



INTRODUCTION OF A TEST BATTERY FOR IDENTIFICATION OF TALENT IN FEMALE VOLLEYBALL PLAYERS

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Abstract:

Purpose: To develop a standardized test battery for the selection and identification of talented female volleyball players. **Methods:** Two hundred (N=200) junior national level female volleyball players ($M_{age}=15.5$ years & $SD_{age}=\pm 1.0$) from five states in India have voluntarily participated in this study. Total 22 test items comprise of eight anthropometric measurements, eight physical fitness and six volleyball skills were administered on the subject according to standard procedure. **Results:** After administering item analysis, residual correlation matrix, and factor analysis eight test items i.e. weight, height, vertical jump, spiking, setting, service, service reception & passing and blocking were finally elicited to constitute the test battery for identification of talent in female volleyball players. The reliability coefficient using split-half was 0.82

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and for validity index item-sum correlation coefficients were 0.73 to 0.79 ($p < 0.01$). The 5-point gradation criteria and cut-off value for selection principle in each test were developed. Percentile and T-scale norms for each test item in the battery were also developed. **Conclusions:** These findings demonstrate that the measurements of the above mention anthropometric characteristics, physical fitness, and volleyball skill tests may assist coaches in the early phases of talent identification in volleyball games for the female players.

Keywords: anthropometric, physical fitness, vertical jump, service, spiking, blocking

1. Introduction

Sports talent is the sum total of pre-requisites qualities possessed by a person which will enable him/her to achieve high performance in sports in the future. The pre-requisites include anthropometric characteristics, physical fitness components, physique, technical skills, tactical efficiency, psychological and physiological attributes. Talent identification and development has become an important area of research in sports. Due to rapidly increasing participation and performance density, only persons who have the talent and a chance of winning a medal in the international competition should be identified by the sports scientist. Research also suggested that talent alone is not guaranteed for winning a medal. Talent has to be coupled with hard and rigorous training spread over several years.

Volleyball is a team sport played at all competitive levels (e.g., youth, Olympic, and professional) and places an emphasis on explosive movements such as jumping, hitting, and blocking (Marques et al., 2006; Freitas et al., 2015; Sheppard et al., 2007). Moreover, Agility, change of direction and straight sprints are the respective fitness feature of intermittent team sport (Islam & Kundu, 2020). In volleyball, anthropometric characteristics, individual physical performance and technical and tactical skills are most important factors that contribute to the success of a team in competitions (Häkkinen, 1993). It requires players to compete in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Gabbett & Georgieff, 2007). These high-intensity bouts include both horizontal approach movements (spike jumps, SPJ) and movements without an approach i.e. jump setting, jousts, blocking (Sheppard et al., 2009). Nowadays, elite volleyball players are quicker, stronger and in better physical condition than before, which could be a result of year-round training and developing skills that add strength, power and fitness specific to their sport (Scates & Linn, 2003). This is a very difficult task as the trainability of performance pre-requisites depends basically on heredity and training activity and both are affected by a multitude of factors during the course of life.

Several sports science disciplines are actively engaged in tackling the problem of talent identification and its development. Still, no clear cut formula or procedure is available for identifying talent for various sports. Thus, the researchers took an attempt

to develop a standardized test battery in volleyball game for the selection and identification of talented female volleyball players.

2. Material and Methods

2.1 Study Participants

Two hundred (N=200) national level junior female volleyball players between 12 to 18 years in age ranged ($M_{age}=15.5$ years & $SD_{age}=\pm 1.0$) from six different states in India were voluntarily participated in this study. The participants belonged from West Bengal (N=35), Kerala (N=36), Delhi (N=22), Tamil Nadu (N=42), Haryana (N=51), and Punjab (N=14). All the players were represented their respective states in the national level volleyball championship. The subjects were well informed about the aim of this study prior to administration of the tests and their written consent was also obtained. The age of the subjects was calculated from the date of birth as recorded in their institution. Necessary permissions from the institution and also from the coaches were also obtained. To make the subjects involve themselves in the fitness and skill test program necessary instructions were given before administration of the tests. The researcher has explained the purpose of the study to the subjects and their part in the study. The subjects were sufficiently motivated to perform their maximal level during physical fitness and volleyball skill tests. The "Board of Studies", Department of Physical Education, Visva-Bharati University, went through the whole procedure of this study and forwarded this to the institutional (university) research board. Finally, the university research board approved the study.

2.2 Procedures

Initially 26 test items were selected but after receiving suggestions and recommendations from various experts in volleyball game, finally 22 test items were retained under three dimensions: anthropometric, physical fitness and volleyball skill. Eight anthropometric measurements i.e. height, weight, arm length, leg length, arm girth, thigh girth, and calf girth were measured as recommended by ISAK (Ros et al., 2019) and % body fat was calculated using YMCA equation, 1989 (Goldin et al., 1989). Physical fitness dimension consisting of standing reach, vertical jump, 20 m dash, modified sit-&-reach, 9-3-6-3-9 m agility run, spike jump, block jump, and basketball distance throw. Service, service reception and passing, setting, spiking, blocking and court defense tests were administered as volleyball skills. The 22 test items were administered on the female volleyball players at different places as per the availability of the players using standard procedures and instruments.

2.3 Assessment of Physical Fitness

2.3.1 Standing reach

Standing reach was determined as the maximum distance between the finger tip of the hitting hand and ground, while standing at 90 degrees to the wall (sideways) without shoes.

2.3.2 Vertical jump

It was determined to take off with maximal explosive strength with both legs and touch the wall with closer hand at the highest jump point. The maximum distance between the reaching height and the jumping height provided the score.

2.3.3 20-m dash

A 20-m distance was marked on the floor. Standing start was used and the starter used the command 'ready-go' to start. The subject ran as fast as possible and time was taken to the 1/100 second.

2.3.4 9-3-6-3-9 m agility run

Lines at 6-m, 9-m, 12-m and 18-m distance from the starting line were marked on the volleyball court. The subject stand behind the starting line and ran on the signal to the 9-m line touching it with extended palm and foot; then returned 3-m back to touch the line in the same way; then ran 6-m ahead, then again 3-m back, and eventually ran fast to the line was 18-m from the starting line. Time was taken to the nearest 1/100 of a second.

2.3.5 Medicine ball throws from sitting position

From a sitting position the subject was asked to throw 1-kg medicine ball forward as far as possible without lifting the hip from the support and bending the knees and elbows. The distance measured in mts. was the score.

2.3.6 Modified sit-and-reach test

A fifteen inches line was drawn on the floor and the yard stick were placed on the line of the floor. The subject was asked to sit down on the floor (long sitting position) so that the near age of the heel was placed just behind the marked line and the sitting position was beyond the zero end of the yard stick with knees locked and heels not more than five inches apart. The performer then stretched forward and touched the fingertips of both hands as many inches down the stick as possible. The reaching fingertip on the yardstick in inches was the score.

2.3.7 Spike Jump

The standing reach height of the subject was measured on a smooth wall. The subject was then asked to stand on the floor 3-4 m away from the wall. With the investigator's command the subject took an approach run towards the wall and jumped with a full

spiking action and kept a mark on the wall with color chalk dust by the palm of the spiking hand. A normal run up of volleyball spike was allowed. The score of spike jump was recorded to nearest cm by subtracting the jumping height to the standing reach height of the subject.

2.3.8 Block Jump

The standing reach height of both hands of the subject was measured on a smooth wall. The subject was then asked to take a jump against the wall by bending both knees and swinging hands at the chest level. The subject jumped and marked the wall by both hand's fingertips at the maximum height. No approach run or hopping was allowed. The distance between jumping height to standing reach height in cm was the score of the test.

2.4 Assessment of Volleyball Skill

2.4.1 Service

Russell & Lange (1940) serving test was administered for the service test. The court dimension, administration of the test and scoring was followed as specified in the serving test.

2.4.2 Service reception

In one side of a volleyball court, a 3 sq m box was marked in the centre behind the attack line. A square of 1.5 m was marked in the attacking zone close to the center line and 2 m inside from the right side line. The subject stood in the 3 sq m box and player from the opposite court make service from behind the service line of that court to the 3 sq m area. The testing player received the served ball and passed the ball to the 1.5 m box. 1 point was awarded for each legal reception. If the received ball travelled outside of the 1.5 sqm box no point was given. After completion of 10 trials the total points from successful service reception was the score of the test.

2.4.3 Setting

In one side of a standard volleyball court, a coach, positioned approximately 5 m from the setting player. A circle with 80 cm in diameter marked near the net 5.5 m. away from the setting player. The setter was asked to stand inside the setter position. The coach from her position throws the balls to the setter with an over head pass. The subject sets the ball towards the target area at net height. Players who successfully set the ball through the target were awarded 3 points. Balls that hit the outside edge of the target but did not go through the target were awarded 2 points. Players who set the ball within 2.3 m of the net (and therefore 1.5 m of the target) were awarded 1 point. Balls that did not reach the target areas were awarded no points. The aggregate from 6 trials was recorded as a player's accuracy score in setting.

2.4.4 Spiking

In one side of a regular volleyball court a parallel line was drawn 1.5 m inside from the end line. Another parallel line was marked 3 m away from the centre line. Two long 1.5 m line were marked inside and parallel to the each side line, extending from the centre line to the end line. The subjects were allowed to select spiking zone on her choice. She or any other player was given the first pass to the setter. After making a setting by the setter the testing spiker made a spike without any fault. The spiker has executed only straight-arm spike from any zone of her wish. Total 10 trials were given to the tester. Out of 10 spikes, only successful spikes (if the ball lands in specified area) were counted and awarded as score of individual. For each successful spike a single point was awarded.

2.4.5 Blocking

The subject was asked to stand near the net in one side of a standard volleyball court. From the other side two support players- one set the ball and another spike the ball forcefully as possible. At the same time viewing the ball in the air the testing blocker tried to block the spiked ball by two hands taking an approach jump. After blocking if the ball landed into the opponent's attacking zone, the subject was awarded three points, landed into the opponent's defense zone- two points, landed to the blocker's own court- one point and ball travelled outside of the court no point was awarded to the subject. 10 trials were given to each subject and total score was credited in favour of the subject.

2.4.6 Court defense

In one side of a regular volleyball court a square of 1.5 m was marked in the attacking zone close to the center line and 2 m inside from the right-side line. The subject was instructed to stand at the fifth or sixth position of her own defensive zone. From the opponents court the smasher spike the ball powerfully into the opponent's defensive zone and the testing subject tried to defense the ball successfully. If the defender passed the defensive ball directly to the 1.5 sq m area she was awarded 3 points, ball did not travelled to the 1.5 sq m area but to her court- 2 points and ball outside of the court but travelled within the range of the other players of the same court- awarded 1 point. But when the ball went beyond the limit of the player's reaching, no point was given. Out of 10 trails the total points was the score of the test.

2.5 Data Analyses

AAHPERD Advanced Statistical Analysis Software for Research in Exercise and Health Science, Verson-17, 2003 was employed to develop a test battery with a precise number of test items.

3. Results

Mean and SD, Item analysis followed by Factor analysis of the obtained data were calculated and presented in the tables.

Table 1: Descriptive statistics and item analysis
 (item-difficulty and item-discrimination) of the selected variables

Dimension	Test Items	Code No	Mean (M)	Standard Deviation(SD)	Item-Difficulty	Item-Discrimination
Anthropometry	Height (cm)	A ₁	166.65	6.237	0.67	0.54
	Weight (Kg)	A ₂	53.24	7.516	0.51	0.56
	Arm length (cm)	A ₃	74.75	4.674	0.53	0.50
	Leg Length (cm)	A ₄	99.55	6.3988	0.58	0.47
	Arm Girth (cm)	A ₅	24.01	1.9609	0.66	0.48
	Thigh Girth (cm)	A ₆	50.49	5.664	0.60	0.43
	Calf Girth (cm)	A ₇	33.67	3.822	0.54	0.57
	% Body Fat	A ₈	22.13	5.267	0.64	0.65
Physical Fitness	Standing Reach (cm)	B ₉	215.34	10.401	0.66	0.53
	Vertical Jump (cm)	B ₁₀	39.49	7.93	0.57	0.49
	20 m. Dash (sec)	B ₁₁	3.78	0.458	0.52	0.44
	Agility Run (sec)	B ₁₂	12.46	1.017	0.64	0.58
	Seat & Reach (inch)	B ₁₃	5.56	1.178	0.55	0.49
	Basketball Distance throw (cm)	B₁₄	559.83	90.741	0.25*	0.27*
	Block Jump (cm)	B ₁₅	250.97	13.529	0.67	0.59
	Spike Jump (cm)	B ₁₆	258.83	14.673	0.59	0.43
Volleyball Skill	Service (score)	C ₁₇	21.48	4.7160	0.63	0.45
	Service Reception & Passing (score)	C ₁₈	6.26	1.507	0.60	0.37
	Setting (score)	C ₁₉	10.05	3.363	0.57	0.50
	Spiking (score)	C ₂₀	16.91	6.924	0.52	0.43
	Blocking (score)	C ₂₁	7.24	5.331	0.73	0.65
	Court defense (score)	C ₂₂	11.42	6.009	0.51	0.42

* B₁₄ were discarded due to insufficient value of item-difficulty and item-discrimination

3.1 Findings from Item Analysis

The results of item analysis revealed from the Table1 that only one test item i.e., Basketball distance throw (B₁₄) had been discarded. In reality, administration of these retained 21 items on one individual requires more financial involvement, time consuming and needs assistance from expert individuals and also exhaustive for a volleyball player to undergo tests. Therefore, it was thought desirable to further reduce the test-items, if any, through factor analysis.

3.2 Factor Analysis

Holzinger's bi-factor method, a variation of Spearman's two-factor method, was used as there were number of factors involved in the test battery. However, primarily, correlation matrix for retained 21 test items were prepared and presented in the Table 2.

Table2: Correlation matrix of the retained test-items in the test battery

	A1	A2	A3	A4	A5	A6	A7	A8	B9	B10	B11	B12	B13	B15	B16	C17	C18	C19	C20	C21	C22
A1	--	0.15	0.68	0.75	0.21	0.45	0.12	-0.19	0.74	0.10	0.14	0.16	0.19	0.68	0.78	0.21	0.10	0.13	0.17	0.16	0.71
A2		--	0.78	0.63	0.21	0.65	0.22	0.25	0.62	0.21	0.23	0.33	0.20	0.76	0.62	0.10	0.25	0.26	0.20	0.60	0.62
A3			--	0.72	0.42	0.45	0.25	0.46	0.71	0.25	0.21	0.23	0.11	0.72	0.63	0.19	0.19	0.21	0.26	0.75	0.53
A4				--	0.29	0.71	0.16	-0.51	0.54	0.30	0.25	0.26	0.13	0.70	0.54	0.12	0.20	-0.45	0.15	0.23	0.58
A5					--	0.73	0.19	-0.31	0.63	0.20	0.32	0.22	0.16	0.66	0.60	0.11	0.25	0.11	0.23	0.50	0.70
A6						--	0.23	-0.22	0.60	0.15	0.23	0.33	0.16	0.74	0.50	0.25	0.21	0.20	-0.43	0.54	0.69
A7							--	-0.65	0.54	0.14	0.28	0.17	0.26	0.69	0.66	0.20	0.18	0.15	0.15	0.75	0.66
A8								--	-0.26	-0.31	-0.70	-0.69	-0.65	-0.65	-0.60	-0.55	-0.73	-0.54	-0.56	-0.69	-0.22
B9									--	0.16	0.29	0.13	0.27	0.78	0.75	0.13	0.22	0.25	0.14	0.70	-0.21
B10										--	0.26	0.22	0.18	0.70	0.69	0.17	-0.14	-0.46	0.09	0.51	0.78
B11											--	0.11	0.13	0.68	0.70	0.14	0.24	0.31	0.10	0.21	0.62
B12												--	0.22	0.60	0.52	0.13	0.20	0.19	0.20	-0.42	-0.56
B13													--	0.79	0.55	0.10	0.21	0.17	0.14	0.59	0.60
B15														--	0.66	0.14	0.24	0.12	0.23	0.63	0.54
B16															--	0.19	0.16	0.25	0.17	0.46	0.53
C17																--	0.14	0.26	0.11	0.65	0.63
C18																	--	0.18	0.21	0.71	0.46
C19																		--	-0.22	0.35	0.61
C20																			--	0.37	0.65
C21																				--	0.59
C22																					--

3.3 Findings from First, Second and Third Residual Correlation Matrix

From the correlation matrix given in Table-2 it was clear that many of the items have positive and high correlations. However, any one of them could be eliminated here. Therefore, there was a need to compute the first residual matrix and accordingly, it was found that standing reach (B9) had been eliminated. But still there were many items in the first residual correlation matrix having positive and high correlations. Therefore, there was a need of second residual matrix with 20 items and consequently, it was evident that court defense (C22) had been eliminated. But many items in the second residual correlation matrix have positive and high correlations. Therefore, there was a need of third residual matrix with 19 items. Third residual matrix elicited that thigh girth (A6), block jump (B15), and spike jump (B16) have been eliminated and many of the items have similar correlation. Therefore, it was decided to stop the residual correlation matrix and move to Centroid Factor Matrix with 16 items for identifying the authentic test-items in discarding the poor items out rightly.

3.4 Centroid Factor Matrix

Prior to Centroid Factor Matrix, the common factors present among the test items which disturbed the other items was determined. In fact, the common factors of all the test items were evaluated by using Tucker's Phi-analysis, Humphrey's Rule and Coombs' Criterion. The values for each item were shown in the Table- 3. This, in fact, helped to remove the poor test-items accordingly from the Test Battery.

Table 3: Determination of common factors among the test-items

Factors	Tucker's Phi-Analysis	Humphrey's Rule	Coombs' Criterion
A1	0.56	0.09	10
A2	0.38	0.14	05
A3	0.72*	0.04*	38*
A4	0.75*	0.02*	43*
A5	0.80*	0.03*	35*
A7	0.73*	0.04*	39*
A8	0.77*	0.01*	45*
B10	0.38	0.03*	12
B11	0.82*	0.02*	33*
B12	0.74*	0.04*	36*
B13	0.77*	0.01*	32*
C17	0.33	0.08	17
C18	0.27	0.07	15
C19	0.30	0.05	19
C20	0.36	0.04	21
C21	0.25	0.03	13
Accepted value	Below 0.70	Above 0.05	Below 31
* Discarded			

3.5 Observation on Common Factors Determination

Since there were 3 major dimensions (anthropometric, physical fitness & volleyball skill) in the Test Battery, there may be possibility of number of common factors. In Table- 3, values of Phi- analysis, Humphrey's Rule and Coombs' Criterion were given for each variable to determine the poor items. The criterion to accept or reject was also given in Table-3. According to the criterion given, arm length (A3), leg length (A4), arm girth (A5), calf girth (A7), % body fat (A8), 20 mts. dash (B11), agility (B12), sit-and-reach (B13) have been discarded.

Table 4: Centroid Factor Matrix of the Volleyball Test Battery

Sl. No	Test-items	Factor			h^2	No. of Reflections
		I	II	III		
1	Height (A1)	0.76	0.75	0.75	0.76	1
2	Weight (A2)	0.66	0.64	0.64	0.66	2
3	Vertical Jump (B10)	0.68	0.68	0.70	0.70	2
4	Service (C17)	0.62	0.63	0.62	0.57	1
5	Service reception and passing (C18)	0.74	0.75	0.75	0.77	1
6	Setting (C19)	0.68	0.67	0.68	0.74	1
7	Spiking (C20)	0.71	0.70	0.70	0.71	1
8	Blocking (C21)	0.75	0.76	0.75	0.75	1

Eight test items were finally retained after using Tucker's Phi-analysis values, values of Humphrey's rule, and Coombs' Criterion. These were: height (A1), weight (A2), vertical jump (B10), service (C17), service reception and passing (C18), setting (C19), spiking (C20), and blocking (C21) respectively. This result also supported that there should be

three Factor level in Centroid Factor Matrix. The Centroid Factor Matrix of the Test Battery was presented in Table 4.

3.6 Observation on Centroid Factor Matrix Analysis

The Centroid loading of test-items as rounded with two decimal places were finally recorded and presented in Table- 4. The appearance of higher h^2 values in almost all the test items (h^2 : 0.76, 0.66, 0.70, 0.57, 0.77, 0.74, 0.71, and 0.75) having considerably minimum reflections (i.e., from 1 to 2) have been revealed. In fact, minimum reflection indicated that there were a minimum possibility of existence of common factors among the test-items and consequently appearance of higher h^2 values indicated the authenticity of the test-items.

In reality, analysis of items, residual correlation matrix, 'r' common factors, and Centroid factor matrix have revealed that 8 items i.e. Weight, Height, Vertical Jump, Spiking, Setting, Service Reception & Passing, Service, and Blocking in order of simple to complex principle as determined by the Item difficulty and Item discrimination values were finally retained that considered as the development of a Test Battery for Talent Identification of Female Volleyball Players (Table 4).

3.7 Determination of the Reliability and Validity of the Developed Test Battery

The reliability was established for the developed test battery of the female volleyball players using Split-half method. The reliability coefficient (Split-half) of the Test Battery was found 0.82 which was statistically significant at the 0.01 level.

The content validity and the judgment validity were determined by analyzing the opinions of the various experts across the country in the area of volleyball game. Initially 26 test items were selected but after expert's judgment 22 test items were finally accepted. Item analysis was computed to find out the item difficulty and item discrimination of the eight test items of the battery.

Validity Index was determined using Item-sum correlations and the validity coefficients of the Test Battery were ranging from 0.73 - 0.79 which all were significant at the 0.01 level. Therefore, the developed Test Battery possessed sufficient degree of validity.

As the 8 test items were standard tests therefore the developed battery maintained its objectivity.

3.8 Establishing the Norms of the Test Battery

The characteristics of distribution of scores as obtained by the female volleyball players of 8 test items in the Battery were evaluated in terms of normality before establishing the norms. Distribution of scores of all test items was positively skewed, three were platykurtic and five were leptokurtic and within $\pm 3 \sigma$ area almost 100% scores were belonging. The CR of the Skewness and Kurtosis were found not significant even at the 0.05 level ($p > 0.05$). As the distributions of 8 test items were found nearly normal, therefore, norms in terms of Percentile Scale and T-Scale were developed (Table 5 & 6).

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Table 5: Percentile Scale: Test Battery for Talent identification of the Female Volleyball Players

Percentile	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)	Percentile	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)
1	38.21	152.80	26.01	4.00	4.00	3.01	10.01	0.00	51	53.00	167.30	41.0	16.00	10.00	6.00	21.00	6.00
2	39.03	153.20	29.0	4.02	4.00	4.00	11.02	0.00	52	53.52	167.60	41.0	16.00	10.00	6.00	21.00	6.00
3	40.84	153.70	29.03	5.03	5.00	4.00	12.00	0.00	53	54.00	167.60	41.0	17.00	10.00	6.00	21.00	6.53
4	42.00	154.44	30.0	6.08	5.00	4.00	14.00	0.00	54	54.00	167.60	41.0	17.00	10.00	6.00	21.00	7.00
5	42.00	155.43	31.0	8.00	5.00	4.00	14.00	0.00	55	54.00	167.70	41.0	17.00	10.00	6.00	21.00	7.00
6	43.00	157.22	31.0	8.00	6.00	4.00	15.00	0.00	56	54.00	168.00	42.0	17.00	10.00	6.00	21.00	7.00
7	43.00	157.65	31.0	8.00	6.00	4.00	15.00	0.00	57	54.17	168.00	42.0	18.00	10.00	6.00	21.57	7.00
8	43.54	158.41	31.0	8.00	6.00	4.00	15.08	0.00	58	54.71	168.00	42.0	18.00	10.00	6.00	22.00	7.00
9	44.00	158.51	31.0	8.09	6.00	4.00	16.00	0.09	59	55.00	168.10	42.0	18.00	10.00	6.00	22.00	7.00
10	44.00	158.74	32.0	9.00	6.00	4.10	16.00	1.00	60	55.00	168.16	42.0	18.00	10.00	7.00	22.60	7.00
11	44.00	159.16	32.0	9.00	6.00	5.00	16.11	1.00	61	55.00	168.42	43.0	18.00	10.00	7.00	23.00	7.61
12	44.56	159.82	32.0	9.00	6.12	5.00	17.00	2.00	62	55.00	168.70	43.0	19.00	10.62	7.00	23.00	8.00
13	45.00	160.00	32.0	9.13	7.00	5.00	17.00	2.00	63	55.33	169.46	43.0	19.00	11.00	7.00	23.00	8.00
14	45.00	160.10	32.0	10.00	7.00	5.00	17.00	2.00	64	56.00	169.50	43.64	19.00	11.00	7.00	23.00	8.00
15	45.00	160.10	32.0	10.00	7.00	5.00	17.00	2.00	65	56.00	169.77	44.0	19.65	11.00	7.00	23.00	8.00
16	45.00	160.10	32.0	10.00	7.00	5.00	17.00	3.00	66	56.00	169.80	44.66	20.00	11.00	7.00	23.66	8.66
17	45.05	160.22	32.0	10.00	7.00	5.00	17.00	3.00	67	56.00	170.00	45.0	20.00	11.00	7.00	24.00	9.00
18	45.34	160.40	33.0	10.00	7.00	5.00	18.00	3.00	68	56.34	170.10	45.0	20.00	11.00	7.00	24.00	9.00
19	45.62	160.52	33.0	10.00	7.00	5.00	18.00	3.00	69	56.60	170.10	45.0	20.00	11.00	7.00	24.00	9.00
20	46.00	160.92	33.0	11.00	7.00	5.00	18.00	3.00	70	57.00	170.10	45.0	20.70	11.70	7.00	24.00	9.00
21	46.00	161.14	34.21	11.00	7.00	5.00	18.00	3.00	71	57.71	170.27	45.0	21.00	12.00	7.00	24.00	9.71
22	46.11	161.50	35.0	11.00	7.00	5.00	18.00	3.00	72	58.00	170.37	45.0	21.00	12.00	7.00	24.00	10.00
23	47.00	161.50	35.0	11.00	7.00	5.00	18.00	3.23	73	58.00	170.60	45.0	21.00	12.00	7.00	24.73	10.00
24	47.00	161.52	35.0	11.24	8.00	5.00	18.00	4.00	74	58.30	171.00	45.0	21.74	12.00	7.00	25.00	10.00
25	47.63	161.63	35.0	12.00	8.00	5.00	18.00	4.00	75	58.88	171.18	45.0	22.00	12.00	7.00	25.00	10.00
26	48.00	161.93	36.0	12.00	8.00	5.00	18.00	4.00	76	59.00	171.38	45.0	22.00	12.00	7.00	25.00	10.00
27	48.00	162.03	36.0	12.00	8.00	5.00	18.00	4.00	77	59.00	171.40	46.0	22.00	12.00	7.00	25.00	10.00
28	48.00	162.40	36.0	12.00	8.00	5.00	18.00	4.00	78	60.00	171.50	46.0	23.00	12.00	8.00	26.00	10.78
29	48.15	163.20	36.0	12.00	8.00	5.00	18.29	4.00	79	60.00	171.58	47.0	23.00	12.00	8.00	26.00	11.00
30	49.00	163.26	36.0	12.00	8.00	5.00	19.00	4.00	80	60.00	171.94	47.0	24.00	12.00	8.00	26.00	11.00

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Percentile	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)	Percentile	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)
31	49.00	163.43	37.0	12.00	8.00	5.00	19.00	4.00	81	60.00	172.00	47.0	24.00	12.00	8.00	26.00	11.00
32	49.00	163.80	37.0	12.00	8.00	5.00	19.00	4.00	82	60.00	172.28	47.0	24.00	13.00	8.00	26.00	11.82
33	49.00	164.07	37.0	12.33	8.00	5.00	19.00	4.00	83	60.92	172.40	47.0	24.00	13.00	8.00	26.00	12.00
34	49.14	164.30	37.0	13.00	8.00	5.00	19.00	4.00	84	61.00	173.37	47.0	24.00	14.00	8.00	26.84	12.00
35	50.00	164.50	37.35	13.00	8.00	5.00	19.00	4.00	85	61.00	173.70	48.0	25.00	14.00	8.00	27.00	12.85
36	50.00	164.50	38.0	13.00	8.00	5.36	19.00	4.00	86	61.00	173.70	48.0	25.00	14.00	8.00	27.00	13.86
37	50.00	164.50	38.0	13.00	8.37	6.00	19.37	4.00	87	61.96	173.89	48.0	25.00	14.00	8.00	27.87	14.00
38	50.00	164.58	38.0	13.38	9.00	6.00	20.00	4.38	88	62.88	174.09	48.0	25.00	14.88	8.00	28.00	14.88
39	50.00	164.70	38.0	14.00	9.00	6.00	20.00	5.00	89	63.89	174.56	49.0	26.00	15.00	8.00	28.00	15.89
40	50.24	164.78	38.0	14.00	9.00	6.00	20.00	5.00	90	64.00	174.69	49.0	26.90	16.00	8.00	28.00	16.00
41	50.38	165.00	39.0	14.00	9.00	6.00	20.00	5.00	91	64.94	175.27	49.0	27.00	16.00	8.00	28.00	16.91
42	50.71	165.00	39.0	14.00	9.00	6.00	20.00	5.00	92	65.00	175.90	49.0	27.00	16.00	8.00	28.00	17.00
43	51.00	165.24	39.0	15.00	9.00	6.00	20.00	5.00	93	65.00	176.19	49.93	27.93	16.00	8.00	28.00	17.93
44	52.00	165.39	39.44	15.00	9.00	6.00	20.00	5.00	94	66.00	176.20	50.0	28.00	16.00	9.00	28.94	18.00
45	52.00	165.65	40.0	15.00	9.00	6.00	20.00	5.00	95	66.00	176.68	51.0	30.00	16.00	9.00	29.00	18.95
46	52.00	166.00	40.0	15.00	9.00	6.00	20.00	5.00	96	66.00	176.80	51.0	31.96	17.96	9.00	29.96	19.00
47	52.00	166.10	40.0	15.47	9.00	6.00	21.00	5.47	97	67.94	177.19	51.0	32.00	18.00	9.97	30.00	20.00
48	52.24	166.29	40.0	16.00	9.00	6.00	21.00	6.00	98	69.96	177.98	54.94	32.00	18.00	10.00	30.00	20.98
49	52.75	166.65	40.0	16.00	9.00	6.00	21.00	6.00	99	73.96	179.78	62.93	33.00	18.00	10.00	35.95	21.00
50	53.00	167.15	41.0	16.00	10.00	6.00	21.00	6.00	100	76.00	187.90	63.0	36.00	19.00	10.00	36.00	22.00

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Table 6: T-scale: Test Battery for Talent identification of the Female Volleyball Players

T-scale	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)	T-scale	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)
1	16.41	136.09	6.778	-17.09	-6.47	-1.13	-1.66	-18.94	51	53.99	167.27	41.178	17.61	10.38	6.40	21.96	7.78
2	17.16	136.71	7.466	-16.39	-6.14	-0.98	-1.19	-18.41	52	54.74	167.90	41.866	18.31	10.72	6.55	22.43	8.31
3	17.92	137.33	8.154	-15.70	-5.80	-0.83	-0.72	-17.88	53	55.49	168.52	42.554	19.00	11.06	6.70	22.90	8.84
4	18.67	137.96	8.842	-15.00	-5.46	-0.68	-0.25	-17.34	54	56.25	169.15	43.242	19.70	11.39	6.85	23.38	9.38
5	19.42	138.58	9.53	-14.31	-5.13	-0.53	0.23	-16.81	55	57.00	169.77	43.93	20.39	11.73	7.00	23.85	9.91
6	20.17	139.21	10.218	-13.62	-4.79	-0.38	0.70	-16.27	56	57.75	170.39	44.618	21.08	12.07	7.15	24.32	10.45
7	20.92	139.83	10.906	-12.92	-4.45	-0.23	1.17	-15.74	57	58.50	171.02	45.306	21.78	12.41	7.30	24.79	10.98
8	21.67	140.45	11.594	-12.23	-4.11	-0.08	1.64	-15.20	58	59.25	171.64	45.994	22.47	12.74	7.45	25.27	11.52
9	22.43	141.08	2.282	-11.53	-3.78	0.07	2.12	-14.67	59	60.00	172.26	46.602	23.17	13.08	7.60	25.74	12.05
10	23.18	141.70	12.97	-10.84	-3.44	0.22	2.59	-14.13	60	60.76	172.89	47.37	23.86	13.42	7.75	26.21	12.59
11	23.93	142.32	13.658	-10.15	-3.10	0.37	3.06	-13.60	61	61.51	173.51	48.058	24.55	13.75	7.90	26.68	13.12
12	24.68	142.95	14.346	-9.45	-2.77	0.52	3.53	-13.07	62	62.26	174.14	48.746	25.25	14.09	8.05	27.16	13.65
13	25.43	143.57	15.034	-8.76	-2.43	0.67	4.01	-12.53	63	63.01	174.76	49.434	25.94	14.43	8.20	27.63	14.19
14	26.18	144.20	15.722	-8.06	-2.09	0.83	4.48	-12.00	64	63.76	175.38	50.122	26.64	14.77	8.35	28.10	14.72
15	26.93	144.82	16.41	-7.37	-1.75	0.98	4.95	-11.46	65	64.51	176.01	50.81	27.33	15.10	8.50	28.57	15.26
16	27.69	145.44	17.098	-6.68	-1.42	1.13	5.42	-10.93	66	65.27	176.63	51.498	28.02	15.44	8.66	29.05	15.79
17	28.44	146.07	17.786	-5.98	-1.08	1.28	5.90	-10.39	67	66.02	177.25	52.186	28.72	15.78	8.81	29.52	16.33
18	29.19	146.69	18.474	-5.29	-0.74	1.43	6.37	-9.86	68	66.77	177.88	52.874	29.41	16.11	8.96	29.99	16.86
19	29.94	147.31	19.162	-4.59	-0.41	1.58	6.84	-9.33	69	67.52	178.50	53.562	30.11	16.45	9.11	30.46	17.39
20	30.69	147.94	19.85	-3.90	-0.07	1.73	7.31	-8.79	70	68.27	179.13	54.25	30.80	16.79	9.26	30.94	17.93
21	31.44	148.56	20.538	-3.21	0.27	1.88	7.79	-8.26	71	69.02	179.75	54.938	31.49	17.13	9.41	31.41	18.46
22	32.20	149.19	21.226	-2.51	0.61	2.03	8.26	-7.72	72	69.77	180.37	55.626	32.19	17.46	9.56	31.88	19.00
23	32.95	149.81	21.914	-1.82	0.94	2.18	8.73	-7.19	73	70.53	181.00	56.314	32.88	17.80	9.71	32.35	19.53
24	33.70	150.43	22.602	-1.12	1.28	2.33	9.20	-6.65	74	71.28	181.62	57.002	33.58	18.14	9.86	32.83	20.07
25	34.45	151.06	23.29	-0.43	1.62	2.48	9.68	-6.12	75	72.03	182.24	57.69	34.27	18.47	10.01	33.30	20.60
26	35.20	151.68	23.978	0.26	1.95	2.63	10.15	-5.58	76	72.78	182.87	58.378	34.96	18.81	10.16	33.77	21.14
27	35.95	152.30	24.686	0.96	2.29	2.78	10.62	-5.05	77	73.53	183.49	59.066	35.66	19.15	10.31	34.24	21.67
28	36.71	152.93	25.354	1.65	2.63	2.93	11.09	-4.52	78	74.28	184.12	59.754	36.35	19.49	10.46	34.72	22.20
29	37.46	153.55	26.042	2.35	2.97	3.08	11.57	-3.98	79	75.04	184.74	60.442	37.05	19.82	10.61	35.19	22.74
30	38.21	154.18	26.73	3.04	3.30	3.23	12.04	-3.45	80	75.79	185.36	61.13	37.74	20.16	10.76	35.66	23.27

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T-scale	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)	T-scale	Weight (Kg.)	Height (cm)	Vertical Jump (cm)	Spiking (Score)	Setting (Score)	Service reception & Passing (Score)	Service (Score)	Blocking (Score)
31	38.96	154.80	27.418	3.73	3.64	3.39	12.51	-2.91	81	76.54	185.99	61.818	38.43	20.50	10.91	36.13	23.81
32	39.71	155.42	28.106	4.43	3.98	3.54	12.98	-2.38	82	77.29	186.61	62.506	39.13	20.83	11.06	36.61	24.34
33	40.46	156.05	28.794	5.12	4.31	3.69	13.46	-1.84	83	78.04	187.23	63.194	39.82	21.17	11.22	37.08	24.88
34	41.21	156.67	29.482	5.82	4.65	3.84	13.93	-1.31	84	78.79	187.86	63.882	40.52	21.51	11.37	37.55	25.41
35	41.97	157.29	30.17	6.51	4.99	3.99	14.40	-0.77	85	79.55	188.48	64.57	41.21	21.85	11.52	38.02	25.94
36	42.72	157.92	30.858	7.20	5.33	4.14	14.87	-0.24	86	80.30	189.11	65.258	41.90	22.18	11.67	38.50	26.48
37	43.47	158.54	31.546	7.90	5.66	4.29	15.35	0.29	87	81.05	189.73	65.946	42.60	22.52	11.82	38.97	27.01
38	44.22	159.17	32.234	8.59	6.00	4.44	15.82	0.83	88	81.80	190.35	66.634	43.29	22.86	11.97	39.44	27.55
39	44.97	159.79	32.902	9.29	6.34	4.59	16.29	1.36	89	82.55	190.98	67.322	43.99	23.19	12.12	39.91	28.08
40	45.72	160.41	33.61	9.98	6.67	4.74	16.76	1.90	90	83.30	191.60	68.01	44.68	23.53	12.27	40.39	28.62
41	46.48	161.04	34.298	10.67	7.01	4.89	17.24	2.43	91	84.05	192.22	68.698	45.37	23.87	12.42	40.86	29.15
42	47.23	161.66	34.986	11.37	7.35	5.04	17.71	2.97	92	84.81	192.85	69.386	46.07	24.21	12.57	41.33	29.69
43	47.98	162.28	35.674	12.06	7.69	5.19	18.18	3.50	93	85.56	193.47	70.074	46.76	24.54	12.72	41.80	30.22
44	48.73	162.91	36.362	12.76	8.02	5.34	18.65	4.03	94	86.31	194.10	70.762	47.46	24.88	12.87	42.28	30.75
45	49.48	163.53	37.05	13.45	8.36	5.49	19.13	4.57	95	87.06	194.72	71.45	48.15	25.22	13.02	42.75	31.29
46	50.23	164.16	37.738	14.14	8.70	5.64	19.60	5.10	96	87.81	195.34	72.138	48.84	25.55	13.17	43.22	31.82
47	50.99	164.78	38.426	14.84	9.03	5.79	20.07	5.64	97	88.56	195.97	72.826	49.54	25.89	13.32	43.69	32.36
48	51.74	165.40	39.114	15.53	9.37	5.95	20.54	6.17	98	89.32	196.59	73.514	50.23	26.23	13.47	44.17	32.89
49	52.49	166.03	39.802	16.23	9.71	6.10	21.01	6.71	99	90.07	197.21	74.212	50.93	26.57	13.62	44.64	33.43
50	53.24	166.65	40.49	16.92	10.05	6.25	21.49	7.24	100	90.82	197.84	74.89	51.62	26.90	13.78	45.11	33.96

3.9 Derivation of Grades in Eight Test-items of the Test Battery

Grading i.e. Excellent, Very Good, Good, Fair and Poor were derived from the percentile norms and sum of T-scores of the eight test items.

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Table 6: Grading Scale of the Female Volleyball Players Based on Percentile Norms

Test Items	Excellent	Very Good	Good	Fair	Poor
Weight (Kg)	64 and above	58.88 – 63.89	53.0 – 58.30	47.63 – 52.75	47 and below
Height (cm)	174.69 and above	171.18 – 174.56	167.15 – 171.0	161.63 – 166.65	161.52 and below
Vertical Jump (cm)	49.0 and above	45.0 – 48.9	41.0 – 44.9	35.0 – 40.0	34.9 and below
Spiking (score)	27 and above	22 – 26	16 – 21	12 – 15	11 and below
Setting (score)	8 and above	7	6	5	4 and below
Service Reception and Passing (score)	16 and above	12 – 15	10 – 11	8 – 9	7 and below
Service (score)	28 and above	25 – 27	21 – 24	18 – 20	17 and below
Blocking (score)	16 and above	10-15	6 – 9	4 – 5	3 and below
Sum of T-scores of 8 Test Items	462.8 and above	428.8 – 460.28	402.8 – 428.03	375.72 – 401.18	374.67 and below

3.10 Determination of cut-off values for the Selection Criteria of a Talented Female Volleyball Players

To select or to screen a talented female volleyball player, volleyball coaches, physical educators and selectors should consider the following particular standard or cut-off value (Table-7) for each test item in the battery. These values describe that if a player does not possess the following scores she should not be called as talented. Again, if a player fails to possess the required score in a particular test item but obtains 428.03 and above in total score she can be considered as a talented volleyball player.

Table 7: Cut-off Values of the Selection Criteria for Talented Female Volleyball Players

Sl. No.	Test Items	Cut-off Values
1	Height	Not less than 171 cm.
2	Weight	Not less than 58 Kg.
3	Vertical Jump	Not less than 45 cm.
4	Spiking	Not less than 22 scores
5	Setting	Not less than 12 scores
6	Service	Not less than 25 scores
7	Service Reception and Passing	Not less than 7 scores
8	Blocking	Not less than 10 scores
9	Total Score	Not less than 428.03 scores

4. Discussions

Versatility and speediness are the trends of development in modern volleyball sport. "Versatility" means that the athletes should not only be well-prepared for their specific position but also possess high levels of all-round skills in serving, setting, spiking, blocking, and defence. "Speediness" requires the athletes to be able to move quickly to the optimal place on the court. Speediness and agility in tactics, as the key factors, work together to make suddenness the feature of modern volleyball sport (Huang, 1992).

This study is the first time in India to develop a standardized test battery in volleyball game for the selection and identification of talented female volleyball players based on anthropometric characteristics, physical fitness components, and volleyball skills. The results of this study demonstrate that physical characteristics, physical fitness, and skill-based testing offer a reliable method of quantifying development and progress in junior volleyball players. Aouadi et al. (2012) concluded that the measurement of anthropometric characteristics may assist coaches in the early phases of talent identification in volleyball. In this study height, weight, and vertical jump height are usually included as a main factor of talent identification in female junior volleyball players, similar results were reported by previous pertinent studies (Pion et al., 2015; Carvajal et al., 2012; Malousaris et al., 2008). All most similar findings were found by Stamm et al. (2003) on their study where they observe the relationships among 43 anthropometric measurements and 7 physical fitness tests of 32 female volleyball players aged 13-16 years with the proficiency of performing volleyball elements- service, reception, feint, block and spike. They reported that a significant correlation from 14 anthropometric measurements and 7 physical fitness test results with performance of all the elements of the game, being most essential (71-83%) for attack, block, and feint.

5. Conclusions

Volleyball coaches should adopt a cautious approach when attempting to predict the success of players based on their anthropometric characteristics, physical fitness, and results obtained from volleyball skill tests. Although there are many other physiological and psychological factors that are associated with achievement in volleyball, for which further research is needed.

5.1 What Does This Research Add?

The availability of the literature related to anthropometric characteristics, physical fitness, and volleyball skill test, standard data on such parameters are scanty in the Indian context. The present study fulfills the lacunae of literature, that the test battery for identification of talent in Indian female volleyball players.

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Conflicts of Interest

The authors declare that they have no competing interests.

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