Chapter II

REVIEW OF RELATED LITERATURE

The research scholar has made every attempt to acquire literature to this study from various sources such as Journals, Periodicals, Encyclopedia and other books in some of the renowned libraries. The libraries which the scholar consulted were Panjab University, Chandigarh, Post Graduate Institute of Medical Education and Research, Chandigarh, Netaji Subhash National Institute of Sports, Patiala and Lakshmibai National College of Physical Education, Gwalior.

The relevant literature pertaining to the present study has been abstracted in this chapter to provide the background material to evaluate the significance of this study as well as to interpret its findings.

1 Gladden and Colacino measured height, weight, skinfolds, vertical jump and maximal anaerobic power on 94 male and 88 female participants in three divisions (Men's Open, Senior Men's and Women's Open) of the 1974 USVBA national tournament. These volleyball players had a low skinfold total (Men's Open 48.7 mm, Men's 71.2 mm, Women's

open 76.7 mm) and a high vertical jump (Men's open 67.4 cm, Senior Men's 57.5 cm, Women Open 49.6 cm). The females had a very high anaerobic power in both total anaerobic power and anaerobic power per unit of body weight when compared with normal females. When compared with other athletes the males in Men's Open Division had a high total anaerobic power but only an average anaerobic power per unit of body weight. Rank Order correlation between final standings in the tournament and team average for each of the measured variables revealed no significant relationship in Men's Open Division. However, in the Women's Open Division, final standing was significantly correlated with age, height, reach, vertical jump, and maximal height on jump. Partial rank-order correlations showed that height and vertical jump were the major factors correlated with final standing. The differences in the rank-order correlations between the males and females might be explained by either (1) a critical height above the volleyball net, or (2) a higher skill level in the males.

Morrow et. al.² obtained various anthropometric, strength and speed variables on 180 intercollegiate 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. Factor analysis of the measured variables showed that the variables could be dimensioned as body size, speed/fat and strength. Multiple discriminant analysis showed that the teams were significantly different on the factors of strength and speed/fat. Team centroids were plotted in 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. 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.

Phipps\(^3\) compared selected general ability tests, specific skill tests and personality traits as predictors

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of volleyball performances in high school girls. The purpose of this study was to determine which of these variables had the highest relationship with overall performance. The further aim of this investigation was to develop prediction equations from the three variables or combinations of the variables that proved worth while and to determine 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 trying out for varsity teams in six schools. The coaches of each team assigned subjective pre and post season score to each of their respective players. The post season score was used as a criterion measure. It was concluded that:

1. There is little relationship between selected tests of general physical ability and volleyball performance.

2. There is a substantial relationship between selected specific skill tests and volleyball performance.

3. There is a little relationship between selected personality traits and volleyball performance.

4. There is a substantial relationship between volleyball performance and the following combined models: Specific and general, specific and personality and specific, general, and personality combined.
5. The specific test model is the best predictor of volleyball performance.

6. The best combined model for prediction is the general and specific.

7. The specific test model and combinations of the general ability and personality with the specific are better predictors of volleyball performance than the coaches beginning of season judgement.

Disch et.al. developed a test battery in 1974 to analyse the performance of volleyball players. This battery was developed with the help of U.S.A. Women volleyball coaching staff and measurement specialized staff of Rice and Houston University. It discriminated the playing ability of women volleyball players. The tests were selected from the various physical fitness components following the procedure of most reliable and valid information to volleyball playing capacity and also keeping in view that the tests could be administered in teaching and coaching situations and they were closely related to various phases of the game. The tests

were age, weight, height, reach height, percentage fat, vertical jump, tripple hop, 20 meter dash, agility run, basketball throw and Queen's college step test to assess the maturity, structure, body size, leg power, coordination speed controlled speed, arm power, coordination and an aerobic condition.

Hirata\textsuperscript{5} studied 116 Olympic volleyball players who were found to be tall and lean. Their average height was 183.8 cm. and weight 79 Kg. He stated that the forward players required a tall physique and the back players required a small and stout physique. Thus, volleyballers are not so large as basketballers on the whole.

Murgeson\textsuperscript{6} selected thirty male volleyball players of the Lakshmibai National College of Physical Education, Gwalior to study the relationship of height, agility and vertical jump to spiking in volleyball. He concluded that vertical jump is the most reliable single factor which underlies the performance in spiking ability. The variable combinations of height and vertical jump proved to be most


reliable. For three variables height, agility and vertical jump were found to be valid and reliable for predicting spiking ability of male volleyball players.

In Coutts\(^7\) study, eleven members of Canada's National volleyball team were tested on vertical jump ability and Margaria's test of anaerobic power with results expressed in terms of power (Kg·m/sec) and velocity (m/sec) or power per unit body weight (Kg·m/Kg·Sec.). The velocity scores on the two tests were not significantly related \((p < 0.05)\) to each other, and when correlating these values with height and weight, the relationship between velocity on the Margaria test and height was the only significant correlation. Power values on both tests were significantly related \((p < 0.05)\) to each other as well as to height and weight. The average values of 1.52 m/sec. and 108 Kg·m/sec for the Margaria test and 1.56 m/sec and 110 Kg·m/sec on the vertical jump thus provide normative values on two distinct aspects of leg power per unit body weight for female athletes.

Grewal\(^8\) made an attempt to study the physique and body composition, of Indian sports women in different games.

\(^7\)Kenneth D. Coutts, "Leg Power and Canadian Female Volleyball Players" Research Quarterly 47 (October 1976): 332.

\(^8\)Rupinder Grewal, "Physique and Body Composition of Indian Sportsmen with Special Reference to Their Level of Participants" (Unpublished Doctoral Thesis, Punjabi University, Patiala).
The subjects were 492 sports women and 81 controls ranging in age from 17 to 23 years.

The result of his study regarding volleyball game, he stated that the volleyball players are very tall and heavy, though less than the throwers. They possess short trunk, long upper extremities, broad shoulders, big knees and big bodily circumferences including well developed calves. They have longest lower extremities as compared with the other categories of players at different level of competition. The amount of subcutaneous tissue in upper extremities and trunks is more than all other players except throwers. Their mean somatotype is 3.71 - 3.15 - 2.97. They possess muscular arms, fore-arms and calves.

A study was undertaken by Mathew⁹ to determine the relationship of selected anthropometric measurements (height, weight, arm length and upper body length) to performance an Brady Volleyball Test. Pearson's Product Moment Correlation (zero order) was employed to study the relationship of volleyball playing ability to each of the selected anthropometric measurements. For testing the hypothesis the level significance was set at .05. The finding of the study indicated that the variables of height,

⁹Pius Mathew, "Relationship of Selected Anthropometric Measurements to Performance on Brady Volleyball Test" (Unpublished Master's Thesis, Jiwaji University).
weight and arm length showed significantly higher relationship to performance on Brady Volleyball Test, (height = .764, weight = .795, arm length = .792) as compared to the significant but low relationships of leg length and upper body length with performance on Brady Volleyball Test (leg length .544, upper arm length .641). All the above mentioned values were found significant at .05 level of confidence based on the finding of the study the following conclusions were drawn: 1) The height and weight of the players contributed to a much greater extent to the performance of Brady volleyball Test and to volleyball playing ability. 2) Arm length was also found to be an advantageous factor in the performance of Brady Volleyball Test. 3) Leg length and upper body length contributed to the performance on the said test to a very limited extent.

Hosler, Morrow and Jackson\(^\text{10}\) conducted a study on 180 collegiate volleyball players, representing 16-20 teams which participated in 1977 university. It was concluded that the women collegiate volleyball players of this study tended to be slightly taller and heavier than the 166.0 cm

FIG. 27 Relationship Between Pulse Pressure and Volleyball Playing Ability.

$r = 0.09$
develop a physical performance test battery that would prove valid, reliable and practical, when used to identify potentially successful collegiate volleyball players. Statistical techniques utilized provided intercorrelation co-efficient of the independent variables, correlation co-efficient between the independent variable and the dependent variable, step-wise regression co-efficient and constants and the square of the multiple correlation co-efficient for the regression equation at each step. Reliability co-efficients of all items were computed by using intra-class correlation techniques. Within the limitations of this study and based on the findings, the following conclusion is made:

1. Cross-validation procedure employed supported the validity of the six-item battery as a predictor of expected volleyball performance.

Joseph\textsuperscript{12} undertook a study to determine the relationship of power, agility, shoulder flexibility, arm length and leg length to volleyball playing ability. Thirty male

volleyball players of the Lakshmibai National College of Physical Education, Gwalior were selected as subjects. Product moment correlation was used to compute correlation between playing ability and each of the selected independent variables. From the findings of study it may be concluded that:

1. Power is the most reliable variable in prediction of playing ability of men volleyball players.

2. Arm length and leg length are also reliable variables in prediction of playing ability of male volleyball players.

3. The variables of agility and shoulder flexibilit show insignificant relationship in prediction of playing ability of male volleyball players.

Smith13 formed three groups of subjects, 68 beginning players, 11 varsity players and three highly skilled and experienced players in the relationship of volleyball playing ability to scores achieved in the sargent vertical jump.

Vertical jump correlated .35 with the Brady Test .55 with the judges evaluation, and .50 with a combination of Brady Test and judges evaluation for the beginning players. The 'r' between the vertical jumping ability of the varsity players and a potential playing ability ranking by their coach was .36. It was concluded that vertical jump is not an accurate predictor of volleyball playing ability.

Devil14 conducted a study on twenty four volleyball players to find out the relationship of selected strength and flexibility measures to playing ability in volleyball. She concluded in her study that arm strength, abdominal strength, leg strength and shoulder flexibility were significantly related to playing ability in volleyball. Grip strength did not correlate significantly to playing ability in volleyball. Wrist flexibility and ankle flexibility had insignificant relationship to playing ability in volleyball. Trunk flexibility showed negative but insignificant correlation to playing ability in volleyball.

The American Association for Health, Physical Education and Recreation\textsuperscript{15} has constructed a test in volleyball for boys and girls. These tests include the skills such as serving, volleying, passing and set up. They established a high degree of reliability and validity.

Lamp\textsuperscript{16} investigated the volleyball playing ability of 806 junior high school students in relation to various physiological and growth factors. Statistical analysis of the volleyball tests showed them to be objective, reliable and valid measures of playing ability. Positive correlation were found between volleyball playing ability (of both boys and girls) and the factors: age, height, weight and strength. The study revealed that the volleyball tests are reasonably objective, reliable and valid. There is no significant difference between boys and girls in their ability at this age to perform the skills of volleyball. Age and weight are more closely related for girls than for boys in performance in volleyball skills. Height is more important than the other growth factors for boys in relation to volleyball skill test.


\textsuperscript{16}Nancy A. Lamp, "Volleyball Skills of Junior High School Students as a Function of Physical Size and Maturity" Research Quarterly 25 (May 1954): 189-197.
For both boys and girls there is slight positive relationship between strength and volleyball playing ability. A comparison of scores and pubescent status indicates that there is a decided relationship between these fact or for junior high school boys. The more mature boy at each chronological age score higher than the less mature boy. For the girls, all pubescent groups show an early increase in performance with age and in all groups the maximum increase appears to come between 12.75 and 13.25 years. Peak scores for the pubescent and post pubescent groups appear to come in the 14th year, followed by a decline or leveling off scores.

Cox\(^1\) studied the relationship between team performance in volleyball and the skill components of serving, service reception, setting, spiking, spike defense and free ball passing as measured through adapted charting procedures. Multivariate analysis of variance, discriminant analysis and multiple correlation techniques were used to analyze the resultant data of the study.

The result of the study indicate that considered together, the volleyball skills of serving, service reception, setting, spiking, spike defense and free ball

\(^1\)Richard Hardee Cox, "The Relationship Between Selected Volleyball Skill Components And Team Performance of Men's North West Double A Volleyball Teams" Dissertation Abstracts International 34 (March 1974): 5685 A.
passing, as measured by adapted statistical charting procedures, are significantly related to team performance when viewed in terms of winning or losing, and in terms of percent of total points scored by team charted. When the criterion variable of team performance was considered in terms of winning or losing:

1. Serving and free ball passing were of little value in predicting team success;

2. Spiking and spike defense made the greatest contribution towards predicting success; and

3. The order of volleyball skills most influential in predicting team success was spiking followed by spike defense, service reception, setting, serving and free ball passing. When the criterion variable of team performance was expressed as percent of points scored by team being charted:

1. Setting made an insignificant contribution in terms of accounting for the variance of team performance scores;

2. Spiking and spike defense made the major contribution in terms of accounting for the variance of team performance scores; and

3. The order of volleyball skills most influential in predicting team success was spike defense, followed by spiking, service reception, setting, serving and free bal-
passing.

In the study of Knight,\textsuperscript{18} eleven grade girls (N=120) performed at volleyball wall volleys, the volleyball pass in a game situations. Data for determining the relationship of these skills were scores from the administration of Mohr and Haverstick's Repeated wall volleys Test, Liba and Stauff's Volleyball Pass Test, and rating by 4 judges using Suttinger's Rating Scale. Tests were administered at the end of 6-week volleyball unit. Correlations were computed between scores on each of the tests. It was concluded that Liba and Stauff's Volleyball pass test and Mohr and Haverstick's Repeated Wall Volleys Test at the 7-ft. restraining line may be used to predict playing ability as measured by Suttinger's Rating Scale.

French\textsuperscript{19} conducted a study on Achievement Tests in Volleyball for High School Girls. The subjects for this study were unselected groups of 227 high school girls. Group A consisted of 47 girls of the tenth, eleventh and


twelfth grades, and group B of 180 girls of the ninth and tenth grades. It was concluded that -

1. The best combination of measures for practical purposes appears to be the Serving Test with the Repeated Volleys. This combination gives a higher degree of correlation with the criterion than does either item alone. The two tests measure quite different things. This combination is easy to administer since the Repeated Volleys Test may be given along the walls while the serving Test may be given on the court itself, if the floor space is large enough to permit administering and scoring both at the same time.

2. Because of simplicity of administering and scoring and the economy in time and equipment, these tests may be recommended as teaching devices as well as tests for classifying and diagnosing.

Kronqvist and Brumbach\(^{20}\) made a investigation by administering a test to three classes of grade 10 and 11 boys. The purpose of this investigation was to determine the suitability of a rebound, wall volley test as a technique

for evaluating the volleyball playing ability of high school boys. The Pearson Product Moment method of correlation was used to determine the validity of the test. In order to determine the objectivity of the judges' rating, co-efficients of correlation were calculated in which judge's total score for each player was compared with the score given by his colleagues. The reliability of the test was determined by the test-retest technique for each of the three classes and for the 71 subjects treated as one group. It concluded from the study that wall volleying technique can be used as a basis to assist an instructor to determine the volleyball playing ability of high school boys. The test gave evidence of being worthy of further experimentation and use in its present form.

The purpose of Bhola's study was to determine the relationship of absolute by length, relative leg length, foot length, dynamic power, ankle flexibility and agility to jumping ability in volleyball using three stride rhythm. Twenty male volleyball players of the Lakshmibai National College of Physical Education, Gwalior were selected as subjects. On the basis of the findings of the study the

following conclusions were drawn:

1. Foot length and dynamic power showed significant relationship with jumping ability in volleyball using three stride rhythm.

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

3. Agility was significantly related to jumping ability of male volleyball players.

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

Siridhar\textsuperscript{22} studied the thirty male and female volleyball players to see the relationship of selected Motor Fitness components to playing ability in volleyball. Product Moment Correlation (zero order) was used to determine the relationship of selected motor fitness components to playing ability in volleyball and to test the hypothesis the level of significance was set at \textit{.05}.

\textsuperscript{22}Sheela Kumari Siridhar, "Relationship of Selected Motor Fitness Components to Playing Ability in Volleyball" (Unpublished Master's Thesis, Jiwaji University).
In the conclusion, she found that power was the most significant motor fitness components underlying performance in the game of volleyball. Muscular endurance, circulatory-respiratory endurance and flexibility also contributed to the volleyball playing ability in a real manner. Agility showed an insignificant relationship to playing ability in volleyball.

Puhl et al. conducted a study to examine the absolute and relative physical and physiological characteristics of elite men and women volleyball players. They tested eight members of the U.S. Men's National Team and 14 members of Women's University World Games Volleyball Team. The parameters measured included percentage body fat, \( \text{Vo}_2 \text{ max.} \) post exercise blood lactic acid, measures of vertical jumping ability and peak isokinetic torque for knee flexion and extension, shoulder extension and planter flexion at 80, 180, 240 and 300 degrees per second. And they established the following findings that the men were taller, heavier, had a higher body density and lean body weight and lower body fat. For gross measures of jumping ability, the

men achieved greater absolute height for the jump and reach, and greater jump distance above the standing reach.

The purpose of Slaymaker's study was to determine if National Championship caliber volleyball players posses certain measurable kinesiological attributes to a significantly greater degree than skilled players at a lower level of competition. He selected thirty-two subjects in each group i.e. representing championship caliber players, tournament class caliber players and activity class caliber players.

The data were analysed by use of 'F' test and Scheffe's F test. He concluded that:

1. The performance of championship players was significantly greater than the performance of class caliber players in majority of the items tested.

2. The performance of championship players was not significantly greater than the performance of tournament caliber players in a majority of test items, indicating that areas of performance not under discussion must account for

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the differences in playing ability of the two groups.

3. The performance of the tournament caliber group was not significantly greater than the performance of the class caliber group in a majority of test items, indicating that areas of performance not under discussion must account for the differences in playing ability of the two groups.

Clarena,²⁵ studied the relationship of certain factors with success in volleyball. Subjects were twenty-eight members of women's extramural volleyball teams at Illinois State University. Two experienced volleyball coaches established criterion by rating each players on her playing. The following variables were measured height, weight leg extensor strength using dynamometer, skinfold using the large caliper, jumping ability using the jump and reach test, reaction time and movement was measured by apparatus constructed by the investigator. Through 't' test and correlation it was found out that jumping ability and reaction time were significantly related to success in volleyball.

Sodhi, 26 devided volleyball players divided into three groups. The first group comprises players selected for the Indian team for the Asian Games. They are termed National Team (NT) players. Those who were rejected while selecting this team were termed National Camp (NC) the State Level players. Thus the NT players are the topmost layers in the country, with the NC and the State level layers coming second and third respectively. These three groups are compared with one another. He concluded that the volleyball players are taller and larger, lighter for stature and posses longer lower extremities, shorter trunk, more slender chest, narrower hips and greater vital capacity. They possess proportionately longer upper arms and longer lower legs, broader knees and better developed lean tissue in the Thighs. The rating of ectomorphic component is also typically greater, but the body fat is less in these players. The selected players in the National Team have been found to be distinctly superior to the rejected National Camp Players in all these body characteristics.

26Harminder Singh Sodhi, "The Physique and Body Composition of Indian Athletes and Sportsman of Selected Physical Activities" (Unpublished Doctoral Thesis, Punjabi University).
Toriola, Adeniran and Ogunremi,²⁷ Comparatively assessed the body composition and anthropometric characteristics of elite male basketball (n=15) and volleyball (n=15) players and male none athlete (n=20) at the University of Ife, Nigeria. The ages of the subjects ranged from 19 to 29 years. Analysis of variance and Newman-Keuls post hoc method were used to determine significant differences in the physical characteristics of the groups. The basketball players were significantly taller and had markedly larger numerous width than the volleyball and non athletic groups (p 0.05). The nonathletes had significantly higher percent body fat values than both the groups of athletes (p 0.05). The basketball (4.30) and volleyball (4.40) players who were predominantly ectomesomorph had significantly higher ectomorphic component (p 0.05) than the nonathletes (2.5). The differences observed between the athletic groups are related to the morphological factors which influence the basic components of competitive sports performance.

Jeanette\textsuperscript{28} investigated the factor structure of basketball skills in the domain of human motor performance to identify the robust factors in that domain. The subjects for this study were 16 high school girls. A battery of 20 experimental variables were selected on the basis of their representation of a theoretical domain possessing the following hypothesized dimensions: 1. Shooting 2. Passing 3. Jumping 4. Moving without the ball and (5) Moving with the ball.

The study concluded that hypothesized dimensions of basketball playing ability were not supported. The multidimensional model playing ability were not supported. The multidimensional model resulting from this investigation is represented by dribbling, explosive leg strength, lay-up shooting and passing.

Bale and Davis\textsuperscript{29} assessed body build, explosive strength, grip strength and cardiorespiratory fitness of a group of 43 top class female field hockey players and the findings were compared with similar investigations of female

\textsuperscript{28}Gaunt Sharon Jeanette, "Factor Structure of Basketball Playing Ability" Dissertation Abstracts International 40 (Feb.1980): 4472 A.

hockey players and sports women. The hockey players were then divided into four groups according to their respective playing positions on the field and the above morphological, strength and fitness variables were examined in relation to these field positions. The somatotypes and body composition of the forwards and half backs were similar but both these groups were lighter, had lower percent fats, and lean body weight than the backs and goal keepers. The half backs were fittest both on the tests of explosive strength and on the test of cardiovascular fitness.

Ellenburg\textsuperscript{30} carried out an investigation on 110 selected high school varsity basketball players. The purpose of the study were: 1) to determine the value of a battery of ten skill tests and the personal factors of age, height and weight in predicting game performance. 2) to determine which of these tests and personal factors are most useful to high school coaching in predicting performance. 3) to develop a method for predicting player performance in high school basketball competition. Findings of the study reveals that 30 seconds shooting test and vertical jump are

the most reliable for the performance. Height, hand grip, vertical jump, wall volley and 30 second shooting test are most important variables. Reducing the predictor variables from the thirteen item test battery to a five-item battery may be done without losing an appreciable degree of prediction for game performance. The five item battery consisting of height, hand grip, vertical jump, wall volley and 30 second shooting test can be a practical and useful instrument in predicting game performance.

Gordon\textsuperscript{31} conducted a study on twenty female basketball players from the 1976-77 University of Arkansas and Northeastern Oklahoma State University Teams. The purpose of his study was to determine the value of a cardiovascular capacity measure, a leg power measure, an upper body muscular strength and endurance measure, a percent of body fat measure, and a measure of body height as predictors of basketball playing ability and to develop a statistical equation for predicting success in playing college basketball. From the result of the study, the following conclusions were drawn:

1. The Cooper 12-Minute Run and Walk are best measures for predicting basketball playing ability.

2. Measures of leg power and upper body strength and endurance are of limited value when 12-minute Run and Walk is used to predict basketball ability.

3. Body composition measure have some value in predicting basketball playing ability of college women.

Childress, 32 administered the test items to 106 high school basketball players. The purpose of this study was to identify the components of high school basketball playing ability and to construct an evaluate tool for classifying high school basketball players into populations identified as successful and unsuccessful. Twenty-four test items were selected through a review of the related literature as valid measures of the components of high school basketball ability. The result of the study indicated that the components of basketball ability could be isolated, measured and utilized to construct an evaluative tool for classifying players into two populations identified as successful and unsuccessful.

32 James Thomas Childress, "Factor and Discriminant Analysis to Identify and Determine the Effectiveness of Selected Physical Variables in Predicting a Successful Basketball Performer" Dissertation Abstract International 33 (November 1972): 2148 A.
Holland conducted a study to determine the value of speed, agility, upper-arm strength, power, ball-handling ability, reaction, shooting ability, passing ability, height, weight, age and previous experience in predicting ability to play high school basketball to determine which tests are most practical and useful to coaches in small high schools for measuring these characteristics; and to develop a method for predicting a successful high school basketball player.

Means, standard deviations, product moment correlation co-efficients and standard scores were calculated. Multiple regression was computed with the coaches' ratings used as the criterion. Based on the four significant beta co-efficients, multiple correlation was computed. The following conclusions were made:

1. Weight, height, experience, speed, power, ball handling ability, passing ability, shooting ability and reaction influence a player's success in basketball.

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2. Experience, ball handling, passing and shooting ability have the greatest influence on a player's success in basketball.

3. Prediction of successful basketball players from the basketball Ability Scores was 78 percent accurate. The accuracy of the prediction of starters was 68 percent; of second team members, 40 percent; and of the All Star Team, 38 percent.

4. A coach can determine 76 percent of his best players by using the following raw score formula:

\[ X' = (1.54) \times \text{(Number of years of experience)} + \]
\[ + (0.23) \times \text{(Speed dribble test score)} + (0.26) \times \text{(Wall test score)} + (0.15) \times \text{(Shooting test score)} - 10.11. \]

In the study of Malhotra, a comparison of 10 top Indian athlete and 10 non-athlete Indian soldiers was made on their lung functions, maximum oxygen uptake, maximum exercise ventilation and maximum heart rate. In the conclusion of his study, no significant difference has been

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found between the lung volumes of athletes and non-athletes. The athletes, however, have significantly higher \( V_o_2 \) max \((P < 0.001)\) and show a trend for higher \( V_E \) max. The maximum heart rate is significantly lower in the athletes \((P < 0.05)\). Comparison of Indian athletes with the world-class athletes show that the Indian have lower \( V_o_2 \) max and \( V_E \) max. In maximum heart rate and maximum lactic acid build-up, there is no difference.

Espenschade\(^{35}\) studied relationship between physical performance of school children and their age, height and weight. The relationship of age height and weight to performance of boys and girls on California physical performance test was studied in order to evaluate these factors on basis for grouping of students and for the establishment of norms for test performance. Where age is held constant relationships of all performance with height and weight are low. Highest correlation were obtained for boys of junior high school age in the events of jumping and throwing. Significant changes with age do occur in relation-

\(^{35}\)Anna S. Espenschade, "Restudy of Relationship Between Physical Performance of School Children and Age Height and Weight" Research Quarterly 34 (May 1963):144.
with most events for both saxes, age is recommended as a basis for test norms. If grouping according to the six desired, the California classification plan is superior. It shows that age has direct bearing on physical performance.

Selected kinanthropometric characteristics of Indian Volleyball players were studied by Sodhi\textsuperscript{36} et.al., in 1984 during the coaching camps held at Kurukshetra, Karnal and Patiala. The data of 97 volleyball players were divided into four groups—National men (N=12), State(N=21), National University (N=27) and District (N=25) groups. The volleyballers in each group were compared with control group (N=25), as well as the champions reported elsewhere. Each subject was examined with 12 anthropometric measurements and 10 tests of performance. The latter consists of block jump, vertical jump, three successive jumps, 20m dash, agility, basketball throws, 30 sec. sit ups maximum sit ups, flexibility and 2.4 km run. The statistical analysis was carried out to calculates the mean, standard deviation,

analysis of variance and test of significance.

The results of the study reveal that the National and State level players are better than other groups of volleyball players and the controls, with persistent decreasing gradient in most of the variables. On an average the volleyballers in each group are meso-ectomorphic in their somatotype. In skinfolds, the National and State players possess the least value, followed by the University, the District players and the controls with a gradual ascending gradient. On the contrary, in all the physical performance tests the National players are the best followed by the State, the University, the District players, and the controls with a descending gradient of performance.

An attempt has been made by Kansal, Giri and Giri\textsuperscript{37} to study the physique and body composition of Indian national volleyball players and to compare the same with that of olympic volleyball players. The subjects of the study include 14 players of national men volleyball team

and 14 players of national (combined) universities volleyball team. Selected anthropometric measurements namely body weight, height, sitting height, humerus and femur bicondylar diameters; upper arm, chest and calf circumferences as well as biceps, triceps, subscapular, supra-iliac, thigh and calf skinfolds were taken on all subjects with standard techniques. Somatotyping was done by both original Heath & Carter (1967) method and Kansal's modified Heath and Carter method (1983). Percentage body fat was computed by Durnin and Rahaman (1974) formula. Data on Olympic volleyballers reported by Hirata (1979) and Carter (1982) were used for comparisons. Except skinfolds, percentage fat and somatotyping, the mean values of all measurements including weight, height, skeletal diameters and circumferences are found to be highest in Olympic, medium in national India and least in University volleyball players. The average of five skinfolds is 7.8 mm for both Olympic and university players while that of national Indian players is 6.8 mm. However, when the skinfold is observed in percentage of body weight, the olympic players are found to possess minimum value (9.12), followed by national Indian team (9.25) and Indian universities team (11.47). Similar trend is seen in percentage body fat, the mean value being 11.4 in national Indian and 12.9 in universities team while the respective values of olympians were not available.
In the study of Sodhi, Sidhu and Mathur, anthropometric measurements, height, weight and sitting height were taken on 57 hockey players of five upper level teams at Punjabi University, Patiala who participated in Inter College Competition of the University. The data were divided into four groups- the goalkeepers, backs, halves and forwards - according to their specialised positions in the field. The results indicate that all the measurements decline gradually from goalkeepers towards the forward line players, the former being heaviest and tallest as compared to the later. The substantial height also gives the same pattern, however the gradual decline in subichial length, sitting height ratio suggests that in relation to lower extremities, the trunk height increases from the position of goalkeepers to the forward line players. The changing values of pondrel index are also discussed in the text.

Sidhu, Grewal and Verma investigated the positional

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differences in physique and body composition among top level Indian Women hockey players. Thirty Indian women hockey players, selected to participate in the world cup competition to be held at Spain (Madrid), have been studied for stature, weight, three skinfolds, percentage of body fat and anaerobic power. These players were attending the final training camp at NIS, Patiala, during August, 1973. The results show that players differ in physique and body composition according to the field positions, in which the players specialize. Forwards are the lightest whereas backs are heaviest among all. Amount fat is minimum in forwards and maximum in goalkeepers. Distribution of fat at the sites of biceps, triceps and subscapular also show the same trend.

Deshaies measured one hundred and Sixteen Quebec Junior Major League hockey players on 14 variables falling in the biological, psychological and specific motor skill categories. These variables were included in a stepwise regression analysis with ice hockey playing ability as the criterion variable. A prediction equation was obtained

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(P < .05) which included the following four variables: forward speed skating, motivation, visual perceptual speed and anaerobic power. The multiple correlation coefficient obtained was 0.74. The 55% of variance in ice hockey playing ability accounted for by the psychological profile was larger than that observed individually for either the biological (17%), psychological (20%) or the specific skill profile (33%)

Chapman made an investigation of the prediction of success in women's field hockey. The purpose of this study was to determine what, if any, predictive qualities could be identified in a group of skilled women field hockey players. Years of experience and playing position served as a secondary focus in the study. 106 women field hockey players served as subjects. The Scheffe post hoc test was applied when a significant F ratio indicated that differences existed. The Pearson Correlation technique was utilized to determine the relationship between some selected predictor variables. The alpha level of significance was set at .05 for all data in the study.

Result indicated that dynamic balance, ball control and anxiety were the discriminating variables for the groups of selected women field hockey players. Visual perception and manual dexterity, as measured in this study, did not discriminate between successful and less successful field hockey players. Years of playing experience was not an important factor in group classification. Significant differences did exist between ball control skills of goalies and field players. Classification of subjects determined by the stepwise discriminant function analysis indicated that on the basis of the three discriminating variables correct group membership could be predicted 78.95 percent of the time, provided the goalies ball control skills were analysed separately from those of the forwards and backs.

Ozkan,⁴² conducted a study of 77 male high school soccer players between the age of 15 and 18 years old. The purpose of this study was to investigate the physical, physiological and motor skill characteristics of the players. A secondary purpose was to compare the experimental

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variables between playing position, age, groups and playing qualities. Test items consisted of age, height, weight, percentage of body fat, resting heart rate, 1.5 mile run, 50 yard sprint, vertical jump, agility, trunk extension and flexion, ball control, wall volley and obstacle dribble skill tests. The statistical analysis revealed an average height and weight of 174.92 cm and 64.74 kg. for entire group. Average resting heart rate and body fat were 70.07 bpm and 10.38%. The other results were excellent in 1.5 mile, fair on the 50 yard and vertical jump, in agility similar level as college, below average in trunk extension and flexion and in three soccer skill tests, the players scored 85th-100th percentile.

Cassell measured and compared the motor abilities and physical characteristics of collegiate soccer players by the four positions of play, forwards, half backs, full backs and goal keepers. One hundred and twelve college soccer players in the state of Ohio volunteered as subjects.
Subjects were somatotyped according to the Health-carter Anthropometric Somatotyping Method and their percent of body fat estimated through the sloan weir Body Composition Nomogram by skinfolds of subscapula and thigh. The motor ability items included an agility test (S.E.M.O.), a leg power test (Margaria-Kalemen), a soccer ability test (Johnson wall volley), on upperbody strength test (pull-ups), a test for speed (40 yard sprint) and a test of endurance (1.5 mile run). One way analysis of variance showed that within the limitations and delimitations of the study, difference do exist in relation to motor abilities and physical characteristics between some of the positions.

Dey and Dey, conducted a study on 40 players of football. The players were divided into two groups i.e. offensive and defensive players according to their position in game during practice. They concluded in their study that -

1. Offensive players in football possess higher cardiovascular endurance and explosive leg strength than

those of the defensive players.

2. Defensive players in football have significantly higher leg length, thigh girth, height, weight and crural index than those at offensive players.

3. There are no significant differences in speed, calf girth, ponderal index of offensive and defensive players.

Digiovanna\textsuperscript{45} determined the relation of selected structural and functional measures to success in each of several sports, namely, baseball, basketball, football, gymnastics, tennis and track and field. The subjects were 944 college men between 17 and 24 years of age from the southern Illinois University, University of Illinois and the University of Minnesota. In analysis of data the critical ratio, the index of significance and the standard score comparison techniques were employed. The following conclusions were made as per the results of this study:

1. Factor of body structure, muscular strength and

\textsuperscript{45} Vincent Digiovanni. \textit{The Relation of Selected Structural and Functional Measures to Success in College Athletics} Research Quarterly, May 1943: 199-216.
explosive power are associated with athletic success.

2. It also reveals that these factors are of varying importance to performance ability in different sports as indicated by the tendency for each sport to have its own unique pattern of success.

3. Conformity to a normal pattern in these factors is noncondusive to success in athletics.

Amusa selected 46 subjects, who were well conditioned soccer players with at least two years playing experience on the college level. They were tested for running speed, power agility, max, $V_o^2$, strength, anaerobic capacity and flexibility. In addition, 11 anthropometric measurement consisting of skinfolds and body diameters were taken, Soccer playing ability served as the criterion and was measured by the ratings of three experienced soccer coaches based on selected soccer skills and strategies.

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Analysis of data was by zero order correlations and multiple R analysis resulting in the following conclusion: age (experience) is the best single predictor of playing ability, weight, L B W and height are considered good predictors of playing ability, max VO2 and running speed are considered important factors in soccer performance. Flexibility, agility, lactate concentration and leg power are not considered as valid indicators of playing ability.