CHAPTER -II
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REVIEW OF LITERATURE

Review of related literature is a crucial aspect in the planning of any research study and the time spent on such a survey is invariably a wise investment. It serves as a link between the old and new and between the known and yet-to-be known. The researcher wants to know background story. "Not only does he", say Bookwalter & Bookwalter (1989), "Need to know what has been done and how it has been done in the subject area, but he also needs to know the degree of success that was found in the use of the research techniques or methods." It is an exciting task calling for a deep insight and clear perspective of the overall field. It promotes and ensures avoiding unnecessary duplication. It also provides comparative data on the basis of which evaluation and interpretation of the significance of one's findings is worked out.

In fact, the success of any new research project, to a large extent, depends upon how well it is linked with the previous researches of the same kind. Divergences and convergences in the problem, especially in its procedures and processes, cannot be Justified without reference to the past story.

The review of related literature available in the libraries of Kurukshetra University, National Institute of Sports, Patiala, Lakshmibai National Institute of Physical Education, Gwalior, MDU Rohtak and also literature available from the publication of friends (India) Delhi.

This chapter includes a resume of research studies and other literature relevant to the present study. The following sequence has been adopted by the investigator to display the related and critical studies, related to the problems:

1. Studies on Playing ability.
2. Studies Physical fitness
3. Studies on Kin anthropometric variables.
4. Mixed studies or combined studies.

**STUDIES ON PLAYING ABILITY**

**Lockhart and McPherson** (1959) proposed a badminton test for college women, which consist of volleying a shuttlecock against a wall. In the validation of the test, the originators obtained the following correlation .71 between the results and the evaluation of badminton playing ability by three experienced judges, and .60 between the test results and percentage of total games won in a round-robin badminton tournament. The test-retest reliability correlation with the volleying test was .90.

**French and Stutter** (1969) constructed tests of footwork, wrist action and smashing ability to supplement the previously validated French test items and from a battery of skill test in badminton to measure playing ability. A four-test battery of serve, clear wall volley and shuttle resulted in a validity coefficient of .698. Eliminating the serve, govern three tests battery with a validity of .678.

**Miller** (1971) found that both the men’s and women's finalists employed clears more than any other Hitting in all of their games. After analyzing moves of the various types of clears, she devised a Hockey test based on this stroke. With one hundred college women as subjects, reliability co-efficient of .94 was obtained with the test retest given one week apart. Validity coefficient of .83 was reported. The criterion was standing of the subjects after round-robin Hockey play competition.

**Ikeda** (1980) conducted a relationship study of some selected measures with the Hockey playing ability. During the last week of an eight week Hockey skill training a series of tests including wrist flexibility, shuttle race and various measures of
Kinethesis, such as arms-forward-spread, supination, pronation and grip were conducted. Pressure was administered to 72 women students. These test scores were compared to the results on the Hitting and clear the ball tests. There was no significant relationship between wrist, flexibility, kinethesis or agility and Hockey playing ability.

**Kowert (1982)** Constructed a Hockey playing ability test battery for men. The judges rating scale-yielding reliability coefficient of .88 when correlated with the class ranking of the judges' rating scale as determined by the intra-class correlation method. The co-efficient of multiple correlation between the sum of the three judges' rating and found that the Hockey playing ability of male college students (N=46) can be successfully measured by multiple regression equation containing variables of the diagonal run test, French's Hockey hitting Test and Miller's Wrist Test.

**Tergerson (1985)** conducted a study on the relationship of selected measures of wrist strength, vision and general motor ability to volley ball playing ability. The French shot serve and clear test, the Miller wall volley test was given to 23 sophomore college women. Motor ability was measured through the Scott test, planter and dorsi-flexion strength with a tensio-meter, temporal vision with a parameter and depth perception with the Howard-Dolman apparatus. Total volleyball playing ability was correlated, significantly, with general motor ability, depth perception and peripheral vision. The highest and lowest six players were different significantly in motor ability, depth perception and peripheral vision, but not in total wrist-strength.

**O'Connor (1986)** studied speed and skill in relation to success achieved by college women engaged in badminton singles competition. Various badminton skills, specific
movement times and success in singles competition were tested. Analysis by multiple correlation and regression showed that speed and skill were essential for success, but success depends to a greater degree on skill than on speed of movement. The Miller Wall Volley test was the best predictor of success in the singles competition and total body movement was the best time predictor. The study proved that skill is more dominant than speed of movement in the success of badminton, but speed of movement is also considered to be essential. Other things being equal speed of movement will influence success.

**Carlton (1988)** studied the relationship of reaction time, movement time and visual tracking to performance in football. A reaction time-movement time device, pursuit ratio, and the Miller football Wall hitting test were used to collect the data of 32 college women enrolled in football classes at Smith College. Reaction time, movement time and visual tracking had no apparent relationship with performance in football.

**Cooper (1990)** reported that the distance an individual can cover by run walk test in 12 minutes, is a highly reliable and valid indicator of his cardio-respiratory fitness and further Doolittle et al. (1968), concluded that it is more valid than the 600 yards run walk test. Since the co-efficient of correlation of 12 minute run walk test with VO2 maximum was higher (0.90) than that between 600 yards run and VO2 maximum (0.62).

**Cooper (1998)** formerly of the U.S.A. Air Force did extensive research in an attempt to establish a rating scale for measuring relative values of activities in terms of circulio-respiratory conditioning. His research showed the importance of such activities as running, swimming, cycling, walking, handball, football, basketball and others in the development of cardio-vascular endurance.
Pankonin (1999) selected 33 College women randomly from seven beginning tennis classes, who were tested for agility, balance, hand eye co-ordination, grip strength, height and shoulder strength. The criterion of tennis ability was the combination T-score from the Dyer test. Brower and Miller forehand backhand test and skill rating by the judges. The most economical predictor of tennis ability combined agility, balance, arm and shoulder girdle strength for and r .62 height and grip strength improved the `r' slightly, although the correlation of grip strength and hand eye co-ordination with tennis ability was not significant.

Hicks (2003) conducted a study to measure a player's ability to execute selected badminton strokes and general playing ability using 64 college women enrolled in badminton classes. Originally, she wanted a five-item battery of valid and reliable tests, but conducted by recommending three items: a clear test, a smash test and a strategy test. Reliability was determined by the odd-even method for each test item.

Coad, Rasmussen and Mikkelson (2005) investigated the physical demands of recreational volleyball. The subjects were members in a volleyball club in Denmark. The subjects' maximum oxygen uptake was determined by a bicycle ergometer test. By use of a wireless transmitter the heart rate was recorded during two or three game matches of different events in volleyball. The length of work and rest periods was recorded during actual play. The heart rate for every 30 seconds was used to calculate the average rate during a game. The relative workload for every subject was also calculated.

Nain (2008) determined the relationship of balance, speed, strength, height, arm and leg strength to success in collegiate wrestling. Subjects were classified as successful, average or
unsuccessful according to their win / loss percentage. A second classification was weight (i.e. light, middle and heavy weight). All subjects were measured for height, arm length and tested for reaction time and movement time, static elbow flexion strength, explosive leg strength and dynamic balance. Treatment of the data by analysis of variance showed no significant difference among the wrestlers in three weight divisions on dynamic balance, explosive leg strength and reaction time. In elbow flexion, strength, the middle-weights were faster in movement time and reaction time than the heavy weights. The successful wrestlers found better balance than unsuccessful ones.

Bobrich (2009) prepared a Hockey observational rating scale to measure total skill development as a student participant in a regular Hockey game. The tool was developed using two classes of 67 boys enrolled in a high school beginning Hockey courses. The reliability was estimated on a test-retest basis using three qualified judges. Both Pearson's 'r' and analysis of variance techniques were used to determine the reliability of testing tool. The co-efficients ranged from .71 to .87 for section 1 of the observational rating scale and from .60 to .83 for section 11.

Smith (2010) noted that there are certain specific types of qualities in sportsmen, which are essential to reach the top level of athletic performance. Those various types of qualities should be analyzed for different types of sports activities. Once these components have been selected tests can be devised to measure them. The recognition of different types of qualities for each sports activity is the starting point for training.

Conner (2009) studied speed and skill in relation to success achieved by college women engaged in badminton singles competition. Various badminton skills, specific
movement times and success in singles competition were tested. Analysis by multiple correlation and regression showed that speed and skill were essential for success, but success depends to a greater degree on skill than on speed of movement. The Miller Wall Volley test was the best predictor of success in the singles competition and total body movement was the best time predictor.

Narain (2008) constructed and standardized specific physical fitness test for basket ball players. He used factor analysis technique on the data of 100 Inter-college/district basket ball players of North India. As many as seven factors of specific physical fitness were obtained, out of which, five were considered as meaningful to select test items from each factor. One test item having the highest loading was included in the test battery from each factor. The test items that derived were applied to 500 basket ball players to develop the norms.

Pramanik (2010) predicted an equation of physical and physiological variables of playing ability of badminton players out of 22 variables. 25 men badminton players of Maharashtra state were drawn to act as subject's forward regression was applied to draw out the regression. The equation consisted of four items namely reaction time, height, arm length and endurance, which accounted for 87% of the variance while reaction time alone contributed 55% of the variance.

STUDIES ON PHYSICAL FITNESS

Downey states that physical fitness is an inseparable part of sports performance and achievement. The quality of its utilization value is directly proportional to the level of performance. That means the greater the level of fitness, the greater the ability of a person to attain higher level of performance.
Gates and Sheffield (1960) studied that various agility runs have been utilized in motor ability and motor fitness test batteries. The 60 yard shuttle run (10 yard distance) was included in the Medford Boys' Growth study as a measure of speed and agility in a running situation experimented with eighteen tests, fifteen of which involved change of direction while running and three of which were other motor ability items. A criterion measure was established consisting of the total T-score of the subject on all tests. For boys in the seventh, eighth and ninth grades, the 60 yard shuttle run correlated .81 with this criterion at each grade. The reliability coefficient was .93. Lawson obtained similar results with a 40-yard shuttle run for girls aged seven to twelve years; her criterion consisted of full Scale total on twelve obstacle and shuttle run.

Book Walter (1963) developed and selected four indices of motor fitness for assessing high school boys and college men. A 12-item external criterion consisting of two or more measures each of strength velocity, motor ability and endurance was used to validate the indices. The four indices with their validity coefficient are:

<table>
<thead>
<tr>
<th>Index</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Fitness Index I</td>
<td>.860</td>
</tr>
<tr>
<td>(Chins Push-ups)(Vertical jump) +100</td>
<td></td>
</tr>
<tr>
<td>Motor Fitness Index II</td>
<td>.820</td>
</tr>
<tr>
<td>(Chins Push-ups) (Standing broad jump)+100</td>
<td></td>
</tr>
<tr>
<td>Motor Fitness Index III</td>
<td>.840</td>
</tr>
<tr>
<td>(Straddle Chins Push-ups) (Vertical jump)+ 100</td>
<td></td>
</tr>
<tr>
<td>Motor Fitness Index IV</td>
<td>.810</td>
</tr>
<tr>
<td>(Straddle Chins push-ups) (Standing broad jump)+ 100</td>
<td></td>
</tr>
</tbody>
</table>

Scaled scores were established for each of the test items and norms were established for each of the indices. On the basis
of the Index, students were rated as superior, good, fair, poor, or inferior.

**Mean (1965)** conducted a study on Philippines entering freshman student’s American and Japanese boys. The performance tested by AAHPER YOUTH FITNESS test reported that Philippine boys were generally lower and their performances in the pull-ups, softball throw for distance, sit-ups, showed considerable deficiency in arms and abdominal fitness. There is enough evidence indicating the influence and involvement of various physical and motor characteristics on the physical fitness and attitudes of students towards physical activity.

**Flishman (1970)** conducted a study on 14-18 yrs boys and girls using physical fitness test battery to measure motor ability components i.e. flexibility, agility, power, strength, muscular endurance, cardio-vascular endurance. Items tested by extent flexibility, dynamic flexibility, shuttle run, softball throw, hand grip, pull-ups, leg lifts, cable jump, balance, 600 yards (548.64 M) run walk. Test-retest reliability co-efficient for the 10 items ranged from .70 to .93. From one original battery of 85 test items, nine "basic fitness factors" were identified and named. This test is a result of one of the most thorough and comprehensive studies of motor ability components available in the literature.

**Lock Hart Aillance and Mepherson Francis (1971)** studied certain cardio-respiratory changes on two grade seven physical education classes of equal physical fitness. One class ran 880 yards daily in addition to the normal programme and both the classes were tested before and after the 8-week programme. The control group did not increase their cardio-respiratory endurance. The experimental group
improved significantly in the 600 yards run-walk (4.4 sec. and the coach pulse recovery test (6.9 points) but not in Mc-cloy endurance run (0.8 points). The 600 yards run walk proved the best in terms of administration reliability and sensitivity to change.

**Miller (1977)** compared the effect of individual and team sports programme on the physical fitness and motor ability of inter-collegiate freshman. Barrow motor ability test, with items of zigzag run, standing broad jump, medicine ball put, sixty yard dash, softball throw for distance, and wall pass was used to measure the motor ability. The team sports included were basketball, soccer, softball, and volleyball where as the individual sports were badminton, bowling and tennis. After the experimental period was over, subjects were re-tested on Barrow motor ability test. It was conducted that team sports had a significantly different effect only on the 60-yard dash item. The 't' test analysis indicated that the effect of bowling and tennis and the effect of badminton and tennis were significantly different. The team sports had a significantly different effect on the wall pass test and the 't' test analysis indicated the effect of soccer and volleyball and as well as the effect of volley ball and basketball were significantly different.

**MC Kinney (1982)** constructed motor fitness test battery for undergraduate male physical education majors. Forty-nine test items were selected as valid measures of the eight motor fitness components and were administered to 121 undergraduate males. The data were analyzed according to the principle axes method with varimax criterion for rotation. Five factors were isolated and named, speed, endurance, gross strength, power, agility, flexibility and relative muscular strength, and muscular endurance. Two test batteries having five items each were
developed on the basis of the rotated factor loading. Test battery I contained highest loading test items: (1) time limit shuttle run (2) cable tension (3) 10 yard dash (4) thigh flexion flexibility (5) bar push-ups.

Hebbelink (1986) an investigation was made to determine the relationship of the reaction time and movement time of primary grade children to the variables of motor ability and physical fitness. Iowa Brace test of motor ability, the Glower physical fitness test, a reaction time test and a movement time test, were administered to 133 male and 133 female subjects between 5 and 8 years of age statistical treatment of data revealed that reaction time and movement time were significantly related to each item of the physical fitness test and both correlated significantly with the motor ability criterion.

Andrews (1986) undertook a study to establish physical fitness norms for South African boys and to compare their physical fitness level with those of Canadian boys. AAHPER physical fitness battery 1966 consisting of one-minute speed, situps, standing broad jump, the shuttle run, flexed arm hang, 50-yard dash and 300 yard run were administered. 'A' student's T-test was applied to compare the mean scores of the South African and Canadian students. The results were found to be significantly in favour of the South African boys.

Romain (1977) conducted a study to identify the factors that could be isolated, when selected motor fitness measures were administered to 213 male and female pupils between 77 to 99 months of age. Seventeen motor fitness tests were administered. The inter-correlation matrix was subjected to an image analysis. Factor I received high substantial loading on the four variables - six-second run-0.953, shuttle run-0.951, toe touch -0.945, and modified beam-walking -0.885. Factor U
received high loading on five variables, modified side step-0.630; 50-yard dash -0.603, standing broad jump -0.599; one minute lateral jump-0.509, baseball throw-0.448. Factor III received high loading on four variables weight 0.766, height 0.745, grip strength -0.764; baseball throw-0.462.

**Uppal, et al. (1998)** had conducted a study on junior women badminton players, who were under intensive training for a period of four weeks. The programme of physical fitness and skill training helped improving performance, cardio-respiratory endurance and the strength in abdomen, legs, arms and shoulders.

**Joseph (2003)** determined 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. It was concluded that arm length and leg length were reliable variables in predicting playing ability of male volleyball players.

**Singh (2006)** conducted a study to develop physical fitness norms of Punjab state high school boys. He randomly selected five thousand high school boys of Punjab State. The sample included rural and urban subjects in equal number for the collection of data. He included following test items.

1. Standing Broad Jump.
2. Sit and Reach Test.
3. Agility Run.
4. Sit-up bent Knee.
5. 50 Meter dash.
7. Cricket ball throw.
8. 600 meter run walk.

He observed significant difference in number of test items between urban and rural schoolboys. Significant relationship between age and performance of the subjects was also observed. The test items were standardized through the development of percentile norms, which was found to be suitable to assess the physical fitness of Punjab state high school boys ranging 12 to 15 years of age.

Sharma, S.N. (2007) constructed and standardized a specific physical fitness test for badminton players. He used the factors analysis technique on the data of 100 inter-college and district level badminton players of North India. As many as seven factors of specific physical fitness were obtained, out of which five were considered meaningful to select test items for each factor. One test item from each factor, which had the highest loading, was included in the test battery. The derived test items were applied on 500 players to develop norms.

Sharma and Mall (2005) conducted a study to determine the specific physical fitness for the badminton game with one hundred badminton players of inter-district level participation. The data was analyzed using Keiser's Vermax procedure of seven factors i.e. Growth factor, Trunk strength, court agility, flexibility, endurance, shoulder & leg strength along with another factor consisting of age, weight, wrist palmer flexion, wrist dorsi flexion. It was concluded that growth factor and no variables from this factor considered as the determinant of specific fitness of badminton players and another having highest loading on factors trunk strength, court agility, flexibility, endurance, shoulder & leg strength and anthropometric variables were considered with joint
consideration of their significant correlation with the criterion as the determinants of specific physical fitness of badminton.

**Singh (2008)** conducted a study of physical fitness status of students of department of physical education Punjab University Chandigarh and Kurukshetra University Kurukshetra. He collected data on 34 male subjects and 27 female students by using AAHPER physical fitness test. The students of Kurukshetra University were found superior on overall physical fitness status where as girls of Punjab University were significantly better than Kurukshetra University in speed and agility components. However, no significant difference was observed in the overall physical fitness between the subjects of both the universities.

**Sharma (2007)** conducted a study to construct and standardize motor fitness for elementary school children of Delhi. His sample included five hundred boys and girls. The study was conducted in two phases. In the first phase he developed motor fitness battery by using factor analysis technique. The battery consisted of five motor fitness test namely (I) Softball throw, (2) Toe touching (3) Double foot balance (4) 50 meter dash (5) 300 meter run/ walk for girls scale on all the five components of motor fitness for future use.

**STUDIES ON ANTHROPOMETRIC VARIABLES**

( KIN ANTHROPOMETRIC)

**Sinning and Lindberg (1972)** reported that college women gymnasts had proportionally greater muscle mass and concentration of muscle mass in the upper trunk and shoulder girdle. They also found women gymnasts to be smaller in skeletal diameters and circumferences of the lower trunk and the limbs. They reported that upper trunk and upper limb circumferences
were greater in gymnasts in comparison to the general population.

**Novak et al. (1976)** measured the skin folds of cyclists and marathon runners. They reported that cyclists were higher than marathon runners on several skin folds. They took skin folds on 28 track runners from 400m through the marathon. They stated that 400m and 800m runners had significantly higher skin folds at triceps and sub-scapular sites than did marathon runners.

**Smith (1988)** studied anthropometric measurements, arm and leg speed performance of 20 female swimmers as predictors of swim speed and reported that arm speed had a higher predictive relationship to swim speed than did leg speed. He also suggested that in order to improve swimming speed more

**Bhatia and Others (1992)** conducted a study by comparing the anthropometric measurements and body composition between 40 women (20 sprinters and 20 throwers) subjects in the age group of 18 to 25 years, who had participated in University athletic meet K.U.K. The body size was assessed by standing height and body weight. Body structure was interpreted as girth, width, body fat, body density of various body segments. Body density was estimated by Durnin and Rehman's equation (1967), Sin’s (1951) formula used by Durnin and Rehman was applied in estimating the percent of fat. The results were as follows; throwers have more muscular body than sprinters. Throwers have larger diameters than sprinters, which indicate a better development of various regions of throwers. The skin fold measurements are larger in the throwers as compared to sprinters. These measurements show maximum fat deposition in throwers.
Musaiger et al. (1994) analyzed body composition of different groups of athletes in Bahrain. Three hundred four athletes were selected from first class clubs related to four common sports football, handball, volleyball and basketball and compared with fifty three non-athlete adults weight, height, mid-arm circumference and skin fold thickness were measured to significantly greater in vertical jump and the 50-yard dash when compared to the distance runners.

Bandyopadhyay (1997) found out the relationship of selected anthropometric measurements, physical fitness and motor ability to soccer skill performance. All subjects were tested in selected anthropometric measurements, which were chest girth, upper arm girth, thigh girth, calf girth, height and weight. They were also tested in AAHPER YOUTH fitness test for assessing motor ability and Mc Donald soccer skill test for measuring soccer skill performance. The findings indicated that the Mc Donald skill performance had a high correlation with physical fitness and motor ability. The obtained value was .86 and .89 respectively. Those values of correlation were statistically found significantly at .05 level of confidence. As one of the findings was that there was a high correlation in physical fitness level as obtained from AAHPER youth Fitness Test with soccer skill performance.

Sinha (1999) found out the relationship of selected motor traits and anthropometric variables with performance in AAHPER Basketball skill test. To establish relationship between selected motor traits and anthropometric variables to performance the AAHPER basketball skill test, the co-efficient of correlation (r)was used. On the basis of findings of the study the following conclusions were drawn:
1) Explosive power, agility and cardio-vascular endurance are the key motor traits that underline performance of skill in Basketball.

2) Height as well as relative leg length measurements are the main anthropometric characteristics which contribute to skill in basketball.

3) The motor traits of speed, grip strength and flexibility are not the prime factors for performance of skills in basketball.

4) Excess body weight has restricting effect on basketball performance.

Ghai (1999) conducted a study on the relationship of selected physique characteristics and motor ability components with performance of gymnastics. Twenty male gymnasts, who have represented different universities in all India Inter-university competitions, were selected as subjects for the study. The subjects were tested for all the characteristics and motor ability components such as height, weight, chest girth, thigh girth, upper arm girth, strength, flexibility, agility, and dynamic balance were significantly corrected with the performance in gymnastics and physique characteristics were not significant to the performance of gymnasts.

Singh (2002) has studied the kinanthropometric measurements, aerobic and anaerobic fitness among the badminton players. He has made study on 88 badminton players drawn from the northern states of India with the random sampling device and formed three groups i.e. national and inter-varsity, state and inter-varsity, district and inter-college level players. He has taken 18 kinanthropometric variables and applied 12 minutes run and walk test as per results of the study, he drew the
following conclusions, (i) He found no significant difference among the three group of badminton players in their height, length of arms, length of torso and length of legs but found significant difference in weight, circumferences, measurement of chest, upper arm, thigh, calf and body density. He also found significant difference in body fat percentage. (ii) With the interpretation of results he observes that there exists significant difference between aerobic and anaerobic fitness among the three groups of badminton players.

**Mewara (2004)** conducted the study of motor fitness and selected anthropometric variables in relation to their playing ability at different levels of basketball players. He took 180 basketball players dividing into three groups consisting of state level, inter-varsity, national and international level. The playing ability was judged by judging rating scale in the playing situations and tested basketball skill with Johnson Basket Ball Skill Test battery. As per results, he reported that the international level basketball players were significantly better than other group players, i.e. national, inter-varsity and state level and skill performance of the international and national level players were found better among anthropometric parameters, arm length, leg length, age and weight and the motor fitness parameter such as strength, flexibility, endurance, static balance, visual reaction time etc. The mean values of the international level players were better than the other three groups.

He also predicted that the independent variables age, motor fitness, skills and height are the more contributing factors in over all basketball game.

**Chauhan and Chauhan (2005)** have made the study to find out the relationship and anthropometric variables in
execution of explosive arm strength of volleyball players. For this they selected 40 'college volleyball players, who participated in the Kurukshetra University, Kurukshetra inter-college volleyball championship. They were in the age group of 18 to 25 years. All the players appeared for body composition variables and explosive strength test of basketball throw with both hands. To find the relationship product moment method for correlations and Wherry Doo equation for the prediction of explosive arm strength of volleyball players were used as statistical tools. In the findings, they found age; weight and linear measurements have positive correlations at 1% and is contributor to improve the explosive arm strength of volleyball players in the same way. All the diameters also possess positive and significant correlation with explosive arm strength at 1% level and are helpful to improve the performance of the player. The skin fold measurements also have positive and significant correlations with explosive arm strength and r/o level specially in biceps, sub scapular, thigh etc., whereas triceps, midaxillary, supra iliac and calf skin folds have positive correlations at 5 percent level and are contributor to improve the explosive arm strength.

4) **Studies on mixed variables**

**Brongdonr (1983)** compared the physical fitness and anthropometric measurement of pre-adolescent Mexican-American and Anglo-American males. 300 subjects were tested from each group of AAHPER Youth Fitness Test and thirteen anthropometric measurements were made. The findings revealed significant differences between the Mexican American and Anglo-American males in certain physical fitness items and anthropometric measures. When the single factor of age was correlated with each of the individual physical fitness items and each of the anthropometric measures, few significant differences
were evident. The result indicates that the Anglo-American males are larger in gross body size and they were superior in performing selected physical fitness items. Both groups exhibited higher body measurements and fitness scores at each succeeding age level that denoted a relationship between age, physical fitness and physical growth. Age as a predictive factor is equally important to Anglo-American students.

Burke and Bush (1985) studied Physiological and anthropometric measures of young women who had been training regularly by running approximately 50 mile per week for two years. Anthropometric measures included selected segment lengths, diameters, skin-folds and circumferences. He concluded that these women athletes were average in height while lighter than normal for their age and sex, having a high component of Ectomorphy, having a small overall skeletal frame work than normal and low in subcutaneous body fat for their age and sex.

Gharlove (1986) studied the relationship of certain anthropometrical motor ability and reaction movement of high school girls. Correlation analysis showed little relationship existing between the anthropometrical, motor and reaction movement variables.

Carte (1988) in his boom mentioned that the average judo competitor is of 23.4 years old, 173.1 cms. tall and having a weight of 76.5 kg. (pkg. 72.7 kg.) has a Somatotype of 2.0-6, 4-1, 3 (54% Endomorphic Mesomorphic) and skinfolds totaling 44.1 mm. when compared to other weight classified sports. Judo competitors are mostly like wrestlers in age and size variables. They are younger and have lesser arm girths than weight lifters. They tend to be more endomesomorphic in upper weight classes compared to lower ones. Their large proportional mass compared
to the non-weight classified sports, seems to be accounted for by their high mesomorphy.

**Gooden (1989)** Conducted a relationship study on selected anthropometric measurements of leg and foot to speed and vertical jump of male collegiate track and field athletes. Ss = (N = 32) were assigned to five groups according to their respective events: short sprinters, long sprinters, middle distance runners, distance runners and jumpers. All the subjects were exposed to a one week training period before the testing of the vertical jump and 50 yard dash. An ANOVA was used to determine difference between performance scores of all five groups in the vertical jump, 50 yard dash, and selected anthropometric measurements. The Newman-Koala follow up test was employed to make multiple comparisons and a multiple was used to determine the relationship of selected anthropometric measurements to vertical jump and 50 yard dash. There was a high positive relationship between speed of the 50 yard dash and vertical jump. There was no significant relationship between the 12 anthropometric measurements and speed in the 50 yard dash. The short sprinters and jumpers performed significantly greater in the vertical jump and 50 yard dash when compared to other groups. The short sprinters and middle distance runners performed significantly greater in vertical jump and the 50 yards dash when compared to the distance runners.

**Burley, et al.(1991)** investigated the differences among seventh, eighth and ninth grade girls in speed and found that then speed scores were correlated with height and weight that correlations of +.183 and -.003 were obtained. When the speed scores were correlated, with the various lever length of the subjects, the following correlations were obtained: speed and olecranon to unequal tuberosity, .161, speed and olecranon to
acromion process, .120, speed and greater trochanter to the lateral condyle of the tibia, .184. All these correlations indicate a neutral relation between speed and the anthropometric measures used. The mean scores of the eighth grade was .4 second greater than the mean for the seventh grade, the mean difference being the only one statistically significant.

**Novek et al. (1997)** assessed eight distance runner seven swimmer and five gymnasts. The working capacity was determined on bicycle ergometer, oxygen intake, carbon dioxide, respiratory rate, pulse rate and R.O. were determined by Siregmost - FD 88. Vital capacity was measured by a spirometer with an automatic read out. Total body water was determined from the ratio of D20 to H20 by mass spectrometry. Lean body mass was calculated from total body water assessing 73.2 percent hydration. Anthropometrical appraisal of leanness-fatness included subcutaneous fat-fold measurements and calculations of lean diameters of the limbs. In relative values distance runners showed significantly higher oxygen intake which was also achieved to significantly higher work loads compared to swimmers and gymnasts. Vital capacity was significantly higher in favour of swimmers. However, lean body mass was significantly lower in swimmers, percentage wise. Various subcutaneous skinfolds were higher in swimmers thus substantiating findings of biochemical determinations of total body fat.

**Lorihi (1998)** investigated the relationship between swimming and Selected physiological, anthropometric developmental and skill variables in 10-12 year old female competitive swimmers. Each also completed a 400-yard and 50-yard time trial. The data were initially examined by means of a Pearson matrix. The inter correlation matrix indicated that the
best single predictors of swimming performance were height, aerobic capacity and stroke efficiency. When the better swimmers were compared to the poor, however, the importance of physiological parameters disappeared. Body size, skill and exposure to swimming were the most significant group of factors in differentiating between the two classes of performers (to better class performer and the poorer class performer).

**Selder (1998)** conducted a study on anthropometric cardiovascular and motor performance characteristics of physique, motor and university ice hockey players. Characteristics of physique, motor and cardio-vascular fitness were reported 14 varsity hockey players, some of them had represented Canada in 1964 Winter Olympic. Most of the players were dominant mesomorphs with low adipose measurements. It was found that the majority were above average in dips and in dynamometrical strength but average or below in other tests of motor fitness.

**Joseph (1998)** determined 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. It was concluded that arm length and leg length were reliable variables in predicting playing ability of male volleyball players.

**Benny(1998)** conducted a study of anthropometric measurements and body composition variables on judo players. Nine anthropometric measurements and three body composition variables were taken for this study. Judo players ability 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:

1. Performance in judo is positively and significantly related to chest girth.
2. Judo performance is negatively and significantly related to ponderal index which means that for better judo performance judoka should possess greater body weight in proportion to body height.
3. Lean body mass, upper arm/force arm ratio and sitting height are the most important predicting variables under the limitation of this study.

Yokobord and Suzuki (1999) studied 13 judo players and reported that 6 were mesomorph, 3 mesomedials and 4 endomesomorph. Their average was 362 and were classified as mesomorph. Their somatotype was generally described as having large amount of subcutaneous adipose, although it was less than that of Japanese style wrestlers. They also had well developed bones and muscles. gcm2 0.0076 gcm2 and 0.65 respectively. Further more the result of this investigation indicated that the minimal correlating weight equation of tcheng and tipton resulted in total error values (5.54 to 6.06kg) which were too large to be of practical use for high school wrestlers.

Lavonne (2006) examined the relationship of chosen structural- maturational variables to throwing performance in the light of sex differences and developmental differences. The structural maturational variables chosen were height, weight, arm length, and subcutaneous fat. Four measures of throwing performances were used to identify throwing ability of the subjects. These measures were velocity, distance, accuracy and
quality of throwing form. Subjects were 146 first and fourth grades enrolled in an elementary physical education programme. Results indicated that there were differences between boys and girls on throwing performance variables and structural - maturational variables. A significant relationship between arm length and throwing composite was found for first grade girls. For fourth grade boys a significant relationship was found between the two structural - maturational variables of arm length and weight and throwing composite. The structural - maturational variables were found to be a significant predictor of distance throwing for first grade and fourth grade boys.

**Sprague (2005)** 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, bicep skinfold, scapular skinfold, shoulder flexion, ankle flexion, knee extension elbow extension, vital capacity and centre of gravity, other variables recorded included length of time in competitive swimming, months per year spent in workouts, number of workouts per week, amount of participation in other competitive sprinters and age. The stepwise method of multiple regression was used in all analyses. The most consistent variable overall was time in competitions. It was statistically significant in all fourteen analyses. The most consistent physical measures were foot length and bicep size. Each was found significant in at least one analysis for each of three strokes. In each case longer feet
were associated with slower timer and larger biceps were associated with faster timer.

Siret and Pancorbo (2006) undertook this study to identify some anthropometric indicator with influence on competitive results from young elite female swimmers specialized in 100 and 200 m. free style events. Seventy eight swimmers were studied. Weight height, four diameters, four circumferences and six skinfolds were determined on these athletes. Based on these data, the somatotype, body composition and other indices like the activity corpatorial substances (AKS), gluteal circumferences related to height (GC/11), Brocas index (KP) and body surface area (BS) were assessed. These assessments were submitted to factor and lineal correlation analyses with the best time achieved by the athlete at the moment. The femur bicondylar diameter accompanied by better development of thighs and calves was seen in comparison to the defensive players. The forward line players had also slightly less body fat and more of lean body mass.

Amusa (2006) selected 46 subjects who were well conditioned soccer players with at least two years playing experience at the college level. They were tested for anthropometric measurements consisting of skinfolds and body diameters were taken. Analysis of data was by zero order correlations and multiple regression analysis resulting in the conclusion that ago (experience) is the best single predictor of playing ability. Weight, L.B.M. and height are considered good predictors of playing ability.

Heimer, Misigo and Medved (2006) conducted a study in which measurements of anthropometric and functional characteristics were made on a sample of 13 members of the Yogoslav-national volleyball team. The anthropometric characteristics revealed above - average values of longitudinal
dimensions, thereby making possible the extraction of the mesomorphic - ectomorphic somatotype. of anthropometric study. The indicators that were positively correlated (P < 0.05) with the times are as follows: Lean Body Weight (LBW) and BS while endomorphy was in negative sense. Factorial analysis revealed four bipolar factors which were able to explain the 71.6% of variance, showing the corresponding to competitive results, a strong relation to weight, height, lean body weight, Broca's index, activity corporal substance and mesomorphy which point out the importance in considering these indicators when choosing sport talents at an early age.

In his study on junior high school boys and girls, HUNT (2007) concluded that chronological age, standing height and weight are of little value as classifiers in performing the minute sit-up, standing / broad jump and 300-yard run in Manitoba's Physical and Motor Performance Test.

Kansal and others (2006) conducted a research on the physique and body composition of Indian University Soccer players. The zonal champions of the all India Inter-university Football Tournament and the runners-up of the North Zone were taken as the subjects. They concluded that defence line players were significantly taller and heavier and had higher values to most of the parameters examined. Kansal et al (2007) conducted a study in which anthropometric measurements were taken on twenty three football and fifteen volleyball players who attended an Inter-university Coaching Camp with a view of studying their physique and body morphology. One hundred control subjects, also were studied. Differential anthropometric variables including linear, circumferential and skinfold measurements were taken. Body physique was calculated from Skinfolds using
health and Carter method 91967), and body fat was computed from skinfolds using During and Womerseley (1974) equations. It was found that the footballers were of average height, however, the volleyballers were taller than their control counterparts. The footballers had large trunks and smaller lower extremities than the volleyballers who did not differ much from the controls in this relationship. The volleyballers and footballers had linear physique and larger limb girths but less body fat than controls indicating their relatively more muscula rity. The anthropometric somatotype of volleyballers and footballers were 2.16, 23.3, 9.7 and 1.87, 3.59 respectively indicating less endomorphic component than controls. Compared to the Olympic level players, the players of the present study were lighter and shorter.

Sodhi and Sidhu (2008) in their book mentioned that the wrestlers are found to have longer upper extremities, a longer and larger trunk and shorter lower extremities. The longer upper extremities are advantageous to them for an easy reach in many of the technique holds of wrestling and help in having stronger arm grip for catching the larger trunk of an opponent. The longer trunk and shorter extremities bring down the centre of gravity and thus help in increasing the stability of a wrestler. Moreover, the longer and larger trunk adds in the strength of their region of the body which seems essential especially when during the fight, one wrestler is in the hold of another.

Khanna et al. (2008) study consisted of seven judo players and four-teen normal subjects of sedentary habits. On the first day their anthropometric characteristics including body fat percentage, grip strength and anaerobic power were measured. On the secondary their maximum aerobic power was determined. Body fat percentage was determined by measuring
the skinfold thickness over 4 different sites, namely biceps, triceps, suprailliac and subscapular regions with skinfold cliper.

Mean age, height and weight of the judo players did not differ much from the normal sedentary group, even the judosists did not differ among themselves (61.0 - 64.6 kg.) and they formed a single weight category, mean body fat percentage (12.5%) of the judo players was significantly lower than that of the sedentary persons (P 0.05). This signifies that this athletic group has a higher mean lean body mass than that of the normal group. Average fat percentage of the judosists studied, was also comparable to the Canadian Judo Team (Tayler and Brasord 1981). However, the fat percentage of the judosists of the present investigation and also of the Canadian Team was higher than the reported value of the trained weight categorized athletes (Wilmore 1970).

**Callister et al (2009)** studied eighteen male and nine female nationally ranked judo athletes to construct profiles that would provide some understanding of the physiological capacities underlying successful judo performance. Body composition, aerobic capacity, idokinetic elbow and knee flexion and extensor strength, and muscle fiber size and composition of the vastus lateralis were examined. Higher ranked males (except heavy weight) differed from lower ranked males in percentage of body fat (5.1 + 0.6 Vs 8.2 + 0.8 P 0.05). While more successful females tended to have greater upper body strength than less successful females. More striking, however, was that the characteristics examined varied (P 0.05) as a function of weight division for both male and female athletes. As weight division increased, percentage of body fat increased (r = 0.64, 0.72). Among females in particular athletes in the higher weight
divisions were stronger relatively to L.B.M. than those in the lower divisions.

Mitsutsugu et al. (2009) studied the influence of the juvenescent judo practice on their bodies (N = 33). The subjects were grouped into judosists, soccer players, basketball players of each 5th and 6th graders and 7th and 8th graders. The number of subjects of each group was 10 to 12 in each sports events and grade. 14 anthropometric measurements were taken. He found that the percentage of body fat of the judo group was larger than that of other groups and it was much larger in junior high school students. He also concluded that the physique of judo group consisting 5th, 6th, 7th and 8th grades were for above the national average.

Thomson (2010) compared body composition and physical dimensions in young, experienced wrestlers (W. x age + BE = 11.1 + 0.24 years, N = 237). They were the best wrestlers from local wrestling clubs and averaged (+ SE)2.7(+ 0.27) years in experience. They had won 72% (I 1.8%) of the total 75 (+ 9.1) matches. Additionally more than half were the top 3 places in city and or state-meets- and 6 had won an international meet. The 3 were from local elementary schools and were considered typical in the variables to similar group of children from the literature standards densitometric and anthropometric techniques were used to measure the body composition (percent fat from six formula) and physical dimensions of each group. Residual lung volume was determined by the oxygen dilution technique. The Were U Kg. (+ 1.9) lighter (P 0.05) and had a smaller percent of body fat than S (W, x + Se = 13.3 + 0.55% and S, x + SE = 20.0 + 1.13% P .05). The percent body fat of W was more than 2 x maximal value proposed by the American College of Sports Medicine for high school and college wrestlers. The
lower ft of W has reflected in smaller skinfolds (leg transformation) and lower body of circumferences, height or lean weight. It was concluded that wrestlers had lower body fat but similar skeletal structure when compared with typical children. The data suggest for a need for separate standards for minimal wrestling weights of young children.

Sady et al. (2010) compared the body composition and physical dimensions of 23 young, experienced wrestlers with 23 school children. Standard densitometric and anthropometric techniques of each group. The wrestlers were 4 kg. lighter (P 0.05) and had a smaller percent fat than the comparison group 13.3 + 0.66% and 20.0 + 1.13%, respectively). The weight difference between groups were due to the larger fat weight of the comparison group since lean weight differed by only 0.8 kg. Fat differences were also reflected in the larger skinfolds and fat circumferences of the composition group. No group differences were noted in diameters. It was concluded that compared to other children, young experienced wrestlers had similar skeletal structures and lean body weight. The comparison group possessed more body fat.

Johnson (2008) investigated 208 collegiate wrestlers. Subjects were classified as successful and unsuccessful according to their win - loss percentages. A second clarification was by weight (light, weight, middle weight and heavy weight). All the subjects were measured for height, weight, 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 values was successful in predicting success.

Burke and Bush (2009) studied physiological and anthropometric measures of young women who had been
training regularly by running approximately 50 miles per week for two years. Anthropometric measures included selected segment lengths, diameters, skinfolds and circumferences. He concluded that those women athletes were average in height, while lighter than normal for their age and sex. Venkateswarlu (2008) conducted a research on National level 100 kabaddi players, 120 basketball players, 100 track and field athletes and 100 non-athletes. Their age in years, height in cms. and weight in kgms. were recorded. Their skinfold thickness, lean body mass, body fat content, upper arm and lower arm circumferences and their respective diameters were determined. Basket-ball players and throwers were the tallest of all. Throwers were not only the tallest but also the heaviest. Distance runners were the lightest. Kabaddi players and throwers had the highest body fat percent. Throwers, kabaddi players and sprinters were muscular in their upper extremities because of which their scores in the corrected upper and lower arm diameters were greater than those of basketballers, jumpers, middle distance and long distance runners who seemed to be lean and lanky.