CHAPTER II

REVIEW OF RELATED LITERATURE

A review of the literature related to the present study in games and sports is presented in order to provide a background material to analyse the significance of the study. Best (1977) while commenting on the significance of review of literature related to the research problem pointed out, “Practical all human knowledge could be found in books and libraries, unlike other animals that must start a new with each generation, man build upon the accumulated and recorded knowledge on the past.”

A review of the literature related to a particular problem is of great help as it serves to avoid unnecessary work out problem and may help to make progress toward the solution and successful completion of new ones. Apart from avoiding the risk of duplication a research worker gets an idea of the work that has already been done and the work remains to be done in particular field.

With all round advancement in the science of sports the new disciplines are emerging with super specialisations. The physiological factors limiting one's performance in top level sports are well known. The growth of psychological domain and a suitable social and demographic structure, originating from one's family, are also integral organic factors of an individual. The element of scientific basis of selection is being inducted in the procedures of selection of athletes at various levels in some advanced countries. The knowledge form many scientific disciplines in being used for improving the criteria for selection of talent. The physical educationists have designed test procedures for evaluating the fitness of young children.

The performance structure for different games and events is being been evaluated. Proposals are coming up for the selection of potential athletes with the designs of tests and the body height predictions are also an important field in this regard. The genetic aspects of performance have also been worked out though to a limited extent. It is the understanding of interaction of these entire factors that can help us designing the ways in selecting the children for appropriate game and training. The idea is to put the interested individual in a game or event in such a way so that one gives out the best of one's abilities. In this connection, the role of physique is of utmost importance. There seem to be various unchangeable characteristics in the
human body. For example, if the game of basketball needs the players to be tall, then those who are shorter cannot be made taller under normal conditions.

To excel in a physically competitive sport, the player must possess such dimensions of body characteristics which suit the most in his/her sport. Therefore, because of this reason, the anthropometric or physical characteristics are known to be of fundamental importance for individual development to achieve Olympic level performance in a sport. The physique which includes the evaluation of size, shape and form of an individual is of prime importance as to know how far an individual can succeed in becoming a top athlete.

The greater propagation of interest regarding a particular type of physique that produces an athlete with greater performance for a particular event came up around the middle of the twentieth century. In the last few decades, with in sports science the interest in structural and functional evaluation has developed to great extent.

Several investigators have studied the relationship of morphological, anatomical and structural characteristics with physiological and functional phenomena. Most of them have come to the conclusion that a certain correlation exists between the physique or build of the body and the motor capacity. The physical, motor and physiological fitness of top ranking athletes have been evaluated, by the eminent human biologists and physiologists (Cureton 1951; Daniels 1969, 1974; Malhotra et al. 1972;, 1973; Kansal et al. 1980 a & b; Carter 1982; Malhotra & Sodhi, 1982)

Carter (1965) and Perbix (1954) found that female physical education majors differed from other college populations by being more mesomorphic and less endomorphic, Carruth (1952), Morris (1960), Upshaw (1960) and Garrity (1966) showed that physical performance and mesomorphy were favorably related in women.

The relations between human growth and motor performance have also been considered an important area of investigation (Rarick 1973; Shephard;1982; Carter et al. 1981). The genetic aspect of motor performance has also been attempted by de Gray et al. (1974) and Malina and Bouchard (1986). The physiological factors influencing motor performance in different sports too have been revealed by Pugh (1960), Cumming et al. (1973), Malhotra et al. (1972 & 1973), Daniels (1974), Plowman (1974), Verma et al. (1978) Berg & Bell (1980) Shephard (1982), Dirix et al. (1988). Not only this, it is proposed to select potential athletes of future at an early
age with designs of motor performance tests and the body size predictions (Balesvitch and Siris 1970; Sodhi and Sidhu 1984; Punia 1988; Giri 1990; Claessens et al, 1994.)

The present investigator feels that it is the understanding of the interaction of the factor mentioned above on the part of the physical education teachers and coaches of different sport that can help the children and youth in giving out the best of their abilities. For that purpose, it has become essential to know relationships that exist between physical and motor traits. (Behnke and Royce, 1966; Malina 1974, Slaughter et al. 1977). The important question has become to discover if function (performance) relates to structure. Stated in another way, to what extent does knowledge of the constituents of the body enable one to predict performance ability. However, the difference in physique, body composition and anthropometric characteristics of sports and non-sports girls was not clearly known on the basis of various age groups.

The researcher has made an effort to find out the anthropometric measurements and their relation to motor abilities of sports and non-sports girls at different age groups. So the literature concerning to this study is presented in three broad categories:-

1. Anthropometric characteristics of sports and non-sports person.
2. Physique and body composition of sports and non-sports person.
3. Motor abilities of sports and non-sports person.
4. Relationship between anthropometric characteristics and motor abilities.

1. **Anthropometric characteristics of sports and non-sports person.**

The sports probable have to choose their sportive event at an early age as to undergo training in that particular event. Hence, physical education counselors, teachers, trainers and coaches must have specific norms of growth and development patterns of anthropometric and motor performance variables so as to guide the children to select the most appropriate game/sport with respect to potentials of his/her physique and body composition. Some reports on the growth patterns in anthropometric variables and motor performance of Indian children are already available (Malhotra et al. 1973; Sidhu & Wadhan 1974; Sodhi et al.; 1974; Robson et al. 1978; Singh 1978; Uppal and Roy 1986; Sodhi 1980; Kansal 1981; Malhotra and Sodhi 1982; Sodhi et al. 1982; Uppal et. al 1983; Dey 1984; Ghosh et. al 1984; Sodhi

In order to make the results most suitable for practical utility, there is a need to develop separate growth norms of important anthropometric measurements and motor performance variables for different age groups girls. Physical growth is one of the most important aspects resulting in significant changes in physique and body composition of the individuals. In recent years it has aroused wide interest among anthropologists, students of medicine and also among physical educationists. But there still remains a great void in the data on the anthropometric status and motor performance levels of girls.

Cureton (1951) studied 15 Danish gymnasts who were shorter and heavier than his control group. They were the stockiest groups of the several sports compared. The Danish gymnasts were also found to have the most flexible chests.

Parnell (1951) examined athletes and shows that all groups of athletes were taller than the controls. The javelin-throwers, discus throwers and short putters were the tallest and sprinters, the shortest. With regard to the mean weight middle and long distance runners were the lightest than the control group. All other types of athletes had the mean weight above that of the control group. The reciprocal of ponderal index was found to be lowest among heavy-event athletes who also registered a small range. The highest value of this index was in the case of long distance runners, with an average build equal to that of the control series. After studying the physical structure of rowers he found that the proportion of biacromial/bi-iliac diameter was significantly higher in rowers than in the controls, but the chest depth was significantly greater among the controls. Hirata (1966) noted that rowers were next to basketball players in tallness.

Buskirk et al. (1957) determined maximal oxygen intake (VO₂ max) and weight of body fat by immersion densitometry in 46 healthy male student and 13 soldiers. The athletes had a significant by larger VO₂ max per kilogram of fat-free
body weight than sedentary group. Sedentary students were divided into 3 groups i.e. >25% fat, 10-25% fat and <10% fat and no different was found in VO₂ max per kilogram of fat free weight in these groups. Their study concluded that physical conditioning affects the VO₂ max independently of mass of active tissue and that obesity per se has no effect on maximal performance of the respiratory-cardiovascular system in young men.

Morris (1960) studied the structural and functional differences between women athletes and unselected college women significant differences were found between all strength tests, vital capacity, height, mesomorphy and ectomorphy. There was clear evidence that the total strength and leg length per pound of body weight were important factors in performance than the body weight and strength alone.

Bird (1961) reported the anthropometric measurement of male gymnasts. He concluded that the gymnasts had well developed muscles with a light skeletal structure which is advantage from mechanical point of view for small body size. He found that, girth of the chest, biceps, thigh and abdomen to the above average and gluteal & calf measurement below average thus the Gymnasts were above average in upper body development but below average in their lower body measurement.

Ambegaonkar and Dikshit (1964) conducted a study on 27 Indian hockey players and concluded that Indian hockey players and concluded that Indian hockey players have the mean age, height and weight as 24 yrs, 174.1 cm and 60.8 kg respectively.

Correnti and Zauli (1964) examined 166 Olympic track and field competitors and eight swimmers at the 1963 Rome Olympic. They observed that there are differences in age, height, weight and body form among the various events.

The outstanding study to date on track and field is Tanner's (1964) in which 137 competitors in Olympic, British Empire and Commonwealth Games were studied. He found that only half the somatotypes in general populations were present in the Olympic sample which ranged from endo-mesomorph through ecto-mesomorphs to meso-ectomorphs. The sprinters and the 110 m hurdlers together stood out as being considerably more mesomorphic than all other track athletes. Among middle and long distance runners, as clear gradient of build was seen running from the 400 m to the marathon, with the 1500m and 500 m being intermediate. The 400 m men were large, long legged, and broad shouldered in relation to their hip, and fairly heavily muscled. Long distance runners were small, short legged, narrow shouldered and inferior in
musculature. There was no overlap lapping between the 400 m and marathon distributions in height or weight. The 50m walkers, in general, resembled the 1500m runners, though they had shorter legs, like the 500m me, wider hips in relation to their trunk and larger calf muscles for their tibia size.

The throwers of discus, shot put, javelin and hammer differed greatly in physique from the other athletes. As a group, they were taller and heavier, with long arms in relation to their legs. They had broader shoulders and broader hips, even for their trunk size, and were some what fatter than the track athletes. Their proportions of legs to the trunk were similar to those of middle distance runners.

Tanner (1964), observed that all high hurdlers who recorded times under 14 seconds were over six feet tall, with the notable exception of one who though 179.1 cm, had the typically long legs of the Negro hurdler. Longer legs are helpful to take necessary long striders over the hurdles without the loss of time jumping entails. Further, it has been noticed that throwers at different levels of competition are heavier and taller with long muscular arms and wider shoulders.

Medved (1966) studied the height and weight of sportsmen and sportswomen in a city. The greatest deviations regarding height in the positive sense were observed in basketball players, volleyball players and swimmers, whereas wrestlers, boxer and figure skaters were among the sportsmen showing deviations in height in the negative sense.

Carter (1970) rated the somatotype of the member of the 1964 San Diego state football team and 20 university of IOWA football players according to the Heath criteria. It appears from his result that preponderance of endomesomorphic is a pre-requisite of success in football.

Carter (1970) reported that five USSR female Gymnasts were the shortest, lightest and most mesomorphic (3.8-5.2-1.6). Although the sample was small, their mean height (157.0 cm) and the mean weight (53.9 kg) were almost identical with the mean of the female Olympic Gymnasts reported by Hirata (1966). These 102 Gymnasts had a mean height of (157.0 cm) and mean weight (52.0 kg). The small mesomorphic physique is well suited to the requirement of women Gymnasts. Sidhu and Anand (1971) studied 42 athletes and non athletes in which the former were found to be taller and heavier than the latter. The non athletes were seen to possess higher amount of subcutaneous fat than the athletes.
Eiben (1972) studied 125 women athletes during the European athletic championship and published his work in 1972. He found that in each anthropological character the sprinters had small dimensions than all other women athletes their small stature was due mainly to their short trunk. Their lower extremities, especially their thighs, were long as compared with the trunk. The development of their widths was moderate, the upper extremities less muscular, the lower limbs, especially the lower legs, were strong with well developed muscles. The hurdlers were strong and muscular. Their stature was nearly identical with the sprinters, however, their trunk was somewhat longer and their lower extremities relatively shorter. As regards the proportions of the lower extremities, the relatively long legs and shorter thighs were characteristic of them. Their extremities were muscular, especially the lower legs.

The middle distance runners were the most linear and slender. They were the shortest and lightest of all measured European women athletes. Their trunk was the longest and narrowest. Between the two groups of jumpers, the women long jumpers were somewhat smaller. Their trunk was longer, and lower extremities shorter than those of the high jumpers. As opposed to high jumpers, the lower legs of the long jumpers were very long. The high jumpers were taller. Their trunk was relatively short and lower extremities rather long, just like their thighs.

The women throwers were tall, heavy and muscular. Their longer trunk was accompanied with longer lower extremities. Their upper extremities were only slightly longer than the average of all the women athletes. They excelled with a marked width development, especially at the shoulder. The short putters have the most muscular extremities among all the women athletes.

The women discus throwers were the tallest and the heaviest among all the women athletes. Similarly, length of their trunk and lower extremities are the greatest. Their lower legs are relatively long and their thighs relatively short. Their upper extremities were long and strong. Characteristically they displayed the longest span with a well developed shoulder. The muscles of their extremities were highly developed.

The women javelin throwers weighed least among all the women throwers. They were scarcely taller than the shot putters. As compared with the other women throwers, the development of their width and that of the muscles of their extremities was moderate.
Bell (1973) studied young adult rugby players and noticed specific physical characteristics with respect to the field positions of the players.

Malhotra et al. (1973) reported data on 24 top ranking Indian hockey players, the mean age, height and weight were found to be 23.8 years, 172.5 cm and 62.9 kg respectively. The studied these parameters with respect to the field positions of the players in the game. Backs were found to be tallest, followed in a descending order by the halfbacks, forward and the goal keepers, however regarding weight, the forwards were the lightest and the backs the heaviest. The forwards were found to have the minimum percentage body fat which increased gradually towards the halves, backs and goalkeepers.

Sodhi et al. (1974) worked on 57 college hockey players and found similar results to those obtained by Malhotra and his colleagues except goalkeepers who were the tallest and the heaviest in this sample. The subischial height also depicted the same pattern. However, the gradual decline in subischial length, sitting height suggested that in relation to the lower extremities the trunk height increased from the position of goalie to that of forward line players.

Sidhu et al. (1975) took the upper arm roentgenogrammetric and some anthropometric measurements of 22 throwers and compared them with 45 normal non athletes. The throwers were found to be significantly taller and heavier, with bulkier builds of larger circumferential and skeletal measurements.

Sidhu and Wadhan (1975) worked on footballers who were found to be of average height B, with larger trunks and smaller lower extremities than the controls. They also had more of lean tissue in the extremities than the latter.

The Indian top ranking players were studied and compared with Pakistani Olympic players by Sodhi et al. (1980). The Pakistani players showed the gradual trend of increasing height from forward to half backs to full backs and goal keepers. Earlier this trend was observed and reported in Indian hockey players but such a trend was not observed in this investigation. The Pakistani full backs seemed to be the heaviest and their goal keepers lightest among the two teams. The Indian player in general had the wider humerus and femur breadth comparatively. The Indian player had relatively the thicker skin fold with a general downward gradient observed from the forwards to the goal keepers.
Parez (1977) studied the age, height, weight and somatotype of club level female swimmers. He reported that club swimmers were 13.8 years old, 158.2 cm in stature and 46.5 kg in weight. Their somatotype rating was 2.3-3.8-3.4.

Hosler et al. (1978) collected data on the anthropometric measurements, strength and speed characteristics of 80 collegiate women volleyball players representing 16 to 20 team which participated in 1977 University Houston International Volleyball tournament held in Houston Texas. The players of this study tended to be slightly taller (169.92 cm and heavier 65.06 Kg) than the players reported by Conger and Meenab (1967). These women were found to have broader shoulder (37.79) than Jackson and Pollock's (1976) data (36.8 cm) for a more general sample. This study provided norms on speed, strength and anthropometric variables of college women volleyball players.

Sodhi (1980) studied the top ranking Indian national basketballers and found that with the increasing standard of the participants the average stature was greater. The top class teams in the word have a greater average height than the team of lower standard. A significant correlation was seen between the stature and performance in the competition. The value of correlation was very high with the field basket scores. Thus the greater the stature of a basketballer, the better will be his performance.

Spence et al. (1980) also examined the anthropometric and performance characteristic of the highly skilled members of the United States women National volleeyball training team. Out of those, six were selected for the Pan American Team. The selected players were faster, more agile and jumped better than the non selected players. Strength measurement did not indicate the consistent difference where the Vo2 max was greater in the non selected than the qualities and abilities that volleyball requires. Their study suggested that in order to excel in volleyball, the body size and motor ability are of particular importance.

Tanaka and Matusura (1982) studied the anthropometric and physiological variables of 114 Japanese young middle and long distance runners concluded that the anthropometric attributes would predict the distance running performance to about the same degree as physiological attributes.

Claessens et al. (1986) in a study on Judokas show that an outstanding Judoka can be characterized as a robustly built athlete with a rather "thickset" stature with fairly large breadth and girth measurements and with little development of subcutaneous fat. In a study, carried out by Claessens, et al. (1986) the test group
consisted of 24 top class Belgian Judokas varying from 17.0 to 29.3 years in age with a mean age of 21.9 years. Their results show that Judokas are heavy for their stature and have average (about the 50th percentile) length measurements. Except for the biacromial diameter, all the mean values of their breadth measurements are situated near or above the 75th percentile of the reference data. Furthermore, these Judokas have a large mean value for flexed upper arm girth, their mean value if situated between P90 and P97 of the reference data. Relatively smaller skinfolds values are noticeable, especially the very low values for the suprailiac skinfold.

Borms et al. (1984) studied the 66 male world class amateur body builders, originating from 17 countries and with different ethnic backgrounds. Thirty five standardized anthropometric measurements were taken on each subject. The measurement techniques were essentially based on those of Martin & Saller (1957). They concluded that one of the objectives of body builder is to achieve maximum muscular hyper-trophy regardless of weight class. Body builders differ in height and weight according to weight class, but their somatotypes are very similar. In particular, they have similar mesomorphic components in each class. This indicates that body builders in different weight classes achieve proportionally similar muscular hyper-trophy.

Carter (1984) compared the anthropometric data of weight lifters of the 1960, 1968 and 1976 Olympic games by dividing data of 98 weight lifters into four weight categories as 16 lifters in less than 60 kg, 47 in 60 to 79.9 kg, 27 in 80 to 99.9 kg and 8 in plus 100 kg. The man somatotype rating was 1.4-6.7-1.0, 1.8-7.0-1.1, 2.7-7.8-0.7 and 5.1-9.1-0.04 respectively. He found that higher the weight class higher the endomorphy and mesomorphy and lower the ectomorphy. The value of Mesomorphy averaged about 6 to 7 in the lighter weight classes and 8 to 9 in the heavier weight classes. The top class lifters are balanced mesomorphs at the lighter weights and the extreme endomorphs in the heaviest weights.

The Olympic basketball players are the tallest followed by the national team, the state level and district level players (Sodhi & Sidhu 1984). The controls were shortest among all. In general, there was a gradient of decreasing body size from the national team players to state level players through the district level players and the controls. The first mentioned were found to have proportionality longer upper and lower extremities, shorter trunk, broader hips and mere slender chest. The somatotypes indicated that the rating of ectomorphic component was greater in the
case of the state level players then in the case of other groups. However, it is interesting to note that the rating of mesomorphic components was not greater in these players. The Indian basquetballers were, therefore, less muscular than their Olympic counterparts. The lack of ectomesomorphic physique among Indians may be a limiting factor for their better/performance in the international competition.

Sodhi and Sidhu (1984) conducted an extreme study of Indian National football players. They found that the forwards and half back were quite similar to one another and shorter than stoppers and goal keepers. The forwards and halves in National level football team were bigger than their counterparts in the University level football team. But the back of the formers were shorter than those of the latter. The stoppers and goal keepers in the tens group didn't differ appreciably from each other. The forwards in the University and National level football team had shorter lower extremities in relation to the upper extremities. They also possessed broad knee in proportion to elbow. The stopper in the National level football team had relatively broad shoulder and better developed lean tissue in the thigh. The goal keeper in the National level football team were tall and had proportionally small trunks and longer extremities and were lighter in relation to stature, the latter being more lighter than the former in this respect. However the former possessed proportionally broader knee than the latter. Apart from this the goal keeper in the University level footballers were found to have proportionally narrow shoulder, more slender chart and smaller knee, the chest was bigger in relation to their stature. The hip in relation to the stature was broader in the controls. The hip gradually became narrow in case of back, forward, halves, stopper and goal keeper. Their knee in relation to elbow was broader in the forward, halves, back, stopper of the National level footballer than those of the University level footballer.

The Indian wrestler of light, medium and heavy classes reported by Sodhi & Sidhu (1984) showed gradient of gradually increasing size of all the body measurement and the lean tissue area in the limbs. All categories of wrestlers had significantly better developed chest and limb circumferences than the non athletes. In liner measure and width of the shoulder & hips, the light class wrestlers were found to be considerably shorter, the non athlete. The wrestler of medium class and controls however did not differ appreciably in status, the breadth of hips and the length of trunk. In all anthropometric measurements the former were lower than the latter. The heavy class wrestler on the other hand was significantly superior in respect of all body
measurements than the control. There was a gradient of increasing body weight, length of trunk and upper extremities and circumference of the chest with respect to stature. In the wrestler of light medium and heavy classes the trend was however reverse in the case of lower extremity length. Some other scientist also noticed shorter legs in the case of wrestlers. Indian wrestlers had proportionally wider shoulder. But heavy class wrestler possessed wider hips as well.

Sodhi and Sidhu (1984) studied the elite Indian hockey player and found that the forward had proportionally longer legs, longer arms and the shorter trunk. The halves also possessed proportionally longer arms but shorter than those in case of the forwards. They also possessed broader knee in relation to the elbow with proportionally shorter legs and longer trunks. The full backs had proportionally narrow shoulders the goal keepers had the longest legs and arms, smallest trunk and narrowest hips. They also possessed broader knee in relation to the elbow. The weight in relation to the stature was maximum in the forwards and it gradually decreased in the halves, full back and goal keepers. All National hockey players were heavier than the control in this respect.

Sodhi and associated (1984) conducted a study on 635 elite Indian athletes and sportsmen specializing in different sports and events. The results of the study revealed that weight lifters, volleyballers, middle class wrestlers, decathletes, javelin throwers and pole vaulters have the muscle mass ranging from 31 to 34 kg. Surprisingly, the bone mass in case of weight lifters are found to be minimum as compared to other four groups ranging from 10 to 12.7 kg.

Singh (1986) prepared physical fitness norms for high school boys of Punjab State in the age range of 12 to 15 years. He found a significant relationship between the age and performance of the subject.

Daniels, et al (1986) studied the elite and sub elite female middle and long distance runners and reported that there was no difference in age, height, weight and sum of skin skinfolds between elite and sub elite female middle and long distance runners.

Bawa (1987) studied the Indian male National Gymnasts and concluded that Gymnasts who want to excel in gymnastics must possess proportionally larger chest, wide shoulder, thicker arm smaller waist and narrower hip.

In Sandhu's (1987) study on 90 volleyballers and 95 controls, the data were divided into three groups, age from 15.500 to 16.499; 16.500 to 17.499 and 17.500 to
18.499. The differences were found to be non significant between the three groups. He also added that in stature the volleyballers of 16 years are found to be shorter than those of 17 and 18 years. However, surprisingly, differences are non significant between the three groups. The difference between the shortest and the tallest is observed to be only about 2 centimeters. In comparison to volleyball players the data of control subjects show a different picture, indicating a difference of about 8 centimeters between the shortest and the tallest. Further, it has also been observed that volleyballers, in each age group are significantly taller than controls, respectively.

In another study of anthropometric characteristic of the Northern Indian Junior Volleyball players ranging in age between 16 years to 18 years were also reported (Sodhi et al. 1990). The results were based on the cross-sectional data of 90 volleyball players and 94 control subjects. The data was divided age wise into three sub groups. The result of the study revealed that the volleyballers in each age group were significantly taller and heavier than the control of the same age. But amongst the volleyballers the difference in height was found to be statistically non significant between the three age groups. The possibility of developing to National and International level aspirant from amongst the players in the study was also discussed. The volleyballers in each age group possessed considerably greater length of their trunk, broader shoulder and hip, wider humerus and femur, greater size of hand span, larger chest, upper arm, thing and calf circumference than the controls. The difference was statistically significant in most of the cases. The skinfolds showed almost similar status except the biceps, triceps and the subscapular skinfold showing significantly greater value than the controls in the 16 years age group. In somatotype the 16 years volleyballers were significantly more endomorphic than the controls of the same age. But other groups showed similar status in mesomorphy. the 16 years and 18 years volleyballers were considerably better than the controls in the other hand. In ectomorphy the sporting children had lower score than the latter.

Sharma and Shukla (1988) examined 165 athletes belonging to six sports specialties and reported that short distance runners (sprinters) were taller and had long arms and legs with narrowest bicristal breadth and were heavier than long distance runners, long distance runners were shorter and had smaller biacromial breadth, leg length and arm length. They also reported that the sprinters were significantly greater in mesomorphy than long distance runners.
Rajni (1994) studied the twenty three top-ranking Indian weight lifters belonging to three broad weight categories such as, light class (N=8) medium class (N=10) that majority of the weight lifters were over weight by 0.5 to 4.5 Kg for their respective weight categories. Anthropometric measurement of the weight lifters of light, medium and heavy class have shown a gradient of increasing body measurement i.e. light class being the lightest and shortest, the heavy class being the heaviest and tallest, with the middle class being in between the both. There was significant difference in anthropometric measurements among the weight lifters of different weight categories. Further these weight lifters were compared with the weight lifters of Olympic level (de Gray et. al. 1974) the Indian weight lifters were found to be younger in age and had high mean values of sum of three skinfolds and percent body fat.

Singh et al. (2009) studied the 120 inter university athletes. Results of the investigation revealed that runners of 5000m and 10000 m were found to be significantly taller than cross country runner. Long distance runner were shorter as compared to throwers short putter were found to be tallest followed by discuss and javelin throwers.

2. Physique and body composition Of sports and non-sports person

Cureton (1947) measured II American female swimming and diving champions and observed that the swimmers were taller than the average, and they represented an approximation to 3-4-3 and 4-5-4 somatotypes Most of them were mesoendomorphs. In 1951 Cureton reported data on another 25 United States champion swimmers. The physique studies showed that only the swimmers with a very high mesomorphic component had broken the world records, but several slightly built(ecto-mesomorphic) swimmers has succeeded as Olympic or national champions at relatively long racing distances. The Olympic swimmers, on the average were found to be 15.3lb heavier than the whole track and field group. They had a softer musculature, and were somewhat more flexible.

Tappen (1950) prepared somatotype photographs of forty three weight lifters during National Amateur Athletic Union weight lifting championship by using somatotype methods of Sheldon and Krogman. He found that outstanding weight lifters in all the weight lifters in all the weight categories had the mean somatotype of
3-6, 5-1. These lifters had high mesomorphic and low ectomorphic rating, these components had very narrow range, but range was greater in endomorphy.

Cureton (1951) reported data on 25 United States Champion swimmers. The physique studies showed that only the swimmers with a high mesomorphic component had broken the world records, but several slightly built (ectomesomorphic) swimmers had succeed as Olympic or national champions at relatively long racing distance. The Olympic swimmers, on the average were found to be 15.3 lb heavier than the whole track and field group, had a softer musculature, and were somewhat more flexible.

Parnell (1951) studied the rowing women and found that the proportion of biacromial/billiac was significantly higher in rower than that in the controls. But the chest depth was significantly greater among the controls.

Cureton (1954) tested 55 middle aged athletic champions and compared them with 400 middle aged men and with normal young men. The former champions were more mesomorphic (3-5-4), more linear in skeletal build, less fat, with wider shoulders, small hips and small glottal and abdominal girths. They also had stronger dynamic strengths and better cardiovascular tests.

Kroll (1954) studied somatotypes of 36 wrestlers from four universities in the mid western United States. The mean somatotype of his subjects was 2.7 5.0 3.0 and Kroll observed these athletes with agility rather than with more ponders and bulky characteristics, as reported for European wrestlers.

Riendeau (1958) reported the relationship between percentage of body fat and performance in selected motor fitness tests. Significant negative correlation from -0.29 to 0.68 were found between percent body fat and selected motor fitness tests. The test items most affected by fat were those involved running and jumping.

Shelley (1960) found that the athletes who were outstanding in football were largely mesomorphic or mid types and that they were taller and heavier than other athletes.

Heath (1967) studied the somatotype of 55 university football players, using her modifications of Sheldon’s method. When compared with the means for college students rated by Sheldon and others (1940), these football players were approximately one half units higher on the first component, one and three quarters units higher on the second component and one and one quarter unit lower on the third component.
Carter and Lucio (1984) in their study compared High School (Higher secondary) and Olympic (OL) wrestlers on age, height, weight, seem of four skin folds and somatotypes. The two samples did not differ in weight for any group, indicating that sampling effectively control the weight differences with in each group HS wrestlers were younger by 6 to 9 years, taller by 4.4 to 9.6 cm and were higher on height weight ration (HWR) and ectomorphy HS wrestlers were less mesomorphic than OL wrestlers in the three highest weight groups. Comparisons of the separate components revealed that they did not differ on endomorphy but OL wrestlers were more mesomorphic and less ectomorphic than HS wrestlers.

Behnke and Royce (1966) found that certain groups of athletes have demonstrated body composition and body build variables which differ substantially from other types of athletes and non athletes.

From the data of the Tokyo Olympic swimmers, Hirata (1966) concluded that as for the swimmers, there was not so much difference in physique, as see in athletic events. Divers were obviously small. Free style swimmers were rather large and lean. Breast-strokers and butterfly swimmers were rather stout, and the back stroke swimmers were large and lean.

Lewis (1966), studying the M.4 somatotype of "A grade" provincial representatives, and national representative basketball players in New Zealand, he found that the height and weight of players at different levels of selection did not differ, nor did the somatotype rating, except for a decrease in endomorphy by half a unit at the higher levels of selection.

Westlake (1967) divided 61 female track and field athletes of San Diego Country into four groups on the basis of their best event and somatotyped them using the Heath-Carter anthropometric method. The mean somatotypes for each group were: sprinters 3-3,5-4, jumpers 3-3-4-5, distance runners 3-4-3-5, and throwers 5-4-5-2, Throwers differed from the other groups in being heavier, more endomorphic, more mesomorphic and less ectomorphic. Distance runners were shortest and they were less linear than sprinters and jumpers. High endomorphy and mesomorphy seemed to be assets to throwers, as with male throwers the body mass was important.

Carter (1970) displayed that five USSR female gymnasts were the shortest, lightest and most mesomorphic 3.8-5.2-1.6. Olympic gymnasts (N=102), reported by Hirata (1966) had a mean height of 157.0 cm and a mean weight of 52.0kg. The small and mesomorphic physique is well suited to the requirements of women gymnasts.
Carter (1970) in his review of somatotypes of athletes founds the San Diego State and High School runners higher on endomorphy, lower in mesomorphy and slightly higher on ectomorphy than Olympic runners. Olympic runners were the shortest and the lightest. Apparently, somatotype is a selective factor in distance running at the High School level. Because fat is obviously a handicap in running, the low first component ratings are not unexpected. The relatively wide range on the second and third components (approximately four units) means that more people of suitable height and weight can achieve success at one of the distance runs.

Carter (1970) rated members of the 1964 San Diego State Football Team and 20 university of Iowa Football players according to the Heath Criteria. It appears from his results that preponderance of endo-mesomorphs is a pre-requisite of success in football.

Malhotra and his associates (1972) studied the body composition of he throwers, jumpers, sprinters and the middle and long distance runners. The track men and jumpers were found to have a higher lean body mass with less fat content than the throwers who were tall and heavily built. The Jumpers and throwers had stronger muscle power. However the latter were strong in arm and shoulder muscle strength too.

The throwers possessed greater knee width and were more muscular, with greater lean tissue area and the total body fat (Sodhi and Sidhu 1984). However, the lean tissue in the calf region was better developed in sprinters than in this group of throwers.

The javelin throwers had the shortest stature among all field athletes. It is important to note that javelin throwers in India are considerably shorter than the olympic athletes of javelin throw reported by other scientists.

Amongst Indian there was a gradient of decreasing body fat from discus, hammer and shot put throwers to javelin throwers to pole vaulters and the long, high and triple jumpers (Sodhi and sidhu, 1984) The thrower except javelin throwers were the heaviest for their stature, with each group of athletes gradually becoming leaner in a gradient in the above said order. Almost similar results of the height-weight relationship could be derived from average height and weight values given in the studies of Olympic athletes. However, all athletes in India were leaner on the average than the athletes of the respective field event from Olympics.
In a similar study carried out by Malhotra et al. (1973) on 24 top ranking Indian hockey players the mean age, height and weight were found to be 23.8 yrs, 172.5 cm and 62.9 kg respectively. They studied these parameters with respect to the field position of the players in the game. Backs were found to be tallest, followed in a descending order by the halfbacks, forwards and goal keeper. However in respect of weight, the forwards were the lightest and the backs heaviest. The forwards were found to have minimum percentage body fat which increased gradually towards the halves, backs and goalkeepers.

de Garay et al. (1974) have reported on differences in body size and somatotype of male Olympic from some team and individual sports at the Mexico Olympic male field hockey players by Carter et al. (1981) revealed physique differences between the Olympic teams at Montreal 1976.

Slauter et al. (1977) studied 7 to 12 years boys in their study of relationship of body composition to physical performance. It was concluded that body composition had greater correlation with running and jumping variables than the somatotype components.

Steppicka (1977) studied the somatotype in relation to physical performance, sports and body posture. His study revealed that in top athletes certain somatotype is a morphological presupposition of a high sport performance. Further he contended that a weight lifter is supposed to have mesomorphy and relatively short limbs which is from the mechanical point of view an advantage while lifting the weight.

Cureton et al. (1979) incorporated that the growth study in sports is essential because it reveals the development of different tissue components in sportsmen specializing in different physical activities. A particular proportion of the lean body mass or fat may be advantageous in some way in the performance of certain events e.g. Excessive fat is advantageous for channel swimmers (Pugh, 1960) But it is disadvantageous for long distance runners. The regional development of musculature or the lean tissue areas in limb segments may indicate a parallel or unparallel development of different regions depending upon the type of physical activity. Thus, the study of body composition will also help us to understand the suitable conditioning exercises, useful in developing those particular regions which may be useful for a specific activity.

Sodhi & Sidhu (1984) studied the basketball player at different level of competition. The results of their study revealed that the controls were shortest among
all. In general, there was a gradient of decreasing body size from the national team players to state level players through the district level players and the controls. The first mentioned were found to have proportionality longer upper and lower extremities, shorter trunk, broader hips and mere slender chest. The somatotypes indicated that the rating of ectomorphic component was greater in the case of the state level players then in the case of other groups. However, it is interesting to note that the rating of mesomorphic components was not greater in these players. The Indian basketball players were, therefore, less muscular than their Olympic counterparts. The lack of ecto-mesomorphic physique among Indians may be a limiting factor for their better/performance in the international competition.

Bale (1986) evaluated the somatotype of female international hockey players, college cross country, swimming, basketball and educational gymnastics display team athletes. He found the somatotype of international female hockey players as 3.5-4.1-2.6 cross country runner 2.8-3.0-4.8 and gymnastics as 3.5-3.9-2.9. The mean somatotype of modern educational gymnasts and swimmers were very similar. The cross country girls were mesomorphic-ectomorphs, basketball players were mesomorphic-endomorph and hockey players, educational gymnasts and swimmers were endomorphic-mesomorph. Bale suggested that success in performance is due to positive relationship of physical performance to mesomorphy.

Slaughter et al. (1980) found the difference in body size, structure and body composition among 5 college women athletics teams of University of Illinois which included 16 swimmers 13 gymnasts, 12 tennis players, 11 cross country and 11 track and field participants They reported that swimming(170.1) and track team 9 167.1) were significantly taller than other three groups. In terms of fat free mass the swimmers (47.9) track team (46.3 kg) and gymnasts (46.3 kg) had the greatest amount of fat free weight and were significantly higher than tennis (44.2 kg) and cross country team (42.35 kg). In terms of body composition the swimming team had a significantly greater percent fat (25.3%) than the cross country team(16.7%) track team(19.5%) and the gymnastic team(19.8%) but was not significantly different than tennis team (24.7%). The ideal body composition for swimmer create the least amount of water resistance for the greatest amount of propulsion. Women have considerably less drag in water than men do because they ride higher in it due to less upper body density of muscles and bones and more fat around their thighs, fat that
keep their legs from sinking as much as men legs do. Thos higher ride in the water allows women to expand less energy than men in swimming at the same speed.

Carter (1984) compared the anthropometric data of weight lifters of the 1960, 1968 and 1976 Olympic games by dividing data of 98 weight lifters into four weight categories as 16 lifters in less than 60 kg, 47 in 60 to 79.9 kg, 27 in 80 to 99.9 kg and 8 in plus 100 kg. The man somatotype rating was 1.4-6.7-1.0, 1.8-7.0-1.1, 2.7-7.8-0.7 and 5.1-9.1-.04 respectively. He found that higher the weight class higher the endomorphy and mesomorphy and lower the ectomorphy. The value of mesomorphy averaged about 6 to 7 in the lighter weight classes and 8 to 9 in the heavier weight classes. The top class lifters are balanced mesomorphs at the lighter weights and the extreme endomorphs in the heaviest weights.

The Olympic basketball players are the tallest followed by the national team, the state level and district level players (Sodhi & Sidhu 1984). The controls were shortest among all. In general, there was a gradient of decreasing body size from the national team players to state level players through the district level players and the controls. The first mentioned were found to have proportionality longer upper and lower extremities, shorter trunk, broader hips and mere slender chest. The somatotypes indicated that the rating of ectomorphic component was greater in the case of the state level players then in the case of other groups. However, it is interesting to note that the rating of mesomorphic components was not greater in these players. The Indian basketballers were, therefore, less muscular than their Olympic counterparts. The lack of ecto-mesomorphic physique among Indians may be a limiting factor for their better/performance in the international competition.

Salokun and Mathur (1985) measured anthropometric measurements and body composition of the 150 female athletes. The measurements were significantly different (p<.05) between athletes and non athletes and between athletes of different sports a (volleyball, basketball, throwers, sprinters and distance runners)

Bale and Peter (1986) examined twenty nine netball players and divided them into two groups according to their playing standards as elite and good netball players. Significant differences in the variable between the elite and good players suggested that the most able netball player have tall, balanced physique, high in lean body weight and but lower in adipose tissue. They trained significantly more often, had been training longer and in addition to ball skill training they did sprint and long distance running and weight training to improve their strength and fitness. An
examination of physique and body composition in relation to playing position on the net court indicated that the tallest and heaviest players were the attackers and defenders. The centre court players although shorter and lighter had the lowest levels of adiposity as measured by total skinfold and absolute fat, lower bone widths and lower limb circumferences.

Borms et al. (1984) in a study of 66 male world class amateur body builders, originating from 27 countries and different ethnic back grounds. Body builders differ in height and weight according to weight class, but their somatotypes are very similar. In particular, they have similar mesomorphic components in each class.

Carter and Lucio (1984) in their study compared high school (Higher Secondary) and Olympic wrestlers on age, height, weight, sum of four skinfolds and somatotypes. Comparisons of the separate components revealed that they did not differ on endomorph, but Olympic wrestlers were more mesomorphic and less ectomorphic than high school wrestlers.

In a study carried out by Classens et al. (1986) the test group consisted of 24 top class Belgian Judoist varying from 17.0 to 29.3 years of age with a mean age of 21.9 years. For this investigation the total group was divided into two weight categories, under 71kg (n=18) and 71 to 86kg (n=6). Their results show that judoists are heavy for their stature and had average (about the 50th percentile) length measurements are situated near or above the 75th percentile of the reference data. Further most these judoists have a large mean values for flexed upper arm girth, their mean values is situated between P 90 and P97 of the reference data. Relatively smaller skinfold value is noticeable; especially the very low values for the superailliac skinfold of which the mean value is studied between percentile values P3 and P10.

When they compared the somatic structure of the two weight categories with each other, the result indicated that except for the skinfold, a rise in the mean values was found as the weight class increased. However, in case of weight, height and sitting height the differences are significant.

Mokha and Sidhu (1986), showed that the ability of athletes (N=157) ranged from state (highest level) through inter university to district (lowest level) and 81 subjects acted as controls. It was found that the throwers possessed significantly more fat than the jumpers and runners did.

While studying the physical structure of Indian female gymnasts (Shanker, 1986) it was concluded that they were shorter and lighter than the Olympians. They
were also found to have considerably greater percent body fat. It was suggested that in order to improve performance the women gymnasts need rigorous practice schedules to reduce the quantity of fat.

Sharma and Shukla (1988) examined 165 athletes belonging to six sports specialties and reported that short distance runners (sprinters) were taller and had long arms and legs with narrowest bicristal breadth and were heavier than long distance runners, long distance runners were shorter and had smaller biacromial breadth, leg length and arm length. They also reported that the sprinters were significantly greater in mesomorphy than long distance runners.

Sodhi and Singh (1989) studied the Indian Gymnasts during the coaching camp at National Institute of Sports Patiala. 42 Gymnasts were compared with 42 control samples. Each subject was examined with anthropometric measurement and selected test of performance. It was found that Gymnasts have short stature, lighter in body weight, large and stronger upper extremities and lesser body fat. In performance one group of Gymnasts were found to be stronger in sit up and standing broad than the other group. Their Olympic counterparts were similar in stature, body weight, endomorphic component of somatotype. They had significantly lower values of chest circumference and upper extremities.

Johnson and Associates (1991) investigated pre season body composition and anthropometric characteristics of 121 high school wrestlers according to age (15,16 and 17 years old) and body weight (43.36 kg to 86.71 kg). Each age group was further divided into heavy weight (64.01 kg to 86.71 kg). The 15 years old lightweights demonstrated less fat free weight than 16 and 17 years old lightweights, while heavy weights demonstrated similar body composition characteristics across all ages. These results indicated subtle differences in body composition characteristics across narrow age ranges in the lightweight categories of high school wrestlers. The less FFW of the younger and lighter wrestlers could lead to erroneous decisions in the selection of a safe minimal wrestling weight for this age group.

Legaz et al. (2005) studies the changes in performance skinfold thickness and fat patterning after three year of intense athletic conditioning in high level runners. Results showed an increase in performance and decrease in sum of six skinfold (abdominal, front thigh and medial calf skinfolds and the ratio of extremity of trunk skinfolds).
Singh and Kaur G (2009) studied 103 active and non-active postmenopausal women to find the difference in body composition. The results of her studies revealed that active women were significantly lighter and leaner possessing significantly less fat mass, more muscles and bone masses than inactive ones. They have low risk of diseases as assessed on the basis of WHR and lower body fat patterning.

3. Motor abilities of sports and non-sports person.

Parnell (1951) while studying rowing women found that the proportion of biacromial/bi-iliac was significantly higher to rowers than that in the controls, but the chest depth was significantly greater among the controls. Hirata noted that the rowers were next to basketball players in tallness. Somatotypes based on photographs and anthropometric measurements of 21 rower of San Diego state were made by Sutroius and Carter (1970), Long levers muscular strength and cardiovascular endurance were the characteristics sought in championship rowers.

Another study was undertaken by Veerasamy (1973) aimed at assessing the physical fitness level of the students studying in different schools in Gwalior. AAHPER Youth Fitness Test was given to 212 random selected subjects from different schools. The analysis of data indicated that their fitness was related to the degree of regularity in physical activities. It further revealed that physical fitness of the students was independent of their income status.

With the help of AAHPER Youth Fitness Test National norms of 10-17 years boys and girls were established in 1957 with seven items test battery in America. Those were pull up for judging arm and the shoulder girdle strength. Sit ups- for judging efficiently of abdominal and hip flex or muscles, standing broad jump for judging explosive muscle power of leg extensor, 50 yards dash for judging speed, 600 yard run for judging endurance and softball throw.

Cava (1974), has observed that the training load and growth are directly related to each other during the adolescent period and that before and during puberty (between 10 plus and 15 minus year) an athlete's basic preparation is from all points of view, the best method for obtaining, later on, the maximum results in any sports discipline.

A few studies on establishing norms for physical fitness of school students have been conducted in India. Robson (1978) conducted a study on a simple physical fitness test battery for elementary school children numbering 152 boys and 150 girls
of Kendriya Vidyalya, Gwalior. They prepared norms for classification of children into ability group based on their physical fitness levels.

Morrow et al. (1979) evaluated women volleyball players from two colleges for general and specific performance variables prior to a regular season match between the teams. A player's ability rating was the total of four coaches ranking on 1 to 10 scale. The test battery consisted of measures of flexibility, agility, vertical jump, reaction time and cardiovascular endurance and in specific tests forearm volley pass, overhead volley pass, bump set and serve. It was concluded that the skills considered indicative of superior ability were not necessarily the factors which dictated winning performance.

Sodhi (1980) did a study on physical fitness variables of top basketball players. He found that physical fitness variables and morphology of these players were not common. These players have different physical fitness characteristics and morphological factors which differentiate them from the players of other sports activities.

Singh (1981) conducted a cross sectional study dealing with the physical growth and vertical and horizontal jumping ability of male adolescents ranging in age from 12 to 17 years. The data were collected on 278 regular students of Government Multipurpose Higher Secondary School, Patiala. All the 22 anthropometric measurements and six physical performance tests have been used for examining each subject.

The statistical analysis of data disclosed that:

1. With the increase in age, there is a general increase in all the anthropometric measurements and physical performance tests. The better performance groups are better grown up than the poor performance groups.

2. The onset of spurt is noticed in all the anthropometric measurements and physical performance tests. The onset of spurt is found to occur at 13 of 15 years of age.

3. There is high association between physical growth, maturity and performance. The better performance groups are more advanced in maturity than the poor performance group.
In over all performance state players are greater or better than the other groups of volleyball players and the volleyball players are better than the controls in this regard.

Schnabel (1981) defines sports performance as: "Sports performance is a unity of execution and results of sports action or a complex sequence of sports actions measured or evaluated according to agreed and socially determined norms."

Spence et al. (1980) also examined the anthropometric and performance characteristic of the highly skilled members of the United States women National volleyball training team. Out of those, six were selected for the Pan American Team. The selected players were faster, more agile and jumped better than the non selected players. Strength measurement did not indicate the consistent difference where the Vo2 max was greater in the non selected than the qualities and abilities that volleyball requires. Their study suggested that in order to excel in volleyball, the body size and motor ability are of particular importance.

Malhotra and Sodhi (1982) assessed that Indian wrestlers and weight lifters were over weight by 3-6 kg for their respective weight category due to higher fat contents of their body as compared to Olympians of corresponding weight category. Fox and Mathews (1974) seem to have suggested power volleyball as almost purely power of anaerobic sporting activity involving leg power.

Rose and Ward (1984) conducted a study on allometric analysis of weight lifters of 14th Olympic Games and found that the performance of Olympic level weight lifters is correlated to the Galileo's Cubic square law. After the exclusion of heavy class lifters he obtained the mean values for each Olympic Games. It was close to the cube square expectancy of the mass to the power 2/3. It indicates that the strength would increase with mass 0.67. The mean exponent for the 14th Olympic Games was 0.692 with a S.D. of 0.082. He found that winners in each Olympic games geometrically similar in shape and composition. But gross structural constraints can't be ignored. In relative strength performance i.e. strength per unit of body mass, provided all other things are equal, smallness is a distinct advantage, when in gross strength the rest seems to be bigger and better.

Singh H (1986) prepared physical fitness norms for high school boys of Punjab State. Data were collected on five thousand subjects from various schools in the state. The test administered consisted of eight items i.e. standing broad jump, 50m dash, sit and reach test, agility run, sit ups bent knee, Push ups (chairs) cricket ball

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throw, 600 m run/walk. The percentile norms for physical tests were found to be valid and suitable to assess the physical fitness level of the high school boys aged 12 to 15 years found to decrease significant with age after elimination of VO₂ as a variable. Singh and Malhotra (1989) did a study on Indian women Cyclists who attended a National Coaching Camp at Patiala. The result showed that body weight and force of the muscles play an important role in the performance of the cyclists.

Soares et al. (1986) conducted a study which was based on 21 Brazilians Basketball players (mean age 24.43 ± 3.59 years; mean weight 92.33 ± 14.00 kg; and mean height 197.42 ± 9.70 cm) selected for Pan American Games. The players were divided into 3 sub-groups according to their game function: Group I, centres(n=7); Group II, forwards(n=7); Group III, guards(n=5).

They found that aerobic power seems to be important in basketball particularly for teams which use constant speed as a basic strategy; Lower limb muscular strength in forwards and agility in guards are important qualities; in athlete selection in training programmes for basketball. Lastly, they recommended that further studies may focus more attention on the role of each athlete on a basketball team rather than on the team as a whole.

Oppliger and his associates (1986) studied the physical and performance characteristics of 92 age group swimmer (38 male and 54 female) and 58 non swimming controls (28 male and 30 female) between the age of 7 to 12 years. Swimmers were significantly taller, heavier than non swimmers with difference accentuated in the better performer swimmers. They had greater shoulder abduction flexibility than non swimmers with female exhibiting greater ankle and trunk flexibility than male. Older and more proficient swimmers were stronger with male superior to female in all strength measures except dominant grip. Swimmers possessed superior strength and flexibility characteristics when compared to non swimmers.

Ahluwalia et al. 1987 studied 150 non-athlete Punjabi rural girls ranging in age between 11 to 15 years. The measurements were recorded to ascertain their physical growth and see if there was any relationship between anthropometric measurements and performance during the adolescent phase of growth, belonging to Sanghol village of Ludhiana District they have tested the girls in Sergeant jump, shot put and standing broad jump for physical performance.
Body measurements of an individual play an important role in the performance of sports and as such these constitute an essential ingredient in the selection of the athletes. It is a common experience that a shot putter can not execute good performance in the sprinting events and vice-versa Sharma et al. (1987)

Sidhu & Singh (1988) reported that physical performance tests show better performance with increase of age from 8 to 13 years. Mean value of Sargent Jump, standing broad jump and time for 200 meter race, along with their standard deviation, standard error of mean and velocity. Mean Sargent jump is 20.4 cm at age 8 and increase to 27.0 cm at age 13. The maximum velocity obtained during this period is 2.2 cm for age 9 to 10 and 2.1 cm from age 12 to 13 year. The mean standing broad jump 124.5 cm at age 8, which considerably improved to 171.7 cm at age 13 year. The maximum velocity being 17.9 cm per year at age 11.5 years. The average of time taken for 200 meter race improves from 48.8 seconds to 33.2 seconds from 8 to 13 years of age. The best improvement has been recorded at age 10.5 year.

Liu at al (1992) studied in “reliability and validity of the 20 meter shuttle test in American students”. The study examined the test-retest reliability of 20m shuttle test (number of laps). The concurrent validity of the 20 MST (number of laps) and the validity of the predictor equation for VO₂ max developed by Leger et al. (1988). Significant correlation was found between VO₂ peak obtained by a treadmill test to volitional fatigue and VO₂ peak by 20 MST (Number of laps). No significant differences were found, when VO₂ peak was compared with estimated VO₂ max predicted for age and maximal speed of the 20 MST.

Negi and Rajni (1992) noticed that development of physical performance was almost equal for boys of 8 to 12 years. Test of significance showed, no significant differences between almost all performances variables conducted for various age groups.

Naughton et al. (1996) conducted a study on the comparison of two different shuttle run tests for the estimation of VO₂ max. The aim of the study was two fold. The first was too determine the efficacy of the two types of 20 M- shuttle run tests used to estimate VO₂ max, these being the Canadian Version and the European version. The second aim was to determine which of those two had the better capacity to estimate direct VO₂ measurement in laboratory condition. The study consisted of 500 school children aged 12 to 16 years randomly chosen from school to undertake the two tests within seven days of each other. The results of the study suggested that
the ET under estimated direct VO$_2$ max measurement but was more accurate than the CT.

Hemmings et al. (2003) studies the validation of the 20m multi-stage shuttle test as a predictor of peak oxygen uptake in young elite sports performer. In their study twenty nine young athletes (14 boys and 15 girls) selected from national training squad changes at Loughborough University, performed a laboratory treadmill test of peak VO$_2$ and a 20m MST in random order. When data for both males and females were combined, peak VO$_2$ showed significant correlations with biceps, triceps, subscapular and suprailiac skinfold thickness. In summary, the 20-m MST was a weak predictor of peak VO$_2$ max. when male and female data were combined. The addition of triceps skinfold to the 20-M MST improved the predictive power, so that 66% of the variance in peak VO$_2$ was explained.

Singh et al. (2009) conducted a study on randomly selected 1250 girls out which 625 were from rural and 625 were from urban school of Haryana state between the age range of 6-11 years. From the finding of this study it was concluded in legs power urban school girls were superior in age group of 9-10 years. The rural girls of age group of 6-7 years were more agile than urban school girls. In abdominal muscular strength endurance rural school girls were superior in age group 6-7 years. The urban school girls of 6-7 years were better in shoulder girdle strength; but in age group of 9-10 years it was rural school girls who were better than their urban counterparts.

4. Relationship between anthropometric characteristics and motor abilities.

Cozen (1930) was first to study the relationship between physical performance and stature of college men. He observed that there is a negligible correlation between age and height and age and weight. Age has no effect upon performance in general physical activity, but height and weight are apparently influencing factors.

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. However, they found them different from the control sample. They stated, “According to that material body build of a definite type did not appear to be a necessary prerequisite to the achievement of good athletic results.” However, during
1954 the same workers again reported the top-ranking track and field athletes and related 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 correlation between the relative chest in circumference (with stature) and performance was negative and highly significant in the case of sprinters and positive and significant in case of throwers.

Lamp (1954) conducted a study a junior high school boys and girls and found positive correlation between the volleyball-playing ability and age, height, weight and strength.

Riendeau (1958) reported the relationship between percentage of body fat and performance in selected motor fitness tests. Significant negative correlation from -0.29 to 0.68 were found between percent body fat and selected motor fitness tests. The test items most affected by fat were those involved running and jumping.

Morris (1960) studied the structural and functional differences between women athletes and unselected college women. Significant differences were found between all strength tests in vital capacity, height, mesomorphy and ectomorphy.

Ismeal et al. (1963) found substantial positive correlations between per cent lean body mass and performance on the 50 yards dash, pull ups, and standing long jump among 18 boys of 10 to 12 years. They also conducted a factor analysis of these boys on a large number of motor performance and physical development variables. The researchers found that percent lean body mass was the most important item in a factor called "body fatness". The motor performance variables that loaded bearing on this factor were of 50 yards dash, pull ups and vertical jump.

Fox E.L. and Mathews, D.K. (1974) examined the relationship between functional and kinesiological characteristics and the performance of volleyball players of different ages. They found that speed and relative force of movement increased from lower class to top class players. The same tendency was revealed with regard to explosive power and anaerobic dynamic endurance. The analysis of these authors have revealed a high correlation between the level of skill at receiving the ball, smashing and blocking and body height, speed, relative strength, power and anaerobic endurance. Skill at balls set up in top players is extremely dependent on relative strength and explosive power. The average height of players in all best teams all over the world is above 190 cm. Thus for example, the height of smashers was
between 190 and 200cm, and that of base blockers between 188 to 195 cm. Setters tend to be some what slighter but not below 185 cm. The averages of the mentioned data were as much as 5cm lower in the early 1970s.

Slaughter et al. (1977) determined the association of somatotype, body composition and physical performance in 7 to 12 years old boys. Moderate relationship was found between somatotype components, measures of body size and measures of body composition with the physical performance variables of running and jumping. The first component and third component were more closely related to physical component, when each are combined with age, height and weight accounted for a similar amount of the variation in running and jumping performance. Lean body mass when combined with age, height and weight motor for significantly more of the variation in running and jumping performance than the second component when combined with age, height and weight.

Stepnicka (1977) studied the somatotype in relation to physical performance, sports and body posture. The result of the study revealed that in top athlete, a certain somatotype is a morphological presupposition of a high sport performance. Further he contended that a weight lifter supposed to have high value of mesomorphy and relatively short limbs which is from the mechanical point of view an advantage while lifting the weight.

Sidhu and Sodhi (1979) worked on the effect of physical activity on body composition of top-ranking Indian hockey players undergoing coaching for the Asian games of 1974. The players in this investigation was divided into three main main groups in accordance with the load of exercise on different players which was maximum in Group 1 and decreased gradually in the case of the Group 3 players. Group 1 consisted of left in, right in and centre half; group 3, right back, left back and left half. The Group 1 players registered the maximum decrease in body fat after 52 days of intensive training.

Similarly, the group 3 players who underwent the minimum load of physical activity had shown increase in the amount of body fat. The Group 2 players manifested a decrease but to a smaller extent than Group 1. 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 positions.

Most of the anthropometric measurements were largest in the case of the Indian national level fullbacks and smallest in the case of the goalkeepers, with the
forwards and half line players intermediate between the two (Sodhi and Sidhu 1984). However, the differences among these players were non-significant. All players had bulkier limbs and chests than the controls.

Sodhi (1980) observed that Indian national volleyball campers are very poor in all respects than the national team players.

Petroski and Durate (1983) conducted a study on physical fitness characteristics of athletes participating in different sport activities. They concluded that participants in different activities differ in physical fitness characteristics.

Sodhi and his Associates (1982) studied that the relationship of physical characteristics and competitive performance of Indians Gymnasts. They divided the men Gymnasts in 4 sub groups. The best performance showed the tendency of relative young age and typical 'V' shaped structure of their trunk. Strength and flexibility factors were in favour of best performer. Further when they were compared with American and Japanese Gymnasts, it was seen that they lagged behind in lateral growth and size of chest and less of lean body mass. In the recommendations he remarked that taller gymnast is at disadvantage because he has smaller strength body weight ratio than that of short gymnast. Short and lighter Gymnasts are better able to control their own body weight. Centre of gravity of tall Gymnasts are higher from the ground than shorter ones.

Kansal et al. (1986) examined 246 boys from 11-16 years of age for relationship between nine selected anthropometric characteristics and the performance in 100m run, standing broad jump and shot put. Body weight, height, biacromial diameter, humerus bicondylar diameter, upper arm circumference, calf circumference and triceps skinfold thickness were correlated with the performance in three athletic activities in each of the 6 significant relationship with performance in none of the athletic events studied, the value of correlation co-efficient between the remaining anthropometric variables and athletic performance level were quite considerable, ranging in magnitude from 0.186 to 0.822, most of which were reported significant in statistical terms.

Singh (1986) conducted a study on the motor abilities of untrained Indian school boys, 10 to 16 years old with the intention of comparing these abilities with those of school of boys Europe and North America. He found that Indian boys are shorter and lighter than the boys of Europe and North America. The yearly rate of
increments in height: weight and motor abilities of Indian boys is lower than that of Europe and North American boys.

Riendeau et al. (1958) examined the relationship between per cent body fat and selected motor fitness tests. Significant negative correlations from -0.29 to -0.68 were found between percent body fat and the selected motor fitness tests. The test items, most affected by fat, were those which involved running and jumping. Weight did not significantly affect the performance of any of the items except in 220 yards.

Chauhan et al. (1987) found that body weight has insignificant positive relationship with standing broad jump while percentage of fat has insignificant relationship with the standing broad jump. However lean body mass has negative significant relationship with standing broad jump at 18 level of confidence in case of college women. He also observed insignificant negative correlation between standing broad jump and percentage of fat in case of college women.

Sidhu and Singh (1992) found that co-efficient of correlation, is negative between performance of standing broad jump and percentage of fat. Partial correlation has also supported the fact that percentage of fat and body weight does affect the score of power test.

Pal and Murlidharan (1992) found that relationship was not statistically significant between performance in long jump and weight of the subject. The body structure of an athlete has a vital influence on his/her physical performance. Hence, the coaches and physical education teachers while selecting their athletes for participating in any competition give due consideration to the technique possessed by the athletes and at the same time they provide due weight age to various anthropometric measurements.

Sidhu and Singh (1992) also reported the relationship between body composition and performance in standing broad jump of 157 male physical education students of Punjab. The individual body composition variable has significant correlation with power.

Anderson et al. (1994) tested the relationship between physical activity and physical fitness, and the relationship between these variables. 2474 boys and 3535 girls were studied. Results showed that these was a negative relationship between BP and VO₂ max up to 50% percentile (50ml min⁻¹kg⁻¹) in boys and up to the upper 80-90% percentile (45 ml min⁻¹kg⁻¹) in girls. The study concluded in adolescent population VO₂ max related negatively to BP after adjustment for body weight.
physical activity, sex and other fitness measures. Result also showed lower blood pressure with higher VO₂ max until levels of 50 and 45ml min⁻¹kg⁻¹ in boys and girls were reached.

MaCauley et al. (1996) investigated the relationship between physical activity, physical fitness, blood pressure and fibrinogen in 1600 subjects aged 16-74 years. There was an inverse relationship between systolic blood pressure and past activity in men so that those with life-time of participation compared with a file time of inactivity had a lower systolic blood pressure of 6mm Hg. There was a highly significant inverse association between both systolic and diastolic blood pressure and physical fitness (VO₂ max). Study suggested a reduction of 6mm Hg in systolic blood pressure associated with past activity and support that physical activity is of benefit in reducing cardio vascular risk.

Singh, G (1998) conducted a study on 132 Indian weight lifters and concluded that National level weight lifters were shorter having proportionally longer trunk, short legs, short arms and well developed chest and thigh as compared to the state level weight lifters. Further he found that all these anthropometric variables have positive relationship with physical and competition performance. He concluded that one’s anthropometric status in weight lifting is more a function of one’s physical performance and consequently one’s physical performance status is a better indicator of one’s competition performance.

Guerra et al (2002) investigated relationship between cardio respiratory fitness composition and blood pressure in 529 school children. The study showed that were more fit and less fat than girl. Percentage of fat showed an influence on the variance in SBP in girls while age and BMI account significantly to be variance in DBP.

McMurray et al (2002) determine the effect of age, gender and ethnicity of the predicted aerobic power of youth between the age 8-16 years. The study measured height, weight, sun of skinfolds, (triceps and subscapular) and aerobic power from a three stage cycle ergometry test. The study concluded that absolute VO₂ max increase from age 8 to 16 years relative VO₂ max declines and the higher relative VO₂ max of the occasion youth than that of African American youth.