which requires intermittent bouts of high intensity exercise, followed by periods of low intensity activity (i.e. walking or standing) (Marques et al., 2006). These high-intensity bouts include both horizontal approach movements (spike jumps) and movements without an approach i.e. jump setting, jousts, blocking (Sheppard et al., 2008). Nowadays, elite volleyball players are quicker, stronger and in better physical condition than before, which could be a result of year-round scientific training and developing skills that added strength, power and fitness specific to their sport (Scates & Linn, 2003).

The performance of volleyball players is influenced by many factors such as physical, physiological and psychological variables, technique, tactics, physique, body size, body composition and application of biomechanical principles. It has been well established that special physical characteristics indicates whether the player would be suitable for the competition at the highest level in a specific sport (Slater et al., 2005). No doubt the performance of player influenced by many factors but still physical fitness components of a specific game is the primary factor among those entire factors (Lidor & Ziv, 2010). Thakur and Sinha, (2010) pointed out that, *“world’s topmost sporting nations are very much conscious on fitness factors which are supposed to play a dominant role in its future performance in sports and games”*. During the course of game, players are required to serve, pass, set, attack, block and dig the ball. Playing volleyball requires strength, power, agility, flexibility, balance, speed and cardiovascular endurance along with performance related factors like body composition, physiological and mechanical aspects as well as skills in order to be played effectively.

The poor performance of Indian athletes and different sports at international competitions has been of great concern, especially to the coaches, physical educationists and sports scientists. Efforts have been made to improve the standards of our sports persons since long; however, little success has so far been achieved in this respect. Performance of any game at national and international level mainly depends upon the specific physical fitness components of that particular game along with others performance related components.

So, this present study was undertaken to measure the selected physical fitness indicators like strength, speed, power, agility, flexibility, muscular endurance and performance indicators namely height, weight, grip strength (left + right), back strength, block jump and spike jump of Indian talented sub-junior female volleyball players and to find out the lacunae in the physical fitness and performance indicators level so that the researcher may come up with some valuable suggestions to improve the performance level of Indian talented sub-junior female volleyball players. With this in keep in mind a study was undertaken to assess the physical fitness and performance indicators of Indian talented sub-junior female volleyball players as compared to age matched controls and their international standard.

## **MATERIAL AND METHODS**

**Selection of Subjects:** The present study was carried out in the Sports Authority of India, Eastern Centre, Calcutta during their National Camp. This study included twenty (20) Indian talented sub-junior female volleyball players as Study Group, aged between 13 to 16 years, who were selected for the participation in sub-junior Asian Championship. The Control Group consisted of twenty (20) age matched female students of different Higher Secondary Schools from Paschim Medinipur district. Prior to the administration of tests, a meeting of the subjects was held in the presence of researcher, coaches and other recorders. The requirements of the testing procedures were explained to them in detail so that there was no ambiguity in their minds regarding the efforts required of them.

**Selection of Physical Fitness and Performance Indicators:** The research scholar had gone through the scientific literatures pertaining to the analysis of physical fitness and performance indicators from different sources and also consulted the volleyball experts and coaches of Sports Authority of India (SAI). Along with the said literatures and expert opinions, the administrative feasibility in terms of availability of instruments and expertise for measuring and recording of data were also given due consideration while selecting the physical fitness and performance indicators. Based on the above mentioned criteria the following physical fitness and performance indicators and their test items were selected as follows:

Physical Fitness and Performance Indicator	Test Item	Unit
Strength (Arm)	3 lb. Medicine Ball Put	Meter
Speed	20 Meter Dash	Second
Power (Legs)	Sargent Vertical Jump	Centimeter
Agility	4x10 Meter Shuttle Run	Second
Flexibility	Set and Reach Test	Centimeter
Muscular Endurance (Abdomen)	Sit Up	Number
Height	Stadiometer	Centimeter
Weight	Weighing Machine	Kilogram
Grip Strength (left + right)	Grip Dynamometer	Kilogram
Back Strength	Back Dynamometer	Kilogram
Block Jump	Block Jump Apparatus	Meter
Spike Jump	Block Jump Apparatus	Meter

**Administration of the testing procedures:** The administration of testing procedures of physical fitness indicators of Indian talented sub-junior female volleyball players are as follows: Arm strength was measured by three (3) pound medicine ball put by best of three trail in meter unit; Speed, 20 meter dash by single trail in second; Power (legs), Sargent vertical jump by best of three trail in centimeter; Agility by best of three trail in second; Flexibility by best of two trail in centimeter and Muscular endurance (abdomen) by bent knees sit up in single trail of continuous legal sit ups in number unit respectively. Among the performance indicators height, weight, grip strength (left + right), back strength, block jump and spike jump were measured through stadiometer in centimeter, weighing machine in kilogram, grip dynamometer in kilogram, back dynamometer in kilogram, block jump apparatus in meter and spike jump apparatus in meter units respectively.

**Statistical analysis:** For the purpose of analysis of data on selected physical fitness and performance indicators of Indian talented sub-junior female volleyball players' of descriptive statistics the mean, standard deviation and standard error of mean were obtained through the Statistical Package for Social Studies, (SPSS, Version 20, Inc., Chicago, Illinois). To check the

difference of mean scores of Study Group and Control Group, the Independent Samples 't' test was applied. The level of significance was set at 0.05.

## RESULTS

The findings pertaining to the physical fitness and performance indicators of Indian talented sub-junior female volleyball players are presented in Table 1.

**Table 1**  
**Mean, Standard Deviation and Range of Physical Fitness and Performance Indicators of Indian Talented Sub-junior Female Volleyball Players (Study Group)**

Physical Fitness and Performance Indicators	Mean	Standard Deviation	Range
Strength (Meter)	5.98	± 0.70	4.40 – 7.02
Speed (Second)	5.21	± 0.16	4.98 – 5.40
Power (Centimeter)	41.19	± 3.74	33 - 51
Agility (Second)	12.20	± 0.20	11.88 – 12.71
Flexibility (Centimeter)	19.71	± 6.38	04 – 29
Muscular Endurance (Number)	16.85	± 3.85	12 – 22
Height (Centimeter)	164.31	± 5.15	154.1 – 170.70
Weight (Kilogram)	56.62	± 5.20	42 – 69
Grip Strength (left + right) (Kilogram)	54.76	± 5.42	47 – 68
Back Strength (Kilogram)	65.14	± 8.42	50 – 76
Block Jump (Meter)	2.50	± 0.08	2.40 – 2.64
Spike Jump (Meter)	2.55	± 0.08	2.45 – 2.69

Table 1 clearly indicates that the mean, standard deviation and range of physical fitness and performance indicators of Indian talented sub-junior female volleyball players. The observed mean, standard deviation and range of physical fitness indicators were: Strength (meter):  $5.98 \pm 0.70$  and 4.40 – 7.02, Speed (second):  $5.21 \pm 0.16$  and 4.98 – 5.40, Power (centimeter):  $41.19 \pm 3.74$  and 33 – 51, Agility (second):  $12.20 \pm 0.20$  and 11.88 – 12.71, Flexibility (centimeter):  $19.71 \pm 6.38$  and 04 – 29, Muscular Endurance (number):  $16.85 \pm 3.85$  and 12 – 22 respectively. The observed mean, standard deviation and range of performance indicators were: Height (Centimeter):  $164.31 \pm 5.15$  and 154.1 – 170.70, Weight (Kilogram):  $56.62 \pm 5.20$  and 42 – 69, Grip Strength (left + right) (Kilogram):  $54.76 \pm 5.42$  and 47 – 68, Back Strength (Kilogram):  $65.14 \pm 8.42$  and 50 – 76, Block Jump (Meter):  $2.50 \pm 0.08$  and 2.40 – 2.64, Spike Jump (Meter):  $2.55 \pm 0.08$  and 2.45 – 2.69 respectively.

The research that was conducted aimed to determine the differences in physical fitness and performance indicators between Indian talented sub-junior female volleyball players (Study Group) and age matched Control Group. Results of Descriptive statistics and Independent Sample 't' test of Indian talented sub-junior female volleyball players (Study Group) and age matched Control Group are presented in Table 2.

**Table 2**  
**Mean, Standard Deviation, Mean Differences & Independent Sample t-test of**  
**Study Group and Control Groups of Selected Physical Fitness Indicators**

Physical Fitness Indicators	Study/Control Group (N=19)	Mean	S.D	M.D	t-value	Sig. (2-tailed)	S/NS
<b>Strength</b>	Study Group	5.98	± 0.70	2.25	8.94	<b>0.000*</b>	<b>S</b>
	Control Group	3.73	± 0.73				
<b>Speed</b>	Study Group	5.21	± 0.16	-1.72	5.39	<b>0.000*</b>	<b>S</b>
	Control Group	6.93	± 0.69				
<b>Power</b>	Study Group	41.19	± 3.74	13.51	8.89	<b>0.000*</b>	<b>S</b>
	Control Group	27.68	± 5.60				
<b>Agility</b>	Study Group	12.20	± 0.20	-3.56	7.06	<b>0.000*</b>	<b>S</b>
	Control Group	15.76	± 1.48				
<b>Flexibility</b>	Study Group	19.71	± 4.38	9.56	10.96	<b>0.000*</b>	<b>S</b>
	Control Group	10.15	± 7.04				
<b>Muscular Endurance</b>	Study Group	16.85	± 3.85	9.54	12.50	<b>0.000*</b>	<b>S</b>
	Control Group	7.31	± 5.59				

\*Significant at .05 level.

Tabulated  $t_{.05} (38) = 2.02$ .

**Table 3**  
**Mean, Standard Deviation, Mean Differences & Independent Sample t-test of**  
**Study Group and Control Groups of Selected Performance Indicators**

Performance Indicators	Study/Control Group (N=19)	Mean	S.D	M.D	t-value	Sig. (2-tailed)	S/NS
<b>Height</b>	Study Group	164.31	± 5.15	8.08	8.85	<b>0.000*</b>	<b>S</b>
	Control Group	156.23	± 7.31				

<b>Weight</b>	Study Group	56.62	$\pm 5.20$	5.74	5.49	<b>0.000*</b>	<b>S</b>
	Control Group	47.88	$\pm 4.63$				
<b>Grip Strength (left + right)</b>	Study Group	54.76	$\pm 5.42$	16.25	7.21	<b>0.000*</b>	<b>S</b>
	Control Group	38.51	$\pm 8.02$				
<b>Back Strength</b>	Study Group	65.14	$\pm 8.42$	20.33	8.08	<b>0.000*</b>	<b>S</b>
	Control Group	44.81	$\pm 10.62$				
<b>Block Jump</b>	Study Group	2.50	$\pm 0.08$	0.29	1.96	<b>0.000*</b>	<b>S</b>
	Control Group	2.21	$\pm 1.38$				
<b>Spike Jump</b>	Study Group	2.55	$\pm 0.08$	0.28	2.06	<b>0.000*</b>	<b>S</b>
	Control Group	2.27	$\pm 1.39$				

\*Significant at .05 level.

Tabulated  $t_{.05}(38) = 2.02$ .

S.D = Standard Deviation, M.D = Mean difference, S = Significant & NS = Not significant.

## DISCUSSION OF FINDINGS

The findings with regard to the comparison of selected physical fitness and performance indicators between Study Group and Control Group revealed significant differences exist in arm strength, speed, power, agility, flexibility, muscular endurance as well as height, weight, grip strength (left + right), back strength, block jump and spike jump. Discussion of findings has been made according to the physical fitness indicators and then performance indicators wise:

**Strength:** The competitive volleyball is techno-tactical sport. The requirement of the performance in this sport is the development of a high degree of conditional and coordinative abilities. Therefore, the physical fitness indicators like strength, speed, power, agility, flexibility and muscular endurance which determine performance in this sport must be measured. Muscular strength especially of legs, arms, abdomen and fingers are the important requirement of a volleyball player. Spiking contributes 44% of the game which is the outcome of muscular strength and power of legs and arms. Strength of arms muscles for diving, rolling, blocking and even in serving plays a dominant part in the volleyball game (Horak, J. 1978).

The perusal of table 2 indicates that the mean  $\pm$  SD of arm strength for Study Group and Control Group were  $5.98 \pm 0.70$  meter and  $3.73 \pm 0.73$  meter respectively. There was a significant difference exist in arm strength between the mean scores of Study Group and Control Group, since the calculated t-value 8.94 was higher than the tabulated t-value 2.02 which was required to be significant at 38 degree of freedom with 0.05 level of confidence. It shows that Study Group i.e. Indian talented sub-junior female volleyball players have performed significantly better in arm strength component than of Control Group. Nikolaidis, et al., (2012) conducted a study on Greek junior female volleyball players (14-18 years age) and they found their players were obtained 8.85 meter in arm strength. From the above discussion it may be stated that, Indian talented sub-junior female volleyball players are poor in arm strength that that of international counterpart.

**Speed:** Table 2 reveals that there was a significant difference between the mean scores of Study Group and Control Group in speed, since the calculated t-value 5.39 was higher than the tabulated t-value 2.02 which was required to be significant at 38 degree of freedom with 0.05 level of confidence. It shows that Study Group i.e. Indian talented sub-junior female volleyball players have performed significantly better in speed than that of their Control Group. Yavuz, S.C. (2015) conducted a study on 'Somatic and Physical Characteristics of Adolescent Female Volleyball Teams at Different Success Levels'. The researcher found that the 1<sup>st</sup> and 2<sup>nd</sup> success groups of volleyball players scored in 20 meter run 4.36 and 4.73 second respectively. But in this study Indian talented sub-junior female volleyball players obtained 5.21 second, which indicated that Study Group i.e. Indian talented sub-junior female volleyball players are slower in speed of physical fitness indicator than that of international standard.

**Power:** Power may be defined as the ability to release maximum force in the fastest possible time as in jumping and throwing activities. The game of volleyball is a game of power. For peak performance in volleyball, the muscles which are the source of power must be strong. It is important for a volleyball player to have explosive power in legs because he has to jump hundreds of times during the match or tournament for executing spiking skill or blocking skill. Thus, a good vertical jump during the spike, block and jump service depends on strength, speed and technique. Table 2 depicts that there was a significant difference between the mean scores of Study Group and Control Group in power of legs, since the calculated t-value 41.19 was higher than the tabulated t-value 2.02 which was required to be significant at 38 degree of freedom with 0.05 level of confidence. It shows that Study Group i.e. Indian talented sub-junior female volleyball players have performed significantly superior in power of legs component than that of Control Group. Smith, D. J. et al., (1992) observed that, vertical jumping scores of Canadian female sub-junior national (15 years) and Canadian female sub-junior national (16 years) volleyball players have 54.00 centimeter and 55.00 centimeter respectively, whereas the Indian talented sub-junior female junior female volleyball players the same has 41.19 centimeter.

Kasabalis, A. et al., (2005) have found a significant correlation between anaerobic power and jumping performance in volleyball players and they have suggested that vertical jump may predict maximum anaerobic power and could be used by the coaches as a practical and easy to apply field screening test for evaluation in volleyball training. Sheppard, J.M. (2012) has shown that to progress from sub-junior to junior and junior to senior national teams, volleyball players must increase their vertical jump ability for counter movement and spike. Thus, from the findings and suggestions of various researchers it may conclude that, power is one of the most important physical fitness indicator which determining the performance level of volleyball players at highest level. Exercises like isotonic and isometric weight training, rope skipping, ankle strengthening exercise; ballistic resistance training, hip flexibility exercises, sprinting and most of all reactive jumping exercises helps in improve the vertical jumping ability for spiking and block skills development in the game of volleyball.

**Agility:** The game volleyball requires a high degree of running maneuverability and total body agility so that the player may able to gain better court position and compete with her opponents on both offensive and defensive maneuvers. Fast acceleration is also requires to be able to sprint to advantageous positions while attacking and counter attacking. Agility is even more important to leave the spiked ball and makes drops by diving and rolling as well as maintaining again good court positions for further defense. With the agility component the volleyball player has to change their body position quickly and accurately to receive the ball. Table 2 reveals that there was a significant difference between the mean scores of Study Group and Control Group in agility, since the calculated t-value 12.20 was higher than the tabulated t-value 2.02 which was required to be significant at 38 degree of freedom with 0.05 level of confidence. It shows that Study Group i.e. Indian talented sub-junior female volleyball players have performed significantly better in agility component than Control Group. Sijel, E. (2015) conducted a study 'on Power,

Agility and Speed (PAS) among junior female team games players'. Among the games, female sub-junior volleyball players obtained agility (4x10 meter) in pre-test and post test scores of 10.70 second and 10.32 second respectively. This literature indicates that in agility our Indian talented sub-junior female volleyball players also lacking behind as compared to international level.

**Flexibility:** Flexibility is the ability of an individual to move the body and its parts through as wide range of motion as possible without undue strain to the articulations and muscular attachments. Flexibility provides another dimension in performance that allows a higher degree of freedom and ease of movement coupled with some important implications for greater safety from injury. In volleyball, the players have to move suddenly in forward direction, sideways or downward directions, so flexibility of hip and back is of utmost importance. So, the research scholar has decided to go with Sit and Reach test. In this study, the mean trunk flexibility of Study Group i.e. Indian talented sub-junior female volleyball players and Control Group has been 19.71 centimeter and 10.15 centimeter respectively and the difference has been found to be statistically significant at 0.05 level of confidence. Duncan, M.J. et al., (2006) have found mean values for Sit and Reach test in national level female volleyball players to be 23.50 centimeter, which has been more than our Indian talented sub-junior female volleyball players. Lee, E.J. et al., (1989) have found significant and positive correlation between vertical jump and hip flexion. His findings have supported the assumption that greater flexibility is related to greater skilled performance. Thus, he has concluded that greater hip flexibility may benefit the jumping ability. So that, the researcher may conclude that Indian talented sub-junior female volleyball players in this study have good in flexibility as physical fitness indicator when compared to Control Group. But the available literature indicates that in agility, Indian sub-junior female volleyball players lacking behind as compared to international counterpart. For improving flexibility of trunk, various lower back and hamstring stretching exercises are advised which are to be done regularly and executed properly and gradually.

**Muscular Endurance:** Muscular endurance is the ability to repeat a series of muscle contractions without fatigue. Volleyball has been described as interval sport with both anaerobic as well as aerobic component. In long matches or tournament play, the players have to bend, jump and move thousands of times which need good muscular endurance. It is one of the required qualities for excelling in volleyball game. In this study, muscular endurance of abdomen has been assessed by number of maximum bent knees sit ups executed correctly by the Study Group and Control Group. The average number of maximum sit ups for Study Group has been 16.85 in number and for Control group 7.31 in number, the difference being statistically significant. Yavuz, S.C. (2015) observed that the sit up score of muscular endurance of adolescent female national volleyball team of Turkey to be 25.40 in number. So, when compared with international level Indian talented sub-junior female volleyball players still it lags behind when compared to national/international standards.

The findings with regard to the comparison of performance indicators between Study Group and Control Group revealed significant differences exist in height, weight, grip strength (left + right), back strength, block jump and spike jump. Discussion of findings has been made according to the performance indicators wise:

Sports performance is based in a complex and intricate diversity of variables which include physical, physiological, psychological and morphological and body type (somatic traits & body composition) factors. Volleyball players must have great physical conditions especially related to somatic traits and body composition. Body height, being the most important characteristic trait of volleyball players is significantly conditioned genetically (Milicerowa, H. 1973). In volleyball, teams compete by manipulating skills of spiking and blocking high above the head. Therefore, the presence of tall players is an indispensable factor in the success of a team (Gaurav et al., 2010). A perusal of above table 2 reveals that the mean difference of body height



for Study Group and Control Group is 8.08 centimeter in favour of Study Group i.e. Indian talented sub-junior female volleyball players, which is significant at 0.05 level of confidence. Smith, D. J. et al., (1992) examined in their study and reported that the Canadian sub-junior female volleyball players at an average height of 172.00 centimeter, which is taller than Indian talented sub-junior female volleyball players. Thus, lower height of Indian sub-junior female volleyball players might be the one of the reason for their dismal performances at the international level. Thus, selection criteria can explain the observed results, as there has been a tendency to recruit the tallest players in the game of volleyball.

The mean weight of the Indian talented sub-junior female volleyball players in the present study  $56.62 \pm 5.20$  kilogram is greater than the age matched Control Group of  $47.88 \pm 4.63$  kilogram which is significant at 0.05 level of confidence but lesser than the members of competitive European volleyball club team ( $62.80 \pm 6.61$  kilogram) studied by Melrose, D.R et al., (2007).

In the present study other performance indicators of Indian talented sub-junior female volleyball players and their aged matched Control Group have been evaluated in relation to their grip strength (left + right), back strength, block jump and spike jump. This study indicates the existence of differences between Indian talented sub-junior female volleyball players and their aged matched Control Group. The results of grip strength (left + right), back strength, block jump and spike jump shows that the Indian talented sub-junior female volleyball players are better in all performance indicators compared than aged matched Control Group. In this part of the study researcher could not compared the performance indicators of grip strength (left + right), back strength, block jump and spike jump of Indian talented sub-junior female volleyball players with their international standard due to unavailable literature.

## CONCLUSIONS

From the above discussion of physical fitness and performance indicators of Indian talented sub-junior female volleyball players and their age matched Control Group, it may be safely be concluded that the Study Group i.e. Indian talented sub-junior female volleyball players are better in strength, speed, power, agility, flexibility and muscular endurance components of physical fitness indicators and height, weight, grip strength (left + right), back strength, block jump and spike jump of performance indicators when compared with age matched Control Group. In respect of availability of literatures when researcher compared the different components of physical fitness and performance indicators of Indian talented sub-junior female volleyball players are lagging behind compared to that of international counterparts. From the discussion it may also be concluded that volleyball coaches, physical educationists and sports scientists should examine the components of physical fitness as well as performance indicators of specific game of their players and use this information when planning the training and conditioning programmes. It is recommended that physical fitness and performance indicators testing be carried out throughout the season to assess the strengths and weaknesses of each team/player. The result of this study helps to the volleyball coaches, physical educationists and sports scientists for selection of their female sub-junior and junior female teams.

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