CHAPTER II

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TEST CONSTRUCTION STUDIES

There are certain tests available for measuring general physical and motor fitness in the field of physical education. Cooper (1970) developed a cardiovascular endurance test based on running for 12 minutes.

Fleishman (1964) developed a motor fitness test by investigating several test items and using the factor analysis technique. Fleishman's test can be used at the school as well as college levels. Similarly, there are other test batteries available for use in the area of general motor fitness. These include the Barrow Test of Motor Ability (1954), the Motor Performance Test Factor analysed by Jackson (1971) and the AAPHER Youth Fitness Test (1976). However, all these and other such tests cannot be used to measure the specific motor fitness of volleyball players.

There are several factors which determine the state of fitness, some of which are considered more important than others. Many are negative determinants, such as smoking. Feebler (1962) claims that "each person is fit when his
capacity is developed and maintained at a level near his individual capacity for the demands that are most likely to be made on him in the future."

Sage (1977) points out that the greater the variety of sensory and motor experiences that individuals have during their early years, the fuller will be their motor ability repertoire, within the limitations set by their genetic heritage.

In order that every player performs to his capacity, the levels of general and specific motor fitness are required to be enhanced.

Reindeau (1958) examined the relationship between the percentage of body fat and performance in selected motor fitness tests. Significant negative correlations from -.29 to -.28 were found between per cent body fat and motor fitness test. The test items most affected by this fact were those which involve running and jumping.

Richardson (1977) investigated the relationship between grip strength, wrist flexion, arm length and the velocity of a thrown baseball among male high school baseball players. The study concluded that grip strength had a significant positive correlation with baseball throwing
velocity, whereas the range of flexion had no significant relationship.

Saluhter, Lohman and Mincer (1977), in their study of the relationship between somatotype and body composition on the one hand and physical performance on the other concluded that somatotype components had a lower correlation with the running and jumping variables than the body composition or body size variables.

Burger (1973) explains that physical conditioning is specific to a sport. The demands as to what type of conditioning exercises to include in a training programme can be recognised only on understanding the primary biological systems stressed during a game and the kind of activities which provide this type of stress during practice. The body adapts in time to the type of stress placed upon it. This physiological adaptation is necessary for physical conditioning to occur. However, the nature of the adaptation is specific to the kinds of activities used in training.

McKinney (1972) constructed a motor fitness test battery for undergraduate male physical education majors. Fortynine test items were selected as valid measures of eight motor fitness components and were administered to 121 undergraduate males. The data were analysed according
to the Principle Axes Method with the Varimax Criterion for Rotation. Five factors were isolated and named—speed endurance, gross strength, power-agility, flexibility and muscular endurance. Two test batteries having five items each were developed on the basis of the rotated factor loadings.

Test Battery I contained the highest loading test items: (1) time-limit shuttle run (2) cable tension (3) 10-yard dash (4) thigh flexion flexibility and (5) Roger's Physical Fitness Index. Test Battery II contained five administratively feasible test items: (1) time-limit shuttle run (2) ankle planter flexion strength (3) the Illinois Agility Run (4) thigh flexion flexibility and (5) bar push-ups.

Uppal and Roy (1986) investigated motor fitness components as predictors of soccer playing ability. They hypothesised that predictions could be made on the basis of motor fitness with regard to the playing ability.

Thirty male soccer players from Jiwaji University, Gwalior, were selected as subjects for motor components, namely speed (50 m dash, agility (4 x 100m shuttle run), maximum leg strength (leg dynamometer), explosive leg strength (standing broad jump), and cardiorespiratory endurance (Cooper's 12-minute Run/Walk Test). The soccer playing ability of the subjects was assessed with the help of a panel. The statistical design of data included zero order correlation, multiple correlation and prediction equation and the Whery-Dollittel Method.
of Regression Equation. The findings of this study revealed that all of three independent variables (speed, agility, endurance) were significantly related to the dependent variable (soccer playing ability). Since the multiple regression coefficients have been found related to soccer performance, therefore, for better performance in soccer, all the independent components chosen in the study must be considered. Soccer playing ability could be predicted with the help of the developed predictional equation.

Butts (1967) used the Fleishman Basic Fitness Test and the Scott Motor Ability Test for undergraduate college women students. The Spearman Rank Correlations Coefficient and Fisher Matched 't' Formula were applied to ascertain whether the differences were statistically significant. It was concluded that of the 10 activities studied, basketball, field hockey and tennis made the greatest overall contribution to an improvement in the physical fitness and motor ability levels.

Huntington (1968) in his study of the relationship evaluated differences in achievement between groups of boys at different strength levels on selected motor fitness tests inorder to form high, middle and low-strength groups. The motor fitness tests administered were the agility test battery, the cardiorespiratory endurance test battery, the power test and running speed test battery. The
relationship between strength and individual fitness tests and between strength and total test batteries were determined by the Pearson Product Moment Technique. It was concluded that the cable tensiometer strength test did not appear to be practical in predicting achievement on the selected motor fitness tests.

Romain (1977) conducted a study to identify the factors that could be isolated when selected motor fitness measures were administered to male and female pupils. Seventeen motor fitness tests were administered. The intercorrelation matrix was subjected to an image analysis. Factor I received high substantial loadings on four variables: the six-second run - 0.953; the shuttle run - 0.951; toe touch - 0.945; and modified beam walking - 0.885. Factor II received high loadings on five variables: modified side step - 0.630; 50-yard dash - 0.603; standing broad jump - 0.599; one-minute lateral jump - 0.509; and baseball throw - 0.448. Factor III received high loadings on four variables: weight - 0.766; height - 0.745; grip strength - 0.764; baseball throw - 0.462.

Hoffman (1971) compared the effects of four programmes of physical education on the development of physical fitness levels. The four programmes were 10 minutes of circuit training, 10 minutes of calisthenics, a 10-minute programme
It was concluded that the physical fitness and general motor ability of highly physically fit and less physically fit students could be improved by a 10-minute programme of either circuit training, calisthenics or a combination of isotonic-isometric exercises.

Shore (1972) constructed a motor fitness test battery for lower elementary grade boys. Thirty experimental test items, considered valid and reliable measures of motor fitness, were administered to 238 boys. Two test batteries containing seven items each were developed on the basis of the rotated factor loading of the test items. Test Battery I contained the highest loaded test item for each factor: (1) Clarke's Strength Composite, (2) McCloy's Endurance Ratio, (3) Well's Sit and Reach, (4) Bass Balance On a Stick, (5) Leg flexion and extensional flexibility, (6) arm flexion or back flexibility and (7) modified push-ups. Test Battery II contained more administratively feasible test items: (1) Grip strength, (2) 300yd run, (3) Wells Sit and Reach, (4) Bass Balance on a Stick Lengthwise, (5) leg flexion and extension flexibility, (6) arm flexion or back flexibility and (7) modified push-ups.

Paul (1987) constructed and standardized specific
physical fitness tests for soccer players. He used the factor analysis technique on the data of 100 university soccer players of the North Zone (India). As many as seven factors of specific physical fitness were obtained, out of which six were considered as meaningful to select test items from each factor. One test item from each factor with the highest loading was included in the test battery. The derived test items were applied on 500 soccer players to develop norms.

Hunt (1975) conducted a study to determine the relationship between standing height, weight, chronological age, and the ability to perform the compulsory items of the Manitoba Physical and Motor Fitness Performance Test. The variables of physical and motor fitness included 1 minute sit-ups, the standing broad jump, and the 300 yd run. The results of this study showed that chronological age, height and weight were of little value as classifiers in the performance of the compulsory items of the Manitoba Physical and Motor Fitness Performance Test.

Copp Patrick Ross (1972) constructed a scientifically designed evaluative instrument for assessing the motor fitness of first, second and third grade girls. Thirty test items selected through a pilot investigation were administered to 183 subjects. The Pearson Product Moment
Raw Score Formula and the Zero Order Correlation Co-efficient were used to construct a correlation matrix for a factor analysis of the data using the Principal Axes Method. The battery of the seven most valued measures which loaded the highest on each factor was developed and included, Clarke's Strength Composite, McCloy's Endurance Ratio, leg extension and flexion, Well's Sit and Reach, dodging run, Bass Lengthwise Stick Balance and the vertical jump.

Robbins (1985) conducted a study to develop percentile norms for Alabama students, based on their performances on both the AAHPER Youth Fitness Test (YFT) and the AAHPERED Health Related Fitness Test (HRFT). Alabama means were compared with national means. A sample t-test was used to determine significant differences between the means. The Alabama students performed better on events measuring agility, speed and cardiovascular endurance. The national group performed better on events measuring abdominal muscular endurance and flexibility.

Huntley (1974) analysed the effect of participation in selected physical education activities upon physical fitness and motor ability. The three experimental activity proformas were (1) basic movements (2) rhythmic activities and (3) games, related activities and gymnastics.
Each student was pre and post-tested on the Glober Physical Test. The results revealed that the greatest contribution to physical fitness and motor ability resulted from participation in basic movements and rhythmic activity.

Andrew (1976) undertook a study to establish physical fitness norms for South African boys and compare their physical fitness levels with those of Canadian boys. The AAPHER Physical Fitness Battery (1966) consisting of one-minute speed sit-ups, standing broad jump, shuttle-run, flexed arm hang, 50-yd dash and 300-yd run was administered. t-test was applied to compare the mean scores of the South African and Canadian students. The results were found to be significantly in favour of the South African boys.

Sharma (1987) constructed and standardized a specific physical fitness test for badminton players. He used the factor analysis technique on the data of 100 inter-college and district badminton players of North India. As many as seven factors of specific physical fitness were obtained, out of which five were considered as meaningful to select test items from each factor. One test item from each factor which had the highest loading was included in the test battery. The derived test
items were applied on 500 badminton players to develop norms.

Miller (1971) investigated the effects of individual and team sports programmes on the motor ability of college male students. The Barrow Motor Ability Test was administered to the subjects. They were then assigned to one of three groups—a team sports group, an individual sports group, or a combination sports group. At the end of the winter and spring quarters, the Barrow Motor Ability Test was given again to the subjects. The collected data were subjected to the analysis of covariance and t-test for significance at the 0.05 level. No significant difference was found in the effect on the motor ability of the subjects of the four groups.

SKILL RELATED SPECIFIC FITNESS STUDIES

No matter what the component of conditioning is, be it strength, endurance, flexibility or power, the specificity of training is of primary importance.

The Principle of Specificity has been recognised by a number of sports scientists as vital to introduce high levels of specialisation not only in particular discipline but also in developing the skills of players for particular functions within that discipline. The principle of Specificity has been elaborated in the
statement of John McPhee (1978), coach of the world basketball star, Bill Bradley who played for Princeton University in the early 60's. Van Bredakloff (a Princeton coach) said that Bradley is a great mover; and points out that the basis of all these maneuvers is footwork. Bradley has spent hundreds of hours merely rehearsing the choreography of the game—shifting his feet in the same pattern again and again, until they have worn into his motor subconscious. "A sense of where you are"; (1981) A profile of Bill Bradley at Princeton, second edition, New York: farrar, Straus and Giroux.

Katch and Katch (1981) stress that different activities, depending upon the duration and intensity, require the activation of specific energy systems. While laying stress on specificity principles, he explains that specificity refers to adaptation in the metabolic and physiological systems, depending upon the type of overload imposed.

Jones (1977) explains the Principle of Specificity by saying that training for basketball is playing of basketball. However, this seems to be a narrow approach to specificity. Broadly speaking, one pedagogical and training process must include a number of drills aimed at developing the specific motor fitness components in order
that the learning in technique and tactics accelerates.

Sodhi et al. (1982) studied the physical characteristics and performance of Indian gymnasts. Each gymnast was examined for various anthropometric measurements and strength and flexibility variables. The results of this study show that the better gymnasts had better average strength in all regions of the body than lower-grade gymnasts. This study indicates that relative strength has a direct and sound relationship with the competitive performance in gymnastics.

Disch (1978) made a classification of variables that discriminate among a group of female track athletes. The subjects for this study were 41 members of the Seattle Pacific Track Club (age level 11-21). A number of anthropometric and motor fitness variables were studied. The variables that were primarily responsible for variations among the group were per cent fat, lean body weight, age, visual reaction time, vertical jump and velocity measures at 0-5, 5-10 and 40-50 yards. This test battery was highly useful in classifying track athletes.

Hawkins (1976) explains the Principle of Specificity by investigating the relationship between shoulder strength and sprint speed. The relationship of sprint speed improvement
to several selected variables was also examined. The results of the data analysed revealed no significant relationship between speed improvement and any of the selected variables.

Some researchers have investigated the specificity of the training concept by comparing the stress response of a familiar exercise to that of an unfamiliar exercise. Subjects exercised with treadmill running, bicycling, or served as controls. It was concluded that organ system responses, as measured by serum enzyme changes, are not adversely affected when exposed to unfamiliar conditions of exercise.

Sodhi et al. (1982) emphasised that talent selection for sports during childhood should be based on stature as it is one of the most important morphological characteristics in a majority of sportive activities. He has suggested that the heights of Punjabi male children was an advantage for selection for volleyball in various age groups. However, no work has been conducted with regard to the normative standards of specific motor fitness for male or female players in volleyball. This study could fill this gap by focussing on the problem of specific motor fitness through the construction of a game-specific test in volleyball.

John and John (1972) explain the specificity of
training effects occurring from participation in programmes of treadmill running and bicycle ergometer riding. Two groups of adult male subjects were pre-tested using (PWC) 150 Tests on both the treadmill and bicycle ergometer and were found to be similar in their functional capacities, as measured by above mentioned tests.

For a period of six weeks one group engaged in intensive training while the other group participated in a progressive training programme on a bicycle ergometer. The groups were subsequently post-tested on both. The treadmill and bicycle ergometer tests indicated that the treadmill training group had improved significantly only as measured by the bicycle ergometer test. A two-way ANOVA for repeated measures was employed to test for suspected interaction between the bicycle training programme and the bicycle PWC 150 Tests. It was concluded that training effects of cycling are more specific than those of running and, therefore, the choice of a work capacity test for assessing changes in the circulo-respiratory functional capacity, resulting from exercise, is critical.

Miller (1971) made an assessment to find out whether taking into account women's height and weight on each individual's performance on motor fitness test would result in a more accurate prediction of fitness as measured
by a cardiovascular test. The motor fitness battery consisting of (1) grasshopper leaps (2) forward sit and reach (3) bent arm hang (4) sit-ups and (5) standing long jump and a new modified step test was administered to 66 volunteer women students. The following conclusions were justified: (1) The new modified step test of cardiovascular fitness had little or no relationship to an individual's capacity to perform motor fitness tests. (2) Height influenced the individual's capacity to perform grasshopper leaps and standing long jump. (3) Weight influenced grasshopper leaps, forward sit and reach tests, bent arm hang and sit-ups test performances of the individuals.

Hill (1972) conducted an investigation to determine the relationship of the reaction time and movement time of primary grade children to the variables of motor ability and physical fitness. The IOWA Bruce Test of Motor Ability, the Glover Physical Fitness Test, a reaction-time test and a movement-time test were administered to 133 male and 133 female subjects between five and eight years of age. Statistical treatment of the data revealed that reaction time and movement time were significantly related to each item of the physical fitness test and both correlated significantly with the motor ability criterion.
Alexander Rex Eugene (1973) conducted a study, by means of factor analysis, those factors which contributed to motor performance. Thirtyfour variables were administered to 220 male and female students. The Pearson Product Moment Correlation Co-efficient and factor analysis techniques were employed. Six robust factors that existed in the male group were leg strength and speed, arm and shoulder-girdle strength and endurance and grip strength. For females, the factors of muscular endurance and agility, leg power, explosive strength, balance and static strength of the arms were established.

Bissonette (1974) identified the nature of physical fitness possessed by elementary school boys through factor analysis. Twentyfour physical fitness evaluation items were administered to 112 boys, seven and eight years of age, and 117 boys 11 and 12 of age. The data collected were correlated. Various criteria for rotation were employed to maximize three loadings on each factor. Five similar physical fitness factors were identified for all ages. They were named body fat, the body dimensions' static strength, hip flexibility, recovery pulse and muscular endurance.

Johnson (1978) made an investigation to determine the relationship between the motor creativity and motor performance of young children. The Wyrick Test of Motor
Creativity and a motor performance test battery consisting of the standing broad jump, 40-yd dash, tennis ball throw for a distance, side-stepping and the Bass Stick Test were administered to 48 boys and girls. The results of the investigation indicated that there was a significant positive relationship between motor creativity and motor performance.

**FITNESS STUDIES RELATED TO VOLLEYBALL**

Chand (1975) tried to analyse the fitness demand of volleyball players. He explained that a volleyball player should be gifted with height and a jumping ability, strength of legs, arms and trunk, reaction time, high explosive power, nervous strength, endurance, flexibility and a vast range of agile movements.

Smith (1969) studied the relationship of volleyball playing ability to scores achieved in the Sargent Jump. A 66-strong beginners group was formed. Eleven varsity players and three highly skilled and experienced players were selected. The vertical jump correlated .35 with the Brady Test, .55 with the evaluation of judges' appointed for the study, and .50 with a combination of the Brady Test and the judges' evaluation for the beginners. The 'r' between the vertical jumping ability of the varsity
players and the potential playing ability as ranked by their coaches was .36. It was concluded that the vertical jump was not an accurate predictor of volleyball playing ability.

Bakker (1969) studied the factors associated with success in volleyball. The subjects were 28 members of women's extramural volleyball teams at the Illinois State University. Two experienced volleyball coaches established the criterion by rating each player on her playing ability. The variables measured were height, weight, leg extensor strength using an adjustable dynamometer, skinfolds using a large calliper, jumping ability by using jump and reach tests, and an apparatus constructed by the investigator to measure reaction and movement times. Through the 't' test and correlations it was found that jumping ability and reaction time were significantly related to success in volleyball. A multiple correlation ($R$) of .718 was obtained between the nine variables and the criterion. An 'r' of .53 was obtained between the criterion and reaction time plus jumping ability, and one of .52 between the criterion and jumping ability plus weight. The regression equation computed in this study could be used to predict success in volleyball playing.
Spence et al. (1980) developed a descriptive profile on 15 members of the United States women national volleyball team who were highly skilled. Data were obtained from anthropometric, strength and the physiological and motor performance domains consisting of jump and reach, triple hop, agility run and a 20-metre dash. Within the group, comparisons were made between the six women who were selected for the Pan American team and the nine who were not selected. The Pan American players were taller and heavier and demonstrated better motor ability than the non-selected players. The strength measurements did not indicate consistent differences between the two sub-groups. The non-selected players had a greater $V_{O_2}$ max than those selected. Group comparisons on selected variables were also made between the team players and other women volleyball players. The training team subjects were taller and heavier than the compared groups. The training team group demonstrated a lower heart rate Max (180 beats/minute) than the outer groups and their $V_{O_2}$ Max (43.2 ml/kg/min) was within the range of the compared groups.

Phipps (1982) studied selected general ability tests, specific skill tests and personality traits as predictors of volleyball performances in high school girls.
It was one of the purposes of this study to determine which of these variables had the highest relationship with overall performance. It was also the intention of this investigation to develop prediction equations from three variables or combinations of the validity of the selected equations. Three general ability tests, three specific volleyball skill tests and a personality test were administered to 120 high school girls. The results of this study indicated that the specific test model had the highest correlation with overall performance. The variables of general ability and personality were not related to volleyball performance. The combined equation of general and specific abilities had the highest relationship of any combined model to the criterion score. The specific model was the most valid predictor of criterion scores followed by the combined general and specific model. The specific test model was the best predictor of volleyball performance. The specific test model and combinations of general ability and personality with specific abilities are better predictors of volleyball performance than the coaches' beginning-of-season judgements.

Coutts (1976) tested 11 members of Canada's national women's volleyball team on vertical jump ability and Margaria's Test of Anaerobic Power. It was concluded that the velocity or power per unit body weight exhibited by the subjects
on two tests of leg power were not related to each other. The total power outputs on both tests were significantly correlated to each other and to body size, as indicated by the height and weight. The usual method of scoring vertical jump tests was thus an indicator of the velocity or power per unit body weight, which was unrelated to the total power output during the jump or the velocity and power on the Margaria Power Test.

Gill (1986) conducted a study on 30 students of the Hari Singh's Sabha Higher Secondary School, Patiala, aged between 13 and 16. She observed the skills displayed through the serve test, smash test, repeated volleyball test and the physical performance test of push-ups, squat test, straddle test and vertical jump. Comparing the performances in skill tests and motor fitness tests it was concluded that both had a significant relationship.

Murugesan (1981) established the relationship of height, agility and vertical jump to spiking in volleyball. The researcher conducted tests on 30 male students of LNCPE, Gwalior, and concluded that the vertical jump was the most reliable single variable in predicting the spiking ability of male volleyball players; and that a combination of height and vertical jump ability proved to be the most reliable combination to predict their spiking ability. The combination
of three variables, i.e. height, agility and vertical jump, was also found both valid as well as reliable for predicting spiking ability.

Joseph (1983) conducted a study to determine the relationship of agility, shoulder flexibility, arm length and leg length with volleyball playing ability. For this purpose, he selected 30 volleyball players and found that power was the most reliable variable followed by arm length and leg length in predicting volleyball playing ability. It was also concluded that agility and flexibility did not correlate significantly to volleyball playing ability.

Devi (1985) made a study on 36 college-level volleyball players to determine the relationship of depth perception, agility and speed of movement. The finding reveals that depth perception, agility and speed of movement contribute to volleyball playing ability. A significant correlation of agility and speed of movement may be expected in volleyball as it demands a quick acceleration rate, along with performing movements in any direction. The results showed a significant relationship between speed of movement and agility.

Bhola (1984) conducted a study on 25 volleyball players to study the relationship of absolute leg length, foot
dynamic power and ankle flexibility to jumping ability in volleyball, using a three-stride rhythm. The tests included a 50-metre run, side step and Sargent Jump. It was concluded that:

1. Foot length and dynamic power showed a significant relationship to jumping ability in volleyball, using the three-stride rhythm.

2. Right and left ankle flexibility also showed a significant relationship to jumping ability.

3. Agility was significantly related to jumping ability.

4. The variables of absolute leg length, fore-leg length and thigh-leg length showed an insignificant relationship to jumping ability.

Lamp (1954) analysed in his work the playing ability of 806 junior high school students in relation to various physiological and strength factors. A statistical analysis of the scores of tests on volleyball players showed the factors to be objective, reliable and valid measures of playing ability. Positive correlations were found between the volleyball playing abilities of boys and girls and factors such as age, height, weight and strength. There was no significant difference between boys and girls in their
age and abilities to exhibit skills in volleyball. Age and weight were more closely related for girls than boys in performance skills. Height was more important than other growth factors for boys in volleyball. For both there was a positive relationship between strength and volleyball playing ability. A comparison of scores and pubescent status indicated that there was a decided relationship between these factors for this level. The more mature boys perform better than others. For girls, all pubescent groups showed an early increase in performance with age and a decline after the 14th year.

Devi (1985) conducted a study of the relationship of selected strength and flexibility measures by using Roger's formula, sit-ups, leg dynamometer, trunk flexibility by the sit-and-reach test and shoulder flexibility by the metric scale, testing 24 volleyball players of Lakshmibai National College of Physical Education (LNCPE), Gwalior. She concluded that arm, abdominal and leg strength were significantly related to playing ability in volleyball. Shoulder flexibility also contributed significantly to playing ability. Grip strength did not correlate with performance and wrist flexibility and ankle flexibility were not significant for playing ability. Trunk flexion to also showed a non-significant correlation/volleyball playing ability.
Disch et al. (1977) developed a test battery in 1974 to analyse the performance of volleyball players. This battery was developed with the help of the U.S. women's volleyball coaching staff and measurement specialized staff of Rice and Houston University. It assessed the playing ability of women volleyball players. The tests were selected from various physical fitness components, following the procedure of taking the most reliable and valid information on volleyball playing capacity, and also keeping in view that the tests could be administered in teaching and coaching situations and that they were closely related to various phases of the game. Data was collected on age, weight, height, reach height, percentage fat, vertical jump, triple hop, 20-metre dash, agility run, basketball throw and the Queen's College Step Test to assess the maturity, structure, body size, leg power, coordination speed, controlled speed, arm power, coordination and anaerobic conditions.

Toyoda (1971) found through his study that volleyball players have different types of physical requirements in accordance with the nature of the activity. He concluded that a volleyball player requires muscular strength and power and also muscular endurance, circulo-respiratory endurance, agility and speed of movement, flexibility of muscles and joints and an ability to control body movements.
like timing, rhythm, balance or coordination and relaxation and coordination of the whole body. These elements had a significant relationship with volleyball skills.

Morrow et al. (1979) attempted to know the importance of various anthropometric strength and speed variables which were obtained on 180 inter-collegiate women volleyball players who participated in a regional round-robin tournament. The purpose of the study was to determine the factors underlying the motor performance of the women and then determine if there was any relationship between the factors and team success. A factor analysis of the measured variables showed that these could be dimensioned as body size, speed/fat and strength. Multiple discriminant analysis showed that the teams were significantly different on the factor of strength and speed/fat. Team centroids were plotted in a two-dimensional discriminant space and this graphic representation showed that the stronger, faster and leaner teams were the most successful in tournament play. The results showed that the basic factors of speed/fat and strength were related to team success. The multiple discriminant analysis helped to identify the two most important individual variables for team success. Upper body strength and fat weight were identified as most important in differentiating between players of the most and least
successful teams.

Bulgin (1981) proposed a model of physical preparation for volleyball players, to develop a combination of various physical qualities and to check the improvement in the players. This model was prepared and worked out over a period of several years in volleyball improvement groups at the Izmailski Pedagogical Institute where planned training and progress checking was done with the use of eight indicators. The speed of movement was observed with the shuttle run, muscle strength by throwing a medicine ball, speed of arm movement by throwing a tennis ball against a wall and the strength of the extremities by executing the maximum number of repetitions (push-and-squat thrusts) in 15 seconds. The model throws into relief the combination of the various qualities of a volleyball player.

The conclusions were:

1. The constructed model allows for effective planning for improvement in the physical qualities of a player by taking into consideration their individual characteristics.

2. The scores in the separate parameters of the model can be used as control norms for evaluation of physical preparation.
3. The proposed model makes it easier to evaluate the capabilities of the players for selection.

Popovskii (1981), noted that there was a trend to select tall boys for volleyball, giving the example of the XXII Olympic Games in which the average heights of the boys and girls were 190.4 cm and 176.9 cm, respectively.

After analysing the different criteria used for making selections on the basis of height, that is (1) children's original height (2) Shamakova Prediction Criterion (3) Havlíček formula equation from the father and mother's height (4) and a combination of biological and chronological age and their negative features, he expressed the view that improvement in the reliability of the criteria used to predict a high combination may be beneficial as suggested by a Leningrad scientists' team. The boys should not be shorter than 145 cm at the age of nine years and his parents should be taller than the average adult, the father and mother being 179.5 cm and 165.1 cm tall, respectively. Also, during school there should be a check-up of biological ages. The final height of the experimental groups were in the range 180 cm to 194 cm. Children whose parents were between 164 cm and 173.9 cm tall grew to 180-189 cm. Children of taller parents (174 183.9 cm) grew to 190 cm or taller. A boy with a high growth potential can be
Adhikari (1983) conducted a research study on 30 college boys to find out the comparative relationship of power, agility and selected speed characteristics with the block jump and the three-stride jump in volleyball. A different set of tests like the Sergent Jump, the Nelson Speed of Movement Test, squat thrust etc. were used to measure different components and their relationships to each other. The results showed that:

(1) The power of an individual contributed much to performance of the block jump and the three-stride jump and showed a positive relationship between them.

(2) Agility, which was a required factor for performance in the vertical jump, co-relates significantly with block and three-stride jumps.

(3) Speed, reaction time and speed of movement did not contribute much in performance of block and three-stride jumps.

(4) Power and agility played an equal role in the performance of the block jump as well as the three-stride jump because there was no significant
difference between the 'r's of power and agility and the performance at the block and three-stride jumps.

Siridhar (1984), conducted a study on 30 college volleyball players to determine the relationship between agility, flexibility and muscular endurance and playing ability. The tests conducted were the Sergent Jump, side step, trunk flexion, pull-ups, sit-up and one-minute lateral jump. The findings showed that the motor fitness components of power, muscular endurance, circulo-respiratory endurance as well as flexibility contributed to the game of volleyball. The study showed a significant relationship between power and performance. There was a positive relationship between flexibility and playing ability. The circulo-respiratory test showed a significant relationship with playing ability in volleyball because of repeated jumps in the game. Agility also had a significant relationship with playing ability.

Kumar (1985) conducted a study of the inter-relationship between leg power tests and spiking and blocking skills on 32 volleyball players at the National Institute of Sports, Patiala. The tests were vertical jump (without approach and with approach), block jump, three consecutive long jumps with both legs and with left
leg and right leg, standing broad jump, half-squats, a shuttle run (9-3-6-3-9), forward and backward bending of the body, 20m and 40m sprints 60m run, spiking and blocking skills were not inter-correlated. Spiking had a significant correlation with the 40m sprint and the reach jump, with and without approach. The with approach and without approach jump tests were highly correlated with each other. There was a significant correlation between the sprint tests and the jump tests. The test of flexibility was correlated with agility only. Blocking was highly correlated with consecutive jumps. Blocking had a high correlation with the with approach and without approach jumps.

CRITICAL ANALYSIS

A review of the related literature brings out some interesting facts. A majority of the authors referred to have investigated general physical fitness. Although a number of works have been written to prove that it is possible to predict performance by studying specific fitness components, these have been comparatively few and far between, most of them concentrating only on a few components, without developing a comprehensive test battery.

Another interesting fact that comes to light is that most of these studies have been done in advanced,
developed countries and are, therefore, to a large extent limited by the conditions, both physiological and environmental, that prevail in those countries.

We have referred to only a few works by Indian sports scientists. This was only natural because there is lack of extensive work on the subject in India. Moreover, the few Indian authors referred to have, again, dealt with physical fitness only generally, or referred to a few specific components in relation to some sports discipline, without developing a comprehensive test battery. They have done limited research on various components related to volleyball, but none has developed a specific fitness test to generate norms that can aid the selection of teams and predict performance. Of course a few significant studies related to specific fitness have been done in India, e.g. Sharma (1987), Paul (1987). However, no such study has been conducted on female volleyball players.

The review, generally, has tried to indicate the implications of the Principle of Specificity in the field of sports. Most researchers have found that specific fitness can be a predictor of skill performance. This aspect has been highlighted in Section II of this chapter. A number of studies have been coded which have supported the view that
an individual is likely to develop some specific physical fitness traits through participation in a specific activity which he or she might have selected because of his genetic pre-disposition for that activity.

Section III has been focussed on specific fitness studies related to volleyball. The researcher referred to in it have tried to demonstrate the relationship of different fitness components to volleyball playing ability. However, it can be observed that in every study referred to the physical fitness test items are either far too limited or the skills to which the fitness item has been related do not cover the total playing abilities of the player.

This study will be an attempt to investigate, in the area of women's volleyball, a large number of physical fitness tests and their relationship to performance in volleyball. These tests, hopefully, will help to predict the performance of female volleyball players and aid selectors in choosing their teams in an objective manner. Further, the frequent use of these tests in training may help in promoting both specific physical fitness traits as well the skills of women volleyball players.