Chapter-II
Review
of
Related Literature
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REVIEW OF RELATED LITERATURE

The study of relevant literature plays an important role to get a full picture of what has been done with regard to the problem under study. Such a review brings about a deep and clear perspective of the overall field and brings new ideas, theories, comparative materials and helps the development of research procedure.

"Practically all human knowledge can be found in books and libraries. Unlike other animals that must start a new with each generation, man builds upon the accumulated and recorded knowledge of the past. Their constant editing to the vast store of knowledge makes possible progress in all area of human endeavour." (Best, 1982)

In the field of education as in other fields, the investigator needs to acquire comprehensive information about what has been done in the particular area from which he proposes to take up a problem for research. The survey of related literature helps the investigator to find out whether the evidence already available solves the problems adequately with further investigations. It provides ideas, theories, explanations and hypothesis which help an investigator in identifying and formulating his/her problem. It also suggests methods, technique and tools to the investigator for collecting and analysing the data. The investigator can locate comparable data which are useful in the interpretation of the result of his/her investigation last but not the least the related literature contributes to the general scholarship of the investigator.

The research scholar has made every attempt to acquire literature to this study form various sources such as Journals, Periodicals, Encyclopedia and other books in some of the renowned libraries. The libraries which the scholar consulted were Punjab University, Chandigarh, Himachal Pradesh University,
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.

The related studies have been presented on the succeeding pages under different headings.

(A) Reference related to playing ability

(B) Reference related to Kinanthropometry.

(C) Reference related to Physical fitness.

(D) Reference related to body composition

(A) REFERENCE RELATED TO PLAYING ABILITY

Edgren (1932) attempted to predict the actual playing ability of beginners’ basketball players through the developed motor ability and specific basketball skill tests and concluded that the potential playing ability in basketball could be predicted through the general motor ability.

Young and Moser (1934) reported that the playing ability in women’s basketball was depended upon the ability in skills ‘speed passing’, ‘accuracy in passing to moving target’, ‘bounce and shot’, ‘basketball handling skills’ and ‘jump and reach ability’ of a player.

Carpenter (1938) investigated through a study with college women and found a correlation of 0.526 between Sargent jump and track and field scores. She felt and proved that this demonstration showed a positive correlation between power and athletic performance as judged by Track and Field scores.
Eversetf (1952) tested thirty varsity baseball players of the University of low on ability to throw for distance, running speed and agility (shuttle run), ability to visualize partial relationship (Thrustone's 'S' test), ability to make decision quickly (the blocks test) and motor capacity (the General Motor Capacity Score). These subjects were rated according to playing ability by the coach.

Product Moment Correlation, partial Correlation and Multiple Correlation were computed and the following conclusions were made:

1) Sargent Jump was the best single measure for selecting baseball talent.
2) The best economical combination to predict baseball-playing ability was the Sargent Jump, 'S' test, and Blocks test.

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\text{T-score} = 0.92 \text{ Sargent Jump (cm.)} - 0.08 'S' \text{ test (score)} - 0.23 \text{ Blocks Test (sec.)} + 16.19.
\]

Lamp (1954) 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 correlations 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. 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 score.

Ikeda (1960) administered a series of tests including wrist flexibility, shuttle run and various measures of kinesthesis, such as arm forward, wrist extension, wrist flexion, target finger, spread, supination, pronation and grip pressure on 72 women students during the last two week of an eight week badminton camp. These test scores were compared to the results of the volley and clear badminton tests. There was no significant relationship between wrist flexibility, kinesthesis or agility and badminton playing ability.

Peterson (1962) tried to predict basketball performance using psychomotor, cognitive and anthropometrics measures. The sample included forty-three female basketball players. The contribution of GPA, anaerobic, leg power, fifteen yards dash, thirty-yard dash, total body RT, TRT, height and weight to basketball performance once was determined. It was found that only height (r= 0.388) was a significant (p less than 0.05) predictor. The fifteen yard dash total body RT and power were next in order. The 'r' for the four top variables was 0.56 ('p' less than 0.01).

Holland (1965) conducted a study on the predictive value of selected variables in determining the ability to play basketball in small high schools. In order to predict basketball playing ability, he included variables such as speed, agility, upper arm strength, power, ball handling ability, reaction time, shooting ability, passing ability, height weight, age and previous experience. The criterion was the rating of basketball playing ability of each squad member by his coach. The most important variables were found to be experience, ball-handling ability, passing ability and shooting ability. The weighted index with ‘r’ = 0.76, basketball ball handling ability score = 1.54, number of years of
experience + 1.23, score on speed dribble + 0.26, speed on wall volley +0.15,
and score on shooting test - 10.11.

Smith (1969) 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 0.35 with the Brady Test 0.55 with the
judges evaluation, and 0.50 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 0.36. It was concluded that vertical jump is not an accurate predictor
of volleyball playing ability.

Gilbert (1969) conducted a study of selected variables in predicting
basketball player’s ability and performance at college level. He demonstrated
that at the college level a battery of four independent variables selected from
total of ten variables best reflect composite basketball ability and performance.
These four variables include ability criterion, arm strength, penny cup test and
speed pass. However, since the desired multiple r of 0.95 was not reached, this
limits the utilization of this battery as a predictive measure of basketball ability.

In the study of Knight (1970), 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.
Test 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.
Gordon (1978) 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 measures have some value in predicting basketball playing ability of college women.

Amusa (1979) selected 46 students, who were well-conditioned soccer players with at least two years playing experience at the college level. They were tested for running speed, power, agility, and max. VO$_2$, strength, anaerobic capacity and flexibility. In addition, 11 anthropometrics measurements consisting of skin fold and body diameters etc. 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. Analysis of data was made by zero order correlation and multiple regression analysis resulting in the following conclusions: age (experience) is the best single predictor of playing ability. Weight, LBW and height were considered good predictors of playing ability. Max. VO$_2$ and running speed are considered important factors in soccer performance. Flexibility, agility, lactate concentration and leg power were not considered as valid indicators of playing ability.
Gordon (1979) predicted basketball-playing ability from cardiovascular capacity, leg power, upper body strength and endurance, body composition, and body height. Subjects were 20 women varsity basketball players from two colleges, 10 from each college separate prediction equation were developed for five criterion measures, an ability rating consisting of four offensive – defensive descriptive terms the Tutko-Richard General Personality Rating. Composite score of the two measures the Noll Comparative Rating Scale, which utilized game statistics and the rating of the players by the coach. Data were analyzed through Step – Wise Multiple Regression Programme the best prediction equation was found to be:

\[
\text{Basketball ability} = 9.053 + 1.364 (12 \text{ minute run}) - 0.113 \text{ height.}
\]

Devi (1980) 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 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.

Ostrovsky (1980) after studying seventy-three basketball players with twenty-seven tests found that the following seven factors share up to 84.0 percent in the total dispersion of playing ability.

Physical qualities:

a) Speed combined with dexterity.
b). Quality of Jump.
c) Speed endurance.

technical qualities:
d) Accuracy of long shooting.
e) Nationality of dribbling.
f) Technique of defense.
g) Accuracy of high-speed pass.

An inter-connected test battery involving all those factors was constructed and utilized by him in coaching for the four top league basketball teams.

Hachn (1980) studied the Knox basketball test as a predictive measure of overall ability in of female high school basketball players, the Knox basketball test was administrated on one hundred and ninety eight (N = 198) girls. The step - wise multiple regression procedure was used to analyze the predictive value of this test. It was found that for the selection of the players dribble shoot test was the significant predictor. The dribble shoot test also significantly correlated with the coaches ranking of junior varsity players and varsity players, the speed pass and dribble significantly predict the division between the junior varsity and varsity players. Although the comparison was significant to skill test accounted for only 11.1% to 28.31% of the total variation in the dependent variables.

Jeanette (1980) 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: (i) Shooting (ii) Passing (iii) Jumping (iv) Moving without the ball and (v) 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.

Datta (1984) while investigating on selected physical, physiological and psychological variables as predictors in hockey performance founds that there was significant relationship between cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition to hockey playing ability. The relationship between percentage body fat and playing ability showed that higher percentage of body fat might be considered as an extra burden or dead weight which the individual had to carry and which consequently reduced the efficiency of the players. The hockey players who had scored better in hockey playing ability had a lower percentage of fat as compared to those who gave poor performance in hockey playing ability.

Rawat (1989) studied to determine the physical, physiological and motor skill variables of men volleyball players, which could best contribute in the playing ability of volleyball players. He found that among physical variables explosive power, agility and ankle flexibility were main contributors to volley ball player ability and cardiovascular endurance, lean body weight and pulse pressure among physiological variables were the best contributors to volleyball playing ability.

A study was undertaken by Mathew (1984) 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 0.05. The finding of the study indicated that the variables of height, weight and arm
length showed significantly higher relationship to performance on Brady Volleyball Test, (height=0.764, weight = 0.795 arm length=0.792) as compared to the significant but low relationships of leg length and upper body length with performance on Brady Volleyball test (leg length=0.544, upper arm length=0.641). All the above mentioned values were found significant at 0.05 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 Brandy Volleyball Test.

3) Leg length and upper body length contributed to the performance on the said test to a very limited extent.

Joseph (1983) 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 flexibility show insignificant relationship in prediction of playing ability of male volleyball players.
Indu Majumdar and M. Advin (2000) Measured physical fitness of Basketball Players. They selected 180 male players for the test. All players participated in Maharashtra State Basketball Competition. Following four tests were conducted to measure physical fitness of Basketball players:

1) Vertical Jump;
2) 30 meter dash for running;
3) Shuttle run for agility;
4) Cooper 12 minutes run/walk test for cardiovascular endurance.

They concluded that race 30 meter dash and shooting in basket has close relation. Physical fitness and basketball playing ability have also close relation.

Chauhan, M.S. (2003) conducted a study on the prediction of sprinting ability of secondary school boys of Haryana in relation to their anthropometric measurements. He concluded that:

1) Age and body weight have highly significant and negative correlation with sprinting performance (100 meters) at 5 percent level.
2) Height, leg length, foreleg length, thigh length, total arm length, upper arm length, forearm length and foot length have significant and negative correlation with performance.
3) Shoulder, chest, abdomen, hip, thigh and calf girth have significant and negative correlations with sprinting performance of school boys.
4) Among body diameters, biacromial, ankle and bicratal diameters are significantly and negatively correlated with sprinting performance of secondary school boys.
5) Subscapular and thigh skinfolds have been found to possess significant and negative correlation with sprinting performance of school boys.
6) Lean body mass and fat weight also possesses significant and negative correlation with sprinting performance of school boys.
7) Multiple correlation of combination of three selected anthropometric variables i.e. leg length, biacromial diameter and lean body mass with sprinting performance has been found significant. The multiple correlations is of sufficient size and hence can be put in the prediction equation for the sprinting performance.

8) The square of the determinants of multiple correlation is 0.6724, which can measure 67.24% of the total performance through these three variables can be measured by other factors which affect the performance.

Bhola, G. (2004) investigated on the prediction of playing abilities of North Indian Junior Basketball players in relation to their motor fitness and selected kinanthropometric measurements. Subjects were 200 junior basketball players of North India. He concluded that age, height, sitting height, leg length, thigh length, total arm length, upper arm length, fore arm length and hand length have significant and positive correlation whereas lower leg length, weight and foot length have significant but negative correlations with the performance of field goal speed ability of the junior basketball players. Arm, chest, thigh and knee girth have positive and significant correlations and calf girth has negative and significant correlation. Other variables have no significant correlations with performance in field goal speed ability of the subject. Elbow and femur bicondylar diameter have positive and significant correlations whereas wrist has negative but significant correlation with performance in field goal speed ability.

(B) REFERENCES RELATED TO KINANTHROPOMETRIC

Cosen (1930) in his study, “Relationship in stature and physical performance” correlated the composite scores of the six events, i.e., 13 feet rope climb, 100 yard dash, running broad jump, shot put and discus throw with age, height and weight. He concluded that height and weight were apparently
the influencing factor to some extent in these performances though the
correlation was not significant enough so as to put use for prediction equation.

Johnson (1938) worked out the relationship between chest volume and
other body measurements. An empirical formula was found out for getting the
chest volume from the measurement of chest. He derived a correlation between
chest volume and weight and the co-efficient was found to be quite high
(0.734).

Espenchade (1940) offer finding the highest correlation of physical
performance with age, recommended it as the basic for test norms. The quality
of physical performance is related to various basic traits of boys and girls such
their maturation, boys, size, shape, proportion, composition and physique.
Many of these traits are acquired during the growing years through hereditary
and are affected by environmental factors including motor activity. Children
differ significantly in their basic traits while participating in motor activity does
not change their maturity or body size appreciably in most case but the
knowledge of growth of these different traits greatly influence their motor
performance. These factors should be considered in judging children’s
potentialities for participation in motor activity.

Cureton (1941) stated that in general, people with long legs and long
arms, and relatively short and small trunks were physically weak types in long-
sustained work, but they might show great speed and endurance at high levels
of athletic activity. Long third class levers are noted for speed and range of
action as well as for their efficiency for force.

Jones (1947) conducted a study on the relationship of strength to
physique and found a combination of body size and body build and provided a
fairly adequate representation of the factors determining strength. A multiple
correlation of .886 was obtained between total strength and endomorphy,
mesomorphy, ectomorphy, height and weight. A partial correlation of .34
between mesomorph and strength increased to 0.61 when height and weight were partialled out.

Romar and Thomas (1947) concluded that there are significant negative correlations of the magnitude of 0.578 to 0.274 between the performance of strenuous physical exercise and external fat on the body. The correlation with endurance running being relatively greater than for other test exercises. Fat is a real handicap in most of strenuous exercises.

Hooks (1950) conducted this study to determine the relationship of 29 selected structural and strength measures to success in the baseball skills of hitting, running, throwing and fielding plus over all playing ability. The structural measures tested have constantly low correlation with the criterion. The measures of strength tested have constantly high correlations with the criterion. 0.79 left shoulder flexion with hitting, 0.72 right shoulder flexion with throwing and 0.67 left shoulder flexion with total ability. Left shoulder flexion is the best single measure found to predict baseball ability.

Telka and his associates (1951) studied 245 finish top ranking track and field athletes and wrestlers. They did not find any appreciable differences in respect of constitution among the athletes of different branches, except in certain extreme groups. Moreover, during 1954, the same workers again reported various body measurements to performance. Throwers were tallest in this material and they seemed also to benefit most from their height. The correlation between the relative shoulder breadth (with stature) and performance was significant in throwers and long distance runners. The correlation between the relative chest circumference (with stature) and performance was negative and highly significant in case of sprinters, positive and significant in case of throwers.

Pare et al (1954) reported the top ranking track and field athletes and related various body measurements to performance. Throwers were the tallest
in this material and they seemed also to benefit most from their height. On the basis of study the following inferences were drawn:

1) The correlation between the relative upper limb length (with stature) and performance was significant in throwers and long distance runners.

2) The correlation between the relative shoulder breadth (with stature) and performance was negative and highly significant in case of throwers.

3) The correlation between the relative chest circumference (with stature) and performance was negative and highly significant in the case of sprinters, and positive in case of throwers.

**Rasch (1954)** in a relationship study correlation the length, strength and weight of the arm with the maximum speed of voluntary movement of the arm. From the experimental findings recorded, there was found no statistically significant correlation between the speed of voluntary movements of the hand, fore-arm and upper-arm and weight, length and strength of the arm and its segments.

**Clarke (1957)** conducted a study to find out the relationship of strength and anthropometric measurements with physical performance of 53 unselected non-disabled male students at the University of Oregon, involving the trunk and legs. He concluded that correlation among some of the anthropometric variables were especially high, i.e., between standing height and leg length (0.91) between foot length and leg length (0.88) between body weight and both hip width and thigh girth (0.87) between height-strength test and trunk flexion and extension (0.65). Multiple correlation were found significant for leg lift (0.74) with body weight, ankle dorsal flexion strength, back lift (.071) with knee extension, strength hip width, trunk flexion strength and knee flexion strength and for standing broad jump (0.66) with adipose tissue over the abdomen (negative) and hips extension strength (positive).
Hammes (1960) conducted a study on the relationship of selected anthropometric measures to the vertical jump of high school girls. He has reported that measurements of total height, sitting height, foot length, metatarsal phalangeal to calcaneous and medial malleolus to calcaneous length had no relationship to vertical jumping ability, using 146 girls as subjects. There was a relationship but not of predictive value of weight, total leg length and lower leg length with vertical jumping ability.

Degutis (1960) carried out a relationship study between the standing broad jump and various maturities, structural and strength measures at twelve years old boys in which the subjects were 81 twelve year old boys in the Medford Oregon Public Schools. The correlation between the standing board jump as criterion and 16 maturity, structural and strength test variables were determined. The following multiple correlations were obtained; anthropometry -0.408 with body weight, leg length and lungs capacity, coordinated strength - 0.393 with strength index back lift and leg lift; cable tension strength -0.520 with elbow flexion and hip extension; combined variables -0.694 with elbow flexion strength body weight, hip extension strength, ankle planter flexion strength and leg strength.

Tanner (1960) and his colleagues conducted a study on the anthropometric measurements of the Olympic players in 1960 at Rome. They studied the different races as well as the same event, in an attempt to study their height, weight and other body measurements. They were compared with each race as the whites were compared with the Negroes. It was found that Negroes were larger than the whites in some measurements, their arms were longer than the whites.

Piscopo (1962) conducted a study to establish norms and to compare skinfold and other anthropometric measurement of pre-adolescent boys from three ethnic groups. The subjects were 647 Hallian, Jewish and Negro pre-adolescent boys. The skinfolds were measured at five sites, other measurements
included height, weight, bi-iliac dimensions and selected girths. Correlations were determined between skinfold and selected body build components. Inter skinfold r's ranged from moderate to high values. The largest percentile scores were found within the Jewish groups. Analysis of variance was employed to compare body fat, height and weight of each group. Significant differences were found relative to certain skinfolds and weight between ethnic groups at 0.01 level.

**Wear and Miller (1962)** studied the relationship of physique and developmental level, as determined by the wetzal grid, to performance in fitness tests, or junior high school boys. They found that subjects who were medium in physique and normal in developments, to be the best performers and the subjects of heavy physique to be the poorest in performance.

**Espenschada (1963)** investigated the relationship of age, height and weight to the performance of boys and girls on performance test, low corrections were found between performance and height and weight when age was held constant.

**Margaret (1964)** studied body structure and design factors in the motor performance of college woman. Pure speed the Sargent jump, 600 yard dash run/walk, back strength, leg strength and the strength index were studied in relation to 43 measurements of body structure and design. All these measurements were secured by means of photogrammetric technique including measures of length, depth, area as well as non-linear expressions of body structures and design. Multiple correlation co-efficient obtained for each of the criterion measured were as given:
<table>
<thead>
<tr>
<th>Criterion</th>
<th>R</th>
<th>Selected Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Speed</td>
<td>0.52</td>
<td>Leg length, (leg BI/Trunk BI) Bitrochantric diameter.</td>
</tr>
<tr>
<td>Sargent Jump</td>
<td>0.677</td>
<td>Shape index, ponderal index ectomorph</td>
</tr>
<tr>
<td>600 yard run/walk</td>
<td>0.427</td>
<td>(Upper leg length/lower leg length) Depth of thigh at gluteal fold.</td>
</tr>
<tr>
<td>Leg Lift</td>
<td>0.628</td>
<td>Area of dorsal upper trunk (upper leg length/lower leg length), Area of lateral leg.</td>
</tr>
<tr>
<td>Back lift</td>
<td>0.632</td>
<td>Depth of thigh at gluteal fold, endomorphy, (upper trunk length/lower trunk length).</td>
</tr>
<tr>
<td>Strength Index</td>
<td>0.650</td>
<td>Area of dorsal upper trunk, lower trunk area, lateral leg area.</td>
</tr>
</tbody>
</table>

These multiple correlations were significant at 0.01 percent level and the highest consistent relationship was found between area measurements and experimental combination of variables.

**Baacke (1964)** utilized data from 87 male students of high school to determine the relationship of selected anthropometric and physical performance measures to performance in running hop-step and jump. He concluded that all the variables, as measured in the study, showed significant relationship with criterion beyond the 0.05 level of confidence.

In an extensive monograph, **Tittel (1965)** made a comparative study on the bodily structure of the best athletes in 100 mt. track, high jump, broad jump, discus throw and shot put, based upon measurements taken on the best competitors in the German Democratic Republic on the one hand and data from athletes competing in corresponding events at the Olympic Games in Rome and Toyko on the other hand. By using single and multiple regression technique, he found mathematical expressions for determining the degree of relationship between certain body measurements and athletic performance.
Hirata (1966) collected anthropometric data for 31 variables on 457 athletes, 309 males in 20 sports and 148 females in 10 sports. The descriptive statistics was used for 12 male sports and 5 female sports. The physique of athletes was analyzed through examination of absolute and relative size, somatotype, body composition and factor analysis of Montreal (1976), Mexico (1968) Olympic athletes. The male athletes from Montreal are larger than those from Mexico City on most measures of body size. The mean somatotypes of the athletes from both Olympic samples were almost identical. The athletes on most size variables, except that the male athletes are lighter and have smaller skinfolds. The athlete of both sexes are less endomorphic and more mesomorphic than the students. In term of proportions, male athletes compared to students have similar mass and tend to have slightly longer limb segments, greater bone breadths (but narrower hips) and upper body girths lower skinfolds and greater bone muscle and residual masses. The exceptions are greater proportional mass in judo competitors, weight lifters and wrestlers, as well as few differences fencers and field hockey players when compared with the students. Among the female sports canoeists, rowers and swimmers have similar proportions, masses to the students but track and field and gymnasts' athletes are proportionally lighter. The female athletes have proportionally narrower hips, larger girth (except for jumpers and smaller skinfolds but larger muscles mass than the students.)

Leuback and Meconville (1966) conducted a study on relationship between flexibility, anthropometric measurements and somatotype of college men and reported low correlation between flexibility and anthropometric measurements and between somatotype and flexibility. A high negative correlation was obtained between body fat and flexibility, somatotype components were found to be highly correlated with certain anthropometric measurements. In a later stage the same author reported many significant correlations between strength and anthropometric measurements. Mesomorphy
the only somatotype component was found to correlate significantly with muscle strength.

Johnson's (1968) study explored the relationship of balance, strength, height, arm and leg length to success in collegiate wrestling. The subjects (N=208) for this investigation were collegiate wrestlers with at least 2 years varsity experience who had wrestled in 50% of their teams bouts during the 1966-67 school year. Subjects were classified as successful, average and unsuccessful according to their win-lose-percentages. A second classification was made by weight (light weight, middle weight, and heavy weight). All subjects were measured for arm and leg length and tested for RT, MT, static elbow flexion, strength, explosive leg strength and dynamic balance. Treatment of the data by ANOVA showed no difference among the wrestlers in the 3 weight divisions on dynamic balance, explosive leg strength and RT. In elbow flexion, strength the middle weights were stronger than the light weights. The light weights and middle weights were faster in MT and RT than the heavy weights. The unsuccessful wrestlers had longer legs than the average and successful wrestlers. Analysis by multiple R and regression showed that no combination of the independent variables was useful in predicting success.

Terrel (1968) studied the relationship of pre and post puberty anthropometric measurements and physical fitness test scores of American Negro and Caucasian females. To measure the physical fitness, AAHPER Youth Fitness Test was used. It was concluded that the Negroes are better than the Caucasians in 50-yard dash and soft ball throw for distances, because they have significantly longer legs, longer arms and hands, longer feet and wider shoulder girdle and narrower pelvic girdle that the Caucasians.

Berg (1969) conducted a study to determine the relationship between age, height, weight, height trochanter (distance from the greater trochanter to the floor), thigh length, leg length, foot length and performance in the standing broad jump. Boys (231) in the fourth, fifth and sixth grades were used as
subject. All correlations were found to be statistically significant at 0.05 percent level. Although significant r’s were low and body segment size could be eliminated as a determinable factor in predicting the success one might achieve in performing the standing broad jump.

**Voll (1970)** determined if ability in basic modern dance skill could be predicted by means of selected anthropometrics and physical fitness measurements. Data for this study was collected on 24 female students participating in one of three No-Eastern Pennsylvania Colleges. Measurements of height, weight, sitting vertex height, left trochanterion height, left tibiae, upper leg length, flexibility, abdominal strength, leg strength, cardio-vascular fitness, and somatotype was taken. As results of statistical treatment, a regression equation with a multiple R of 0.8678 was presented by the author for the prediction of ability in basic modern dance skills and prediction tables for its computation were developed. The author concluded that ability in modern dance skill could be predicted from selected anthropometrics and physical fitness measurements.

**Hoffman (1971)** in his study aimed to look for the best relation between the leg length and frequency of a sprinter’s strides, taking into account the length of his leg. The measurements were taken exclusively during competitions. The result showed that the leg length was correlated more with the athletes running ability than height.

**Bowmen’s (1971)** study investigated the relationship between 29 biographical, physiological and psychological factors and success in wrestling. The purpose of this study was to identify independence variables that were significantly related to wrestling success. One hundred and thirty six high school wrestlers were tested during 1969-70 wrestling season. The data was analysed using multiple correlation and regression analysis. The findings of the study were:
1) All twenty nine independent variables, the biographical variables and the physiological variables were significantly related to wrestling success at .05 level.

2) Seven actors-age, years of wrestling experience, hand grip strength, upper body strength, cardiovascular endurance, desire to achieve and desire to experiment-were significantly related to wrestling success at the .05 level.

Lancy (1973) studied the relationship between dynamic balance, measured by stabilometer at difference stance width and 17 anthropometric and strength variables determined for a group of 96 collage women. Co-efficient of correlations were computed for day one performance, day two performance, performance of the 15 inch width and performance at 10 inch stance width. The anthropometric variables under consideration were weight, height, sitting height, biacomial breadth, bicristal breadth, arm span, subsichial length, height index, sitting height-weight index, biacromial breadth index and ponderal index. The coefficient of correlation between stabilometer performance at the 10 inch stance width and five of the anthropometric variables (i.e., weight, bicristal breadth, subichial length index, bicristal breadth / biaeromial breadth index and ponderal index) were significant at 0.05 level of confidence. No relationship was found between any strength variable.

De Garey, Levine and Carter (1974) after an intensive study of anthropometric measurements of Mexico Olympic athletes concluded that top level performance in particular event demands particular size of body and shape, other aspects being similar. They established strong relationship between the structure of an athlete and specific task (event) in which he excelled. Clear physical prototype exist for optimal performance at Olympic level.

Spragus (1975) examined several ways of the relationship of swimming speed to physical measurements in all four competitive swimming strokes. The
actual 100 yard free style times and the age predicted residuals of those times were used as dependent variables. The physical measurements were height, weight, sitting height, lower leg length, foot length, arm length, fore arm length, waist girth, chest girth, hip girth, upper arm girth, thigh girth, wrist girth, ankle girth, hip width, shoulder width, chest thickness, biceps skinfold, scapular skinfold, shoulder flexion, ankle flexion, knee extension, elbow extension, vital capacity and centre of gravity. Other variables recorded including length of time in competitive swimming, months per year spend in workouts, number of workouts per week, amount of participation in other competitive sprints and age. The stepwise method of multiple regressions was used in all analysis. The most consistent variable overall was time in competitions. It was statistically significant in all fourteen analysis. The mast consistent physical measures were foot length and biceps size. Each was found significant in at least one analysis for each of three strakes. In each case longer feet were associated with slower timer and larger biceps were associated with faster timer.

Johnson (1976) investigated 200 collegiate wrestlers. Subjects were classified as successful and unsuccessful according to their win-loss percentages. A second classification was weight, light weight, middle weight heavy weight. All the subjects were measured for height, arm length and leg length. The unsuccessful wrestlers had longer legs than the average and successful wrestlers. Analysis of multiple regression showed that no combination of the independent variables was successful in predicting success.

Martin (1976) conducted a study by comparing the selected anthropometric measurements and physical performance between Mexican-American and Anglo-American adolescent boys. Comparisons of body size, body structure and physical performance were made between the subjects at adjacent age levels within each individual racial group. The body size was assessed by standing height and body weight measurements. Body structure was interpreted as upper arm girth, chest girth, abdominal girth, thigh girth and calf girth measurements. The physical performance was determined by selected
motor ability tests. It was concluded that the Anglo-American subjects were significantly taller than the Mexican-American subjects. It was also concluded that excluding standing height, the Mexican and Anglo-American subjects did not differ in body size and body structure and also these two races did not differ in physical performances.

**Khan Eraj Ahemad (1978)** – swami Vivekananda, the philosopher saint of India advocated that our country wants muscles of iron and nerves of steel. He further stated that first of all our young men must be strong, religion would come afterwards. The ancient India system of yogic exercises also emphasis. That physical wellbeing besides mental and spiritual attainments. The Ramayana and the Mahabharata justify that physical fitness was given lac of performance during those periods.

**Murugesan (1981)** established the relationship of height, agility and vertical jump to spiking in volleyball. Thirty male volleyball players of lakshmibai National college of physical education, Gwalior were selected as subjects. For estimating standard height, agility, vertical jumping ability and spiking ability, the following tests were employed. Height was measured against wall in centimeters and spiking ability test with the use of five point rating scale respectively. Zero-order correlation was used to compute correlation between spiking and each selected variables i.e. height, agility and vertical jump. The findings indicate that the vertical jump is a very reliable variable for predicting spiking ability of male volleyball players. The order of merit was a combination of three variables, i.e. height, agility and vertical jump. The value of multiple correlation obtained was 0.65 and it was proved to be the most reliable combination because the value of multiple correlation 0.65 obtained was maximum. Therefore, this is the best combination which can be used for predicting spiking ability of male volleyball players.

**Tanaka and Matsura (1982)** studied the anthropometric and physiological variables of 114 Japanese young middle and long distance
runners and concluded that the anthropometric attributes would predict the distance running performance to about the same degree as physiological attributes. As a result of factor analysis and the multiple regression analysis three factors i.e, linearity of physique, girth of physique and subcutaneous fat were extracted and the first two factors were nearly equally related to the 800 meters, 1500 meters and 5000 meters performances, 10,000 meters, however, was best accounted for the second factor.

Sodhi et al (1984) conducted a study selected kinanthropometric characteristics of Indian volleyball players, 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, 20 mt. dash, agility, basketball throws, 30 sec. sit ups maximum sit ups, flexibility and 2.4 km run. The statistical analysis was carried out to calculate the mean, standard deviation, analysis of various and test of significance.

Chouhan, M.S. (1986) studied the relationship between selected anthropometric variables and endurance running performance. He concluded that height, leg length, thigh length, total arm length, shoulder, chest, abdomen, hip and knee girths, thigh and calf skin folds, and lean body mass had significant and negative correlations with 1500 meters endurance running performance, whereas 10,000 meters running performance had statistically insignificant correlations with linear segments, girths and diameter measurements, except with skinfold measurements (triceps, suprailliac, midaxillary, thigh and calf skin folds) and body composition variables (i.e. body density, fat percentage, fat weight and lean body mass).
Multiple correlations of 1500 meter running performance with combination of selected anthropometric variables were significant. Similarly the multiple correlations of 10,000 meter running performance with combination of selected skinfold and body composition variables were significant. But the multiple correlations were not of sufficient size to put them into the prediction equation.

Kishore (1986) conducted a study in which he took 30 intervarsity weight-lifters. Their anthropometric measurements such as arm length, leg length, thigh length, trunk length, thigh girth, calf girth, upper arm girth forearm girth, and skin-fold were measured. He concluded that there were significant relationship between thigh girth, trunk length, upper arm girth, fore­arm girth, lean body mass and weight lifting performance. There was negative relationship between leg length, thigh length and weight lifting performance. There was no significant relationship between arm length, foreleg length, calf girth and weight lifting performance.

Chouhan, M.S., Sharma, V.P. and Sharma, J.C. (1987) Conducted a study on the relationship between selected anthropometric variables and performance in standing broad jump of collegiate women and concluded that age and foot breadth had positive correlation with performance in standing broad jump, whereas hip girth, thigh and calf skin folds, fat weight and lean body mass had significant but negative correlation with the performance in standing broad jump. Further, the multiple correlation of the combination of selected anthropometric variables i.e. age, weight, foot breadth, hip girth and thigh girth with performance in standing broad jump was found to be significant at 0.05 percent level. The multiple correlation found was not sufficient enough to be used in the predication of performance.

Chauhan (1988) conducted a study on the correlation of anthropometric variables with success in putting the shot by college women. He concluded that age, height and biacromial diameter had positive and significant correlations
with success in putting the shorts, whereas sub scapular, thigh and calf skinfolds; body density, and fat weight had negative and significant correlations with the success in putting the shot of college women. Further the multiple correlation (R=0.575, P < 0.05) of the combination of selected anthropometric variables i.e., age, height, total arm length, foot length, hip girth, thigh girth and biacromial diameter with success in putting the shot of college age women was found significant at 5 percent level, but the multiple correlation was not sufficient size to put in the prediction of success in putting the shot.

**Vaz. L.W. (1994)** investigated some of the selected anthropometric characteristics and physical fitness components as predictors of performance in Judo. He found in his study that anthropometric variable namely height, weight, calf-girth, arm girth and ponderal index were related to Judo performance in various weight categories, but leg length, arm length, thigh girth and crural ratio were not seen significantly related to Judo performance.

Combined contribution of anthropometric variables and physical fitness variables to Judo performance in various weight categories were showing significant relations. Multiple regression analysis indicated that predications regarding Judo performance, on the basis of anthropometric and physical fitness variables, can be made with reasonable degree of accuracy.

**Keogh J. (1999)** this study was conducted to determine if anthropometric and fitness testing scores can be used to discriminate between players that were selected in an elite Under 18 Australian rules football side. A training squad of 40 Australian Rules football players was assessed on a battery of standard anthropometric and fitness tests just prior to the selection of the 30 man player roster for the upcoming season. Results showed that the selected players were significantly (P< 0.05) taller and had greater upper body strength than non-selected players. A discriminant analysis was performed which predicted with an accuracy of 80% whether each player was successful or
unsuccessful in gaining selection. This suggested that physical condition part in
determining selection in elite junior Australian Rules football teams.

**Thomas Domic (1999)** study the relationship of motor components and
anthropometric variables to the velocity of basketball throw. Motor fitness
components chosen were wrist strength, waist and shoulder flexibility, and
speed movement of arm. Anthropometric variables were upper arm length,
lower arm length, total arm length, sitting height, leg length and weight.
Twenty five male basketball players in the profession of physical education
were chosen as subjects for the study. Analysis of the data showed that there is
a significant correlation between the velocity of long and hook basketball
passes and the anthropometric variables.

**Singh, S. Singh, J., Singh, H. (2002)** studied on the relationship of
body height and body weight with selected physical fitness variables in
untrained female children of 10 to 14 year’s age groups, with body weight and
height, standing broad jump, thirty meters sprint, medicine ball put, six into ten
meters shuttle run. Standing vertical jump and eight hundred meters run test
were used to assess to the fitness level. They concluded that:

1) There is positive and significant relationship between height and body
weight in all age groups except in 13 year’s group.
2) Height is 10 and 11 years groups is found to be significant related to
body weight, 30 meters run, medicine ball put, standing vertical jump
and standing broad jump test performance.
3) There is no significant relationship between height and selected motor
tests in the age group of thirteen years.
4) A significant relationship does not exist between height and 800 meters
run and 6×10 meters shuttle run.
5) A negative relationship exists between body weight and performance in
standing vertical jump and standing broad jump.
6) A significant relationship exists between body weight and shoulder strength in age group 11 and above.

7) A significant but negative relationship exists between body weight and 800 meters test in age group 10 to 13.

8) Agility shows a significant relationship with body weight in 10 and 13 years age group.

Chauhan, M.S. (2003) conducted a study on the relationship of anthropometric variables and middle distance running performance and concluded that age, height, leg length, thigh length, arm length, shoulder, chest, abdomen, hip, thigh, knee girth, ankle diameter and calf skinfold have positive and significant correlation with middle distance running performance. Lean body mass also has positive and significant correlation. The multiple correlation of combination of anthropometric variables i.e. height, thigh girth, biacromial, thigh skinfold with middle distance running performance is significant at 1% level, but multiple correlation is not of sufficient size so the regression equation cannot put in to prediction of the running performance.

Chauhan (2004) studied on the prediction of performance of university throwers in relation to the anthropometric measurements. He concluded that:

1) Age, body weight, height, sitting height, trunk length, leg length, foreleg length, thing length, total arm length, upper and fore-arm length all have positive and significant correlations with performance of university level throwers.

2) The circumferences, i.e. shoulder, chest, abdomen, hip, arm and thigh circumferences have significant and positive correlations with the throwing performance.

3) Biacromial, biocrystal and elbow diameters possess positive and significant correlation with the performance in throwing event.
4) Among skinfold measurements, biceps, subscapular, suprailliac and calf skinfolds have positive and significant correlations with performance in throwing event.

5) Body density and lean body mass have negative and significant but fat percent and fat weight have positive and significant correlations with throwing performance.

6) Multiple correlations of body weight, height and total arm length collectively have significant correlations with the throwing performance.

7) The size of the multiple correlations is quite sufficient and hence the regression equation can be used for the prediction of throwing performance of university level throwers.

**Kumara, M.H. (2004)** studied to find out the relationship of selected volleyball skills i.e. attack, block and service with stature, age, spike jump and reach, block jump and reach, experience and weight at international level. He concluded that:

1) Jumping strength determine success rate in attack, block and service.

2) Height, age experience and weight of the player have not much to do with the performance in attack, block and service.

3) A change in performance in one factor leads to change in other factor is confirmed in case of spike jump, reach and block jump reach.

4) A significant relation exists between age and experience.

**Singh and Chauhan (2011)** examined the correlation between the selected kinanthropometric variables and explosive leg strength and also to develop the regression equation for the prediction of explosive leg strength basketball players between the age range of 18 to 25 years. They found that height, sitting height, trunk length, leg length, thigh length, shoulder, chest, abdomen, hip girth, elbow, hip, knee diameters, biceps, sub scapular skin folds, fat weight and lean body mass have positive and significant correlation with explosive leg strength at 0.01 level of significance. The size of the multiple
correlations was also sufficiently large and hence regression equation developed for the prediction of the explosive leg strength of Basketball players.

(C) REFERENCE RELATED TO PHYSICAL FITNESS

Barnam (1960) studied the AAHPER youth fitness test battery and administered the test to 78 girls in grade VIII at Methell Junior High School. The girls were classified by the Nielson-Conzens classification index and compared with national norms. The girls were above the average in sit-ups, standing broad jumps, 600 yards run/walk, 50 yard dash and shuttle run but below in the softball throw and modified pull-ups. The differences were attributed to their Physical education programmes.

Pierson and Phillip (1960) conducted a study that Bruce Physical Fitness Index as a predictor of performance in trained distance runners. Eleven (N=11) high school cross-country runners were taken as the subject of the study. An effort was made to determine the relationship between score and performance. Lean Body Mass was calculated according to Rathbum – Pace and Cawgill formula. The inter-correlation of the selected anthropometrics and physiological measurements were recorded during the investigation. The mean score of 32 found for the subjects were considerably above the 26 considered characteristics of athletes on the Bruce Continuum. The man with best performance (9.56 min.) made the highest score (40) on the Bruce Physical Fitness Index, but the man with poorest performance (11.39 min) made the second highest score (37).

When performance of all subjects was correlated with their Bruce Physical Fitness Index ‘r’ was found to be 0.47, which was not statistically significant. The correlation between performance of the total heart count for the first three minutes. Immediately after exercise was ‘r’= 0.52 which was also not significant.
Ponthieux and Barker (1965) reported significant correlation between socio-economic status and performance on the AAHPER test in a mixed racial sample of fifth and sixth grade children. The significant relationships, however, did not consistently favour either the high or the low socio-economic groups. Three of the more commonly measured performance items (the broad jump, 50-yard dash, and throw for distance) showed significant correlation with the socio-economic status. The dash and throw were significantly related to lower socio-economic status for both sexes, while the broad jump was significantly related to upper socio-economic status for girls only. Pull-ups and sit-ups, on the other hand, had a significant relationship with higher socio-economic status.

Mequi (1966) compared physical fitness of Philippine students with Japanese and American students. He found that the Philippine students had, generally lower performance in pull-ups, soft ball throw and sit-ups as compared to the Japanese and the American students.

Bone (1967) administered AAHPER youth fitness test to 100 rural and 100 urban boys. The urban boys were found superior to the rural boys and the difference was significant at 0.01 level. The two samples were weaker on the same components of physical fitness.

Vincent (1967) measured 37 college women enrolled in eight physical education activity courses in attitude, strength and efficiency. Partial and multiple correlations were calculated between these independent variables and success in physical education activities. Regression equations consisting of various combinations of the three independent variables were formulated and tested by analysis of variance. All prediction batteries were significant in the prediction of success in physical education activities, and the following conclusions were drawn.
1) Success in physical education activities can be predicted from the various items under consideration.

2) Among the variables studied as possible contributors to success in physical education activities, the attitude measures were of the highest significance.

3) The use of attitude item alone can be considered as adequate while the inclusion of the strength item is desirable in the prediction of success in physical education activities.

Ellen Burg (1971) conducted a study to predict selected physical variables in determining competitive performance in high school basketball player in 1969. The performance data were collected by performance rating chart Pearson’s Product Moment Correlation, Multiple Correlation and Multiple Regression Equation were used. The results of the study were as follow:

1) Out of the variables used in the study, thirty seconds shooting test and vertical jump were most reliable predictors for the performance used in the study.

2) Height, handgrip, vertical jump, wall volley and thirty-second shooting tests were most important variables contributing to a player’s performance.

3) The five items battery consisting of height, handgrip, vertical jump, wall volley, thirty second shooting test can be a practical and useful instruments in predicting basketball performance of high school basketball players.

Childress (1972) conducted a factor and discriminate analysis to identify and determine the effectiveness of selected physical variables in predicting successful basketball performance. Twenty-four test items were selected through a review of literature as a valid measure of components of high school basketball ability. The test items were administered to 106 high
school basketball players and the resultant data were analyzed through factor analysis. Seven factors were isolated and six were identified as agility, speed, relative muscular endurance, basketball speed manipulation, gross muscular strength, total body movement time and manual dexterity. Two test batteries were constructed, the first consisting of seven test items and the second was composed of the ten test items. The result of the study showed that the component of basketball ability could be isolated, measured and utilized to construct an evaluation tool for classifying players into two populations identified as successful and unsuccessful.

Huntly (1974) made a study on physical fitness and motor ability to find out the effect of these selected physical activities in 1961. Subjects selected at random from first, second and third grade students, who were involved in this study: out of three experimental groups within each grade. An analysis of the results revealed that both physical fitness and motor ability attributes, excluding body reaction time can be significantly improved by structured physical education programme consisting of basic movement and rhythmic activities, games and gymnastics. The best contribution to physical and motor ability resulted from participation in games and related activities.

Ronald (1975) found the contribution of selected fitness variables to college football game performance. Thirty members of the South Eastern State Collegiate Football Teams were selected for this study. From the Multiple Correlation Coefficient, it was found that best predictor of game percentage for defenders were lateral movement for the forwards the best predictor of game percentage was bench step. For combined group the best predictor of game percentage score was vertical jump. For total group it was found that vertical jump and 12 minutes run was two best predictors.

Craig (1976) compared the physical fitness levels of Canadian and South-African school boys. He used AAHPER physical fitness test battery. The
results showed that physical fitness levels of South-African high school boys were higher than those of Canadian high school boys.

**Mookerjee (1978)** made a comparative study of physical fitness of young rural and urban boys in the age group of 13-17 years and also of less active boys of the same age group. The result of this study was that, there is no doubt that regular physical activity contributes significantly to the enhancement of physical status. Physical fitness of rural active subjects were, definitely, of superior level than that of the boys living in the city. Pure food, fresh unpolluted air, and reasonable regular physical hardship are chief contributory factors in promoting physical fitness.

**Robson and associates (1978)** administered the simple physical fitness test battery to study the physical fitness of elementary school children of defense and non-defense personnel. One hundred and fifty boys and girls from five Kendriya Vidyalaya of Gwalior were selected at random, as subjects for the study. To assess the physical fitness, the subjects were administered the simple physical fitness test battery for elementary school children which was constructed at the Lakshmibai National College of physical education, Gwalior, in the year 1977. The test battery composed of six items (50-meter dash, 4x10 meter shuttle run, sit-ups, modified pull-ups, vertical jump and 600 meters run/walk) was administered to both boys and girls. The boys and girls belonging to the defense personnel had shown statistically significant higher performance in physical fitness as compared to boys and girls of the non-defense personnel.

**Ray (1979)** conducted a study to compare the physical fitness of the tribal and the urban students in Tripura. He administered the AAHPER youth fitness test on sixty tribal and sixty urban students studying in MBB College, Agartala. Their age ranged from 16 to 20 years. The mean difference between the physical of urban and tribal students was not found statistically significant at 0.05 level of confidence. It was found that urban students were better in pull-
ups and soft ball throw for distance and their performance was statistically significant at 0.05 level of confidence. But in the remaining five test items i.e. 50-meter dash, 600-meter run/walk, sit-ups, shuttle run and standing broad jump, the performance of none of the groups was found, statistically significant at 0.05 level of confidence.

Cassell (1979) measure and compared the motor abilities and physical characteristics of collegiate soccer players by the four positions of play, forwards, half backs, full backs and goalkeepers 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 item included an agility test (SEMO), a leg power test (Margaria-Kalemen), a soccer ability test (Johnson wall volley), on upper body strength test (pull-ups), a test for speed (40 years 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.

Bhatnagar (1980) conducted a study on 23 rural sportsmen (athletics-8, volleyball-8, Kabaddi-7) of Madhya Pradesh (India) pertaining to their weight, height, sitting height and subcutaneous tissue folds at biceps, triceps, suprailiac and sub-scapular region. They were found to be lighter, shorter and with less amount of fat as compared to normal urban Punjabis. Morphological differences pertaining to sportive activities indicated that volleyball players were the lightest, the shortest with maximum amount of fat as compared to kabaddi players and athletes, whereas kabaddi players were the heaviest and the tallest among all the rural sportsman of Madhya Pradesh.

Saha (1980) made a study to compare the selected physical fitness variables and anthropometric measures of tribal and non-tribal students of
Tripura. They were tested with selected item of AAHPER youth fitness test i.e. 50-yard run, 40-yards shuttle run and 600-yards run/walk and selected anthropometric measurements i.e. chest girth, height, weight, upper arm girth, thigh girth and calf girth. In all tests and measurements, the composite mean scores of tribal students were higher than their non-tribal counter parts but none of the differences in the means were found statistically significant at 0.05 level of confidence.

Toner (1982) examined the relationship of physical fitness skill and mood variables with success in female high school basketball candidates being chosen to become varsity players. McNair’s profile of mood states, Copper’s 12 in. run and walk test, AAHPER Jump and Reach Test, AAHPER Shuttle Run Test, 30 yard dash, AAHPER Under Basket Shot Test, AAHPER Speed Pass test, and the AAHPER Speed Dribble Test were administered on 81 female high school basketball players. At the end to the testing and evaluation period, the jury of coaches, on the basis of their observations during drills and scrimmage competition independently rated each player as either successful or unsuccessful performance. Discriminate analysis procedures supported the following hypothesis:

(a) The fitness factor, skill tests and personal factors (Know together as pre-season variables) Were successful indicators of groups membership while the POMS variables were to a lesser extent and

(b) The battery of tests preseason and POMS variables did correlate with coach’s rating.

Taddonio (1982) reported physical fitness of public school students from economically deprived areas with national norms. Within the limit of this study, (i) there was no difference in the physical fitness of boys and girls from the economically deprived sample and boys girls represented by the 1975 national norms and (ii) within the sample, there was no difference in physical
fitness of boys and girls from high poverty areas and boys and girls from low poverty areas.

**Walker (1982)** conducted a study on white and black female student at Northern High School. 50 white female 10 grade students were randomly selected as the subject. AAHPER youth physical fitness test was used on item. Statically analyzed it was concluded that the black subjects scored significantly higher than the white subjects on leg power, (M=44.6% and 31.2%) and (M=57.8% and 39.1%) respectively. The white subjects performed significance higher than black subjects on abdominal strength (M=31.5% and 24.7%). No other comparisons were significant.

**Barbanti (1983)** established physical fitness norms far Brazilian school children. In the physical fitness test battery he included sit and reach test, modified sit-ups-test, nine minute run, twelve minute run, 50 meters dash and standing long jump. The test were administered to 2,342 school boys and girls and he comprised the selected kinanthropometric measurement of their students and produced the reliable norms.

**Sinha (1984)** conducted a study on selected motor traits and anthropometric variables of AAHPER Basketball skill test and indicated that performance in AAHPER Basketball skill test was significantly related to agility, cardio-vascular endurance, explosive strength, height and crural index, whereas performance in AAHPER Basketball test was not significantly related to speed, grip strength, back flexibility, weight and ponderal index.

**Goslin and Barden (1986)** evaluated physical fitness characteristics of South African high school children. AAHPER Test Battery was administered to 98 white, 92 coloured and 32 black subjects. The white subjects were the tallest, heaviest and most active of the three groups. The black subjects were the strongest of the three groups both relative to body mass and in an absolute sense, despite their smaller stature (p<0.05). White subjects and greater upper
body and lower body power and higher aerobic output compared to coloured
and black students (p 0.05). There was no difference between the groups in
balance, upper body endurance, agility and flexibility.

**Dey and Dey (1987)** 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.

**Uppal and Datta (1988)** studied the motor fitness components as
predictors of hockey performance. The purpose of the study was to identity
those motor fitness components, which could predict the performance in the
game. Seventy-four (n=74) male hockey players from different universities of
India served as subject for the study. The motor fitness components included
were speed, strength, power, agility, dynamic balance, flexibility and
kinesthetic perception. Strait Field Hockey Rating Scale served as criterion
measure to evaluate the hockey playing ability.

**Ignico (1990)** evaluated physical fitness levels of children enrolled in
daily (five classes per week) and weekly (one class per week) physical
education progrannmes. The AAHPERD Physical Fitness Test was
administered to 218 elementary schools children (grades 1-5) from two schools
of similar size. And inspection of means indicated that the daily physical
education school participants were superior on all four test items across the five
grades. Univariate main effect analysis indicated that females were more
flexible, males were faster on the mile run/walk, and females had more subcutaneous fat.

Rhoda (1990) studied three methods of teaching physical fitness and their effect on strength, flexibility and cardiovascular endurance. Students were enrolled in one of the following classes based on the teaching style and methods utilized by the teacher: Style A (Group A), Health Related Aerobic (Group B), Militaristic Anaerobic, Style C (Group C), Traditional Calisthenics. The statistical data indicated that aerobic activities were important for the attainment of leg strength, flexibility and cardiovascular endurance. Anaerobic activities were important for the attainment of strength, flexibility and cardiovascular endurance; and calisthenics/tam sports games were important for the attainment of leg strength and flexibility.

Kanwal Jeet et al., (1991) in their study of prediction of physical fitness on the basis of cognitive style, an important aspect of personality. For the purpose of study a sample N=60) consisting of male and female sports participants and non-participants were taken. The participant's level of participation ranged between inter-university and national. Different cognitive styles were studied through their ‘locus of control’, ‘personal causation’, ‘self-efficacy’ and ‘engagement style’ by employing standardized test batteries. Physical fitness was measured with the help of AAHPER test. The data were analyzed with help of step-wise multiple regression equation. The value of F-ratio showed that engagement style (4.88), personal causation (3.33), self-efficacy (2.87) and influence of powerful others (2.86) were having significant contribution at 0.5 level in predicting physical fitness.

Kumar (1992) conducted a study of motor fitness components as limiting factors in handball performance. Indian male (N=85) handball players were taken as the subject of the study. The age ranged between 20 to 30 years. Five motor fitness components were selected as the predictor through Wherry-Doolittle test selection method. The selected predictors were arm strength, back
strength, spine flexibility, standing broad and 50-meter sprint. Further in order to examine relationship between selected motor fitness components and handball performance, data were analyzed through Pearson's Product Moment Coefficient of Correlation, partial correlation of 1st, 2nd, 3rd and 4th order, the regression equation was finally made through Wherry-Doolittle test selection method. The result of the study reveals that prediction equation of \( X_c = 3.419X_3 + 0.265X_6 - 0.141X_{16} - 0.185X_{12} + 2.565X_{14} + 0.693 \) may be considered as valid predictor of performance in handball.

Chandel (1993) conducted a comparative study on physical fitness, physiological and anthropometrics variables between the tribal and the non-tribal 260 tribal and 220 non-tribal students were selected to act as subjects of the study. AAHPER Youth Fitness Test Battery consisting of six test items i.e. sit ups, Standing broad jump, 50 Yard dash, Shuttle run, 600- Yard run/walk were used to measure physical fitness of the subjects. Selected physiological parameters such as pulse rate, blood pressure, and hemoglobin were measured and some anthropometrics measurements were also took. The following conclusions were drawn:

1) A significant difference in mean score of anthropometrics variables was found in favour of the tribal. They were found heavier in weight, better in height, possessing broader shoulder, wider chest cavity, bigger hip, thigh and calf circumferences.

2) The tribal were found superior in all aspect on physical fitness variables as significant mean difference was found in their favour in sit ups, standing broad jump, shuttle run, 50 yard dash, 600-yard run/walk. Hence, it could be safely concluded that the tribal were superior in speed, agility, and endurance than their counterparts.

3) The tribal were superior to non-tribal in physical fitness, cardiovascular endurance and anthropometrics measurements.
Raman (1993) conducted test on 30 male cricket players from graduate and undergraduate course at Lakshmibai National College of Physical Education, Gwalior in order to determine the relationship of grip strength, leg power, agility and hand and foot reaction time to performance in cricket. Data was collected on grip strength (grip dynamometer), leg power (standing broad jump), agility (40 yard shuttle run), Hand and foot reaction time (electronic reaction timer) and performance was average of subjective rating of three experts during practice and match situations. Pearson Product Moment Correlation was employed to statistically treat and data. It was concluded that:

(i) Hand and foot reactions time is the most important variables in the prediction of cricket playing ability.
(ii) Leg power was another important variables in the prediction of performance in cricket.
(iii) Grip strength was also as important variable of prediction in cricket playing ability.
(iv) Agility was not an important factor in the prediction of performance in cricket.

Micheal (1994) in his study examined whether cardiovascular endurance, body composition, flexibility, and leg power had any relationship on how well golfers perform. The results showed a significant correlation at the 0.05 level between golf scores and balance and power. But the correlation coefficients balance (r = -0.3161) and power (r = -0.3597) were not reliable correlations.

Toor (1996) conducted a study to investigate physical, physiological and anthropometrics determinants of performance in male inter college level sprinters, jumpers and throwers. The data was collected on 105 sprinters, 100 jumpers and 100 throwers. Ten physical, ten physiological and twenty anthropometrics measurements were taken.
Pearson's Product Moment Coefficient Correlation was used to analyze the data to assess the relationship of performance of sprinters, jumpers and throwers with physical, physiological and anthropometrics variables. Multiple step wise regression was applied to assess the combined contribution of physical, physiological and anthropometrics variables with performance. In order to assess the limited factors for top performance, the regression equation was worked out. On the basis of the study he found that:

1) The sprinters performance was significantly related to physical variables namely sit ups, Sargent jump, standing broad jump, back lift and 50 yard dash, physical variables namely recline pulse and sitting pulse rate and anthropometrics variables namely age and calf circumference.

2) The performance of jumpers was found significantly related to physical variables i.e. sit ups, Sargent jump and standing broad jump, anthropometrics variables namely age and biceps skin fold.

3) The performance of throwers was found significantly related to chest normal chest expended variable, elbow width, shoulder width, chest width, knee width hip width and weight variables.

Lolage (1997) defined cardiovascular endurance is characterized by moderate contractions of large muscle groups for relatively long period of time during which maximal adjustment of cardiorespiratory system are necessary. It is the basic components of physical fitness and complex in nature. In understanding cardiovascular endurance, the stamina of the body to maintain a run involve in a definite aerobic expenditure was aptly use as an illusions of the component of physical fitness.

Sethi, Parmod Kumar (2004) investigated physical fitness component as a predictor in the performance of male weightlifter. The subjects of the study were one hundred male weightlifters studying in different universities of India and who had participated in the All India inter-universities weightlifting championship in 2002. He studied seven physical fitness component i.e. speed,
strength, cardiovascular endurance, static balance, agility, power, flexibility which were measured by test items i.e. back full squat test, military press test, sit-ups stick drop test, 50 yard run test, Harvard step test, stork stand test, squat thrust test, standing broad jump, shoulder rotation test and forward bend and reach test respectively. The criterion measure was performance in weight lifting skill performance in snatch and clean and jerk during the championship.

The data were analyzed using the Pearson’s Product Moment Coefficient of Correlation(r) for reassessing the relationship of weightlifting performance to each of the physical fitness components and Regression equation for predicting the weight lifting performance from fitness components. On the basis of the study he found that:

(i) The physical fitness components namely speed, maximum strength, explosive, strength, strength endurance, agility, power were significantly related to snatch in weight lifting.

(ii) Among physical fitness component maximum strength, explosive strength, endurance, agility powers were significantly related to clean and jerk.

(iii) Trunk and shoulder flexibility speed (acceleration ability) cardiovascular endurance and static balances was not found to be significantly related to snatch.

(iv) The relationship of trunk and shoulder flexibility, speed (acceleration and speed of movement) cardiovascular endurance, static balance to clean and jerk respectively was partial led out.

Gopinathan and Helina (2009) determine the relationship of anthropometric and physical fitness variables with handball performance. Results revealed that the anthropometric variables of height, weight, arm length, leg length, palm span and sum of four skinfolds and physical fitness variables of speed, agility, explosive power, shoulder strength, strength endurance and endurance were having significant relationship with handball
performance and only flexibility was not having significant relationship with handball performance.

(D) REFERENCE RELATED TO BODY COMPOSITION

One aspect of the scientific approach which is receiving greater attention is that of body composition. More specially the measurement of the athletes body composition to achieve an optimal playing weight (OPW) is gaining significance in the total training programme. By achieving this optimum plan weight (OPW), the athlete can minimise the negative effect of excess body fat on activity without sacrificing the required nutrition for successful performance (Brozek and key, 1963).

Relationship between total body density, total body potassium, skinfold thickness measurements and AAHPER YOUTH FITNESS TEST performance were determined on 49 pre-pubescent boys, 8 to 11 years old age. Zero order correlation between body composition measures and performance scores were low or moderate, however, using multiple regression analysis it was found that body composition measures significantly (p<.05) increased the variance accounted for above that explained by age, height and weight and in predicting all performance items except sit ups. In general, body density, body potassium and skinfold thickness predicated performance equally well when age, height and weight were held constant. A canonical correlation analysis of the relation between the AAHPER test items and the physical development variable demonstrated that there was a large proportion of common variance between the two sets of variables and significant relationships existed along two independent dimensions. It was concluded that not only variation in body size, but also variation in body composition should be considered when interpreting results of the AAHPER test for individual children and fore comparison of groups of children who differ in body composition.
Too often the judgment concerning optimal playing weight is made on a trial error basis with reference to body weight along disregarding the individual’s physique and composition. Behnke’s two component models of body composition appears to offer the best scientific approach at present for assessing an athlete’s optimal playing weight. This method partitions the body weight (BW) into the lean body mass (LBW) and fat weight (FW). The ratio of FW to BW is the relative fat content (%fat) and is inversely proportional to the hydrostatistically determined body density (Brozek and keys 1963).

Body composition, according to Behnke et al (1963) keys and Brozek (1953) and Novak (1968) is the proportion of lean fat free body mass and depot fat and is one of the human organisms. The relative proportion of these components, while different in males and females through much of the life span are dynamically dependent on developmental level and thus one of interests to those concerned with human growth and development. Furthermore the significant interaction between body composition and energy turnover is among other things, closely related to the function capacities of the consequence in physical fitness and performance of children and adults (key and Brozek; 1953; Parizkova, 1961; and Parizkova, 1963).

Researchers have tried to measure body composition through laboratory method or field method to study the effect of exercise on body composition.

Pierson (1962) investigated the relationship of height, weight lean body mass and body fat to overall speed as determined by sprint start and found no relationship between the bodily measurements and speed. In another study by Pierson (1962), it was reported that “the speed with which an untrained individual can voluntarily react to a visual stimulate has little relationship to his body size or composition.” The subjects, used for this study were medical students classified as short and heavy, short and light, tall and heavy and tall and light.
Lauback (1972) conducted a study on “body composition in relation to muscle strength and range of joint motion” and found high correlation between total lean body mass and measures of high grip strength. The multiple regression equations for the predication of the physical performance from anthropometric and body composition measurement yielded multiple correlation that ranged from .506 to .747 and these equations accounted for only 26 percent to 56 percent of the variance in performance.

Slaughter, Lohman and Misner (1977) conducted a study to determine the association of somatotype, body composition and physical performance in 7 to 12 years old boys. Body composition was estimated as fat and lean body mass from k40 (potassium 40) measurements and from two skinfold thickness measures. Physical performance measures consisted of one mile run, 600 yards run and 50 yards dash, standing broad jump and vertical jump. It was found that in general somatotype components had lower correlation with running and jumping variables than had body composition or body size variables, such as height, weight and percent fat.

In their study relating to somatotype and body composition to physical performance on seven to twelve years old boys, Slaughter and associates (1977) concluded that somatotype components were not highly related to physical performance. However, ponderal index correlated better with performance scores. Somatotype components had lower correlations with running and jumping variables body composition or body size variables.

Sidhu and Sodhi (1979) worked on the effect of physical activity on body composition of elite Indian Hockey Player undergoing coaching for the Asian Games of 1974. The players in the investigation were divided into three main groups in accordance with the load of exercise on different players which has maximum in group I and decreased gradually in the case of the group II and group III players. Groups I consisted of left in, right in and centre half; group II, left out, centre forward and right half; group III, right back, left back
and left half. The group I players registered the maximum decrease in body fat after 52 days of intensive training. Similarly, the group III players who underwent the minimum load of physical stress had shown increases in the amount of body fat. The group II players manifested a decrease but to a smaller extent than group I. After taking account of the varied degree of physical activity of different players, they suggested a need of differential conditioning for players specializing at different field position.

Sodhi (1980) has mentioned that in body composition students the most important aim is not only an overall characterization of body components but also its quantitative evaluation as exact as possible according to actual methodological possibilities. Absolute amount of lean body weight serve together with body weight as basis somatic characteristic of body type and as a reference of standard to which oxygen plate and muscle strength etc. are related. On the other hand, the quantitative changes in deport fat can provide an important information on lipid metabolism and shifts in every substrates used as a fuel for muscles work.

Grewal (1984) made an attempt to study the physique and body composition, of Indian Sports Women in different Games. The subjects were 492 sports women and 81 controls ranging in age from 17 to 23 years.

The results of his study regarding volleyball game, he staged 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 circumference 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.
Uppal and Roy (1986) conducted a study on ‘Relationship of selected strength and body composition variables to performance in shot put and Javelin Throw’ and revealed that the arm strength, grip strength and explosive leg strength were significantly related to performance in shot put. There was a significant relationship between arm strength, explosive leg strength and lean body weight to performance in Javelin throw. The relationship of selected body composition variables namely, body density, lean body weight and percentage of fat to performance in shot put was not significant. Grip strength, body density and fat percentage were not significant related to performance in Javelin throw.

An attempt has been made by Kansal, Giri and Giri (1987) 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, thing and calf skinfolds were taken on all subjects with standard techniques. Somatotyping was done by both original Health & Carter (1967) method and Kansal’s modified Health and Carter method (1985). 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.

Toriola, Adeniran and Ogunremi (1987) 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-uls post hoc method were used to be determine significant differences in the physical characteristics of the groups. The basketball players were significantly taller and had markedly larger humerus width than the volleyball and non-athletic groups (p<0.05). The non-athletes 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 non-athletes (2.5). The differences observed between the athletic groups are related to the morphological factors which influence the basic components of competitive sports performance.

Benny (1988) conducted a study of anthropometric measurements and body composition variables on judo players. Nine anthropometric variables and three body composition variables were taken for this study. Judo performance was taken as the criterion measure and all the variables were taken as the independent variables Pearson’s Product Moment correlation was used to find out the relationship between anthropometric measurements and criterion measure. A multiple correlation was computed to find out the combined effect of the anthropometric measurements to Judo performance. He concluded that; (i) Performance of Judo was positively and significantly related to chest girth, (ii) Judo performance was negatively and significantly related to Ponderal Index which mean that for better Judo performance Judoka should possess greater body weight in proportion to body height, (iii) lean body mass, upper
arm / forearm ratio and sitting height were the most important predicting variables.

**Dey, A.N. (1991)** Conducted a study of anthropometric measurements and body composition of high and low cardio-respiratory fitness of boys and observed that secondary school boys belonging to high cardio-respiratory fitness, fitness group possesses significant small abdominal girth measurements, lower percentage of body fat, less fat weight, higher lean body mass as compared to the subjects belonging to low cardio-respiratory fitness groups. Multiple correlation of absolute variables from both high and low cardio-respiratory fitness groups reveals that both the group possess a peculiar physique and absolute anthropometric variables among themselves maintain certain amount of proportions which is quite unique in itself.

**Sodhi et al. (1991)** Examined body composition of 635 elite Indian Sportsmen. Study includes athletes, wrestlers, boxers, basketball players, badminton players, volleyball players and weight lifters. Study also includes, light class wrestlers (n=20), medium class wrestlers (n=26), and heavy class wrestlers (n=13) and found heavy weight wrestlers possessing maximum muscle mass (42.04 kg) and bone mass (13.83 kg). Percentage body fat is also maximum in heavy weight wrestlers (21.24%). Light weight wrestlers are the group with lowest bone mass (10.62 kg) muscles mass (26.05 kg) and percentage body fat (12.23 kg).

**Singh, A.K. (1999)** studied on the inter relationship of body composition aerobic and anaerobic capacities of volleyball players of different levels of performance. The subjects were 50 male university level volley ball players. On the basis of the result of the study, the following conclusions were made:
1) There was a significant relationship between the body composition and aerobic capacity; and body composition and anaerobic capacity of university level volleyball players.

2) There was no significant relationship between aerobic capacity and anaerobic capacity of university level volleyball players.

3) Aerobic capacity showed higher relationship with body composition when partial contribution of each seen through positive correlation in university level volleyball players.

**Tsunawake et al. (2003)** evaluate the body composition and cardiorespiratory function (VO$_2$ max and O$_2$ debt) in 12 members of the women's volleyball team and 11 members of the women's basketball team that won the championship in the Japan Inter-high school meeting. They reported that volleyball players are taller, heavier and more fat percentage than the basketball players. No significant difference was observed in any measured item of the physique, skinfold thickness, or body composition between the volleyball players and basketball players. The VO$_2$ max and O$_2$ debt max were 22% and 28% higher in the basketball players than in the volleyball players.

**Noel et al. (2003)** assessed body composition of Division I football players (n=69) and compared the findings with previously reported data to ascertain whether the increase in player total body mass that has been observed over the past 10 years has been accompanied by an increase in body fat. Body fat varied significantly across playing position, with the defensive backs, offensive backs, and receivers being the leanest and the offensive linemen and tight ends the most fat. There was no significant relationship between body composition and playing year or scholarship status, nor were any differences observed between ethnic groups.

**Ajit (2004)** studied on the relationship between body composition, somatotyping, skinfold variables and springing ability of athletes. The subjects were 35 male students of D.P.Ed and M.P.Ed Kurukshetra University. Within
the limitation identified and on the basis of the results of the study, the following conclusions were drown:

He concluded that:-

1) The anthropometric variables weight, biceps skinfold, supriliac skinfold, thigh skinfold have positive significant relationship with sprinting ability.

2) The body density and lean body mass have positive and significant correlation with sprinting ability.

3) The two variables, the fat percentage and fat weight have negative and significant correlation with sprinting ability. It suggests that when that fat percentage and fat weight go no decreasing, the time which is the measure of performance also goes on decreasing. Hence the performance increases.

4) The value of $R^2 = .29$ indicates that .29% of the variance in sprinting ability scores of the athlete is counted for by the two skinfold variables, i.e. supriliac and thigh skinfolds, while the remaining 71% of the variance in their performance is still be accounted for or cannot be predicted on the basis of these two variables.

From the above studies of related literature It is clear that physique and body composition and physical fitness has significant contribution in achievement of better performance in the field of games and sports. So, it becomes necessary on the part of the physical educationist and sports scientists in the field to investigate such variables and combination of kinanthropometry and physical fitness variables which are essential ingredients for better performance of participants. If the investigator may become able to find such relations and is in such a position to develop regression equation for the performance than it will be a great contribution to the profession without wasting much energy and time, the suitable physique, body composition and
physical fitness may be evolved for the particular participants in the particular games and sports.

Cavas et al. (2004) investigate the anthropometric parameters and body composition in handball, basketball, badminton, volleyball and underwater rugby players who are students in Physical Education and Sports Department in Turkey. 49 female and 51 male athletes have taken part in this study. The skinfolds of rear thing in female players are significantly higher than those of other female and male skinfold values. Minimum skinfold value has been observed in subscapular and chest of female and male athletes, respectively. Although estimated percentage body fat and body fat weight values in female athletes are significantly higher than those of male athletes, fat free body mass in male athletes is significantly higher than those of female athletes.

Moreno et al. (2004) assess body composition in young male football players (n=239) and compare the results with those of reference population (n=453). Body mass index do not showed any significant difference between football (soccer) and reference groups in any age category. The percentage of total body fat was significantly lower in the football (soccer) group than in the reference group at 9, 11, 12 and 14 years.

Marta et al. (2008) evaluated the body composition and body image of a group of top flight soccer players and compare the results with those of a group of university students used as controls subjects. A total of 56 individual took part in the study; half of them were soccer players and half university students. They did not find significant differences in body image satisfaction between the soccer players and the control subject. However, “the university students perceived their image much more precisely than the soccer players. The body composition study revealed that the soccer’s had more muscle mass and less fat than the control subjects; that is, they were thinner and more defined than the volunteer group. While the control subject tendered to want a more muscular body with the same amount of fat and less than they had, the
soccer players expressed that they wanted more muscle mass, but also more body fat.

Kundu and Bose (2009) investigate the somatotype and body composition differences between north zone and east zone university level Indian women basketball players. The result revealed that the somatotype of both north-east zone women basketball players possessed mesomorphic-endomorphic except the champion university. The physique of the champion team (GNDU) was ectomorphic-endomorph. North zone women basketball players possessed less % fat, less weight of body fat, higher LBM, taller and heavier than the east zone players. GNDU possessed less amount of % fat than the other Universities. Punjabi University players were the taller than other. Endomorphic component, ectomorphic component, % fat and the height of the north zone women basketball players were significantly differ than that of the east zone basketball players.