CHAPTER - 1

INTRODUCTION

Sport can be recognized as an important part of nation's culture. Professional sports teams attract millions of spectators each year. It captures newspaper headlines, where sports news consumes more space than all the arts combined, holds television viewers' attention, and generates corers of rupees a year in revenue for entrepreneurs. Sports also have an impact on international affairs. During the last decade the number of sport participants in our society has increased dramatically. In most cases nine to ten year children are involved. This age is the most vital period of habit formation and consolidation of movement pattern.

Participation of a child in sports is mainly for the purpose of pleasure and joy. Child plays because there is an inner urge to play. In this process of play, several learning situations are created. Infant's day-long-activities are always pleasurable to themselves. These activities are multidimensional and multipurpose. Infants keep themselves actively moving, because through movements they want to live, learn and communicate their emotions and feelings with others. Their movements have neither rules nor space and time limits and have no need for fellows and specific objects and conditions. Nature of play varies from child to child. Play may be with or without instrument. It may be individual or group. It may or may not involve vigorous physical activity. As the child grows bodily and develops mentally, the complexity of
play increases. Simple and innocent play of the child transforms into sport. Organized sport, involving complex motor skills gradually replaces the earlier simple play. Natural, rationalized and stylized movements like running, throwing, jumping, swinging, lifting, catching, pulling, pushing etc. along with teammates and with play equipment like ball, stick, bat or racket, etc. within the boundary of play ground and within the frame work of certain rules are involved in sports.

At this stage of play, the child is exposed to varied situations such as demanding quick decisions, fast and coordinated movements, identifying teammates, understanding strategic play of the opponents and simultaneously planning the appropriate moves to foil their attacks and ultimately succeeding in the match or play. The child is transformed into a player. Successful performance of a player is highly correlated with the degree of improvement in various physical fitness components, which were result of well-structured training schedules.

Knowledge of mental, social, and physical characteristics of potential players are of great importance in matters of selection of potential athletes for a given sport before a serious training begins. A number of investigations have been organized in which performers from various sports have been compared with non-sportsmen and amongst themselves in respect of some of these factors. The physical structure of a sportsman is one of the physical characteristics that influences elite performance. Anthropometrical studies of
sportsmen invariably suggest that sportsmen are morphologically different in some respect or other compared to normal population.

Anthropometry – the measurement of man – provides scientific methods and techniques for taking various measurements and observations of living man and his skeleton. The origins of anthropometry are very ancient. As long ago as the old Egypt and Greece, the artists formulated various standard canons for the human body. The scientific anthropometry, however, began with Johann Friedrich Blumenbach (1752-1840) who laid the foundation of Craniology. He classified mankind into different races on the basis of skull form as seen from above. Charles White developed measurements for long bones-osteometry and worked on the upper limbs of the chimpanzees, Negroes and Europeans.

Many papers were published regarding craniometry and craniolgy, in which we can see the measurements, landmarks to be used as well as the instruments required in taking them. As the time passed attempts were made to review the new techniques from time to time. The American Journal of Physical Anthropology set aside a section of the Journal for publishing articles concerning anthropometric techniques. In 1914 Rudolf Martin brought out a complete textbook on Anthropology, where in he defined more than 100 measurements of the living and of the skeleton in addition to a number of indices.

Wilder in 1918 published a “Laboratory Manual of Physical Anthropology” in English. Hardlicka in 1919 prepared a volume on Anthropometry, in which he suggested 36 somatic measurements and indices.
Mollision in 1938 and Vallois in 1948 also revised and improved the anthropometric techniques and suggested use of less number of measurements and indices. In due course many studies have been undertaken on the anthropometric studies of sports persons, comparing them with non-sportsmen.

Studies have shown that there are structural differences between sportspersons and normal population, between the sportspersons of the same game and also between those of different games. Some studies have shown that some events or games need specific body structure.

Many studies have shown that adult elite gymnasts are more compact with higher lean body mass. They are found to have relatively broad shoulders and narrow hips and shorter limbs in relation to their stature. Relative shortness of forearm and tibial length contributes to shortness of upper and lower limbs, respectively. The gymnasts also show larger relative values for upper arm girths as well as biepicondylar humerus width. The values for calf girth and knee widths are relatively smaller. Somatotypically, adult gymnasts are predominantly mesomorphic. Some studies investigating the relationship of success in gymnastic performance to morphological characteristics indicated that successful gymnasts show these typical morphological characteristics to a larger degree than less accomplished ones. (Digiovanna, 1943; Bosco, 1964; Carter, et al.1971; LeVeau, et al. 1974; Nelson, 1974; Salmela, and Regnier 1978).
Body proportions form another aspect of structure or morphology. Burke and Brush (1979) have shown that relatively longer limbs and shorter trunks characterize successful middle distance runners. The larger length of their limbs was attributed mainly to a longer tibial length (shank). Similarly, male and female gymnasts have been found to have relatively broad shoulders, narrow hips, short limbs, and longer trunk lengths (Cureton, 1941; Digiovanna, 1943; Hahman & Kurth, 1971; Le Veau, Ward, & Nelson 1974; Nelson. 1974).

Dan (1990) in an attempt to determine the relationship of physical fitness and morphological variables to kicking ability among the college Football players found a positive and significant relationship between the morphological variables and the kicking ability. However the details of anthropometric measurements included in the study were not available. Karir and Sidhu (1986) have made some attempt to investigate the morphology of young Football players. However, the study was limited only to height and weight. They reported that the winning team in the tournament was the shortest and most homogenous. They state that short stature is of great advantage in sports like Football. Sidhu and Wadhan (1974) also reported shorter lower limbs for their sample of Football players.

Malhotra et al. (1973) in their investigation of 24 top ranking Indian Hockey players reported that the mean age, height and weight were found to be 23.8 years, 172.5 cm and 62.9 kg respectively. Mishra (1990) in his comparative study of Football and Hockey players reported that Football players are more matured, taller with longer body segments than Hockey players.
The physique of soccer players may be one of the key factors that contribute to the lack of success of Yugoslav soccer teams in international competition. Aspects such as experience, body composition, endurance, balance between anaerobic power and aerobic power, among other factors, are of primary importance in evaluation of elite soccer players (Reilly, 1996).

The purpose of several recent studies (Wisløf et al., 1998; Reilly et al., 2000) was to describe structural and functional characteristics of elite soccer players, and make comparisons with non-elite counterparts to find a relationship between results from the physiological tests and competition level. Understanding the profile of successful players could give coaches, trainers, and exercise scientists better working knowledge of this particular group of athletes.

Burke LM, Read RS, and Gollan RA (1985) in their investigation of anthropometric measurements of top level professional Football league team, second level association Football team and an A grade amateur association Football team observed gradation of body size between teams. The top-level teams were slightly taller and heavier than the other teams and smaller percentage of body fat and a greater fat free mass.

The success of an athlete depends a lot on the body type. Body size, build, and body composition can impair or help performance. Athletic performance relates to body type (body shape and size), and body composition (muscular development and amount of body fat). Body fat contributes no strength advantage and limits endurance, speed, and movement through space.
The advantages of an appropriate amount and distribution of body fat are, shock absorption (Football), buoyancy (swimming), thermal insulation (swimming) and fuel stores (cross-country skiing).

The ideal body composition varies with different sports, but in general the less fat mass, the greater the performance. Body composition refers to the relative percentage of muscle, fat, bone, and other tissue of which the body is composed.

![Pie chart showing components of the body]

**Figure 1: Components of the body**

The body is divided into two components, the fat-free body mass and the fat mass. The fat free mass includes mineral, protein and water.

In order to appraise body shape and composition the technique somatotyping is used. The somatotype is defined as the quantification of the present shape and composition of the human body. It is expressed in a three-number rating representing endomorphy, mesomorphy and ectomorphy.
components respectively, always in the same order. Endomorphy is the relative fatness, mesomorphy is the relative musculo-skeletal robustness, and ectomorphy is the relative linearity or slenderness of a physique. For example, a 3-5-2 rating is recorded in this manner and is read as three, five and two. These numbers give the magnitude of each of the three components. The rating is phenotypical, based on the concept of geometrical size-dissociation and applicable to both genders from childhood to old age. The Heath-Carter method of somatotyping is the most commonly used today.

Musaiger, A.O. et al., (1994) conducted a study on 304 athletes, who were selected from first class clubs related to four common sports (Football, handball, volleyball and basketball) and they compared them with 53 non-athlete adults. Weight, height, mid-arm circumference and skinfold thickness were measured to assess their body composition. The findings revealed that there were differences in body composition among athletes according to the type of sport. Basketballers and volleyballers were the tallest athletes, while handballers were the heaviest ones. Skinfold thickness measurements showed that basketball and handball players have more subcutaneous fat than other athletic groups. As compared with controls, these athletes had higher means for height, weight, subscapular, suprailliac thickness and mid-arm circumference.

Toriola AL, et al., (1985) in an effort to describe the physique associated with regular involvement in sports activity, studied the somatotypes of a group of 51 elite male athletes comprising sprinters (n = 10), basketball (n = 12), soccer (n = 15), and field Hockey (n = 14) players, and 11 male
controls. The subjects' physiques were assessed using the Heath-Carter anthropometric somatotype method. The findings indicated that the controls were significantly more endomorphic (3.5) (p < 0.05) than the soccer players (2.5) and sprinters (2.4). The sprinters (3.6) and basketball players (3.7) had markedly higher ectomorphic ratings (p < 0.05) as compared with the Hockey players (2.0).

Mathur et al., (1985) conducted a study on Somatotype ratings and percentage body fat of 131 elite Nigerian male athletes, average 24.2 years of age, and belonging to badminton (n = 18), basketball (n = 30), field Hockey (n = 24), handball (n = 16), judo (n = 18), and soccer (n = 25) teams. They found Basketball, handball and soccer players were taller and heavier, and had low percent fat values as compared with the other athletic groups. Judo and Hockey players were endomesomorphs. Other sports groups were predominantly ectomesomorphs.

The body type and somatotype studies of A.A.U. Swimmers from Cleveland and Santa Clara Swim Clubs were undertaken by Dupertuis (1965). These young swimmers were considerable higher than the average in mesomorphy but at or about the same general means in endomorphy and ectomorphy.

When the San Diego State Swimmers and Cureton’s (1951) Olympic Swimmers were rated by Carter (1970) according to the Heath–Carter method, their respective Somatotype were found to be 2.9-5.4-2.7. The physique of the channel swimmers was generally much fatter and less linear than those of
competitive swimmers. It may be speculated that channel swimmers might carry large amount of fat for adaptation to their environment of prolonged cold stress.

Carter (1984), in his investigations of Olympic and other elite athletes, has identified distinct somatotypes for the participants, in individual sports disciplines. For example, body-builders have been found to be extreme mesomorphs (Borms. Ross, Duquet, & Carter, 1986), gymnasts ectomesomorphs and middle- and long-distance runners meso-ectomorphs or ectomorphs (Carter, 1984).

Kansal, Gupta and Gupta (1984) undertook a morphological study of Football players of Indian Universities. They compared the morphological profiles of different specialists within the sport of Football such as forwards, halfbacks, backs and goalkeepers in absolute terms. However, upon scaling the mean values of the variables to unisex human model it was observed that these Football players were less ponderous, which reflected in their higher ectomorphy, little long limbed, had about average shoulders but were markedly narrow hipped. Of all the categories, the goalkeepers had longest limbs and narrowest hips, while the backs were most ponderous and had shortest limbs. The mean somatotype was 1.92 - 3.57 -4.17, which meant that these Football players were meso-ectomorphic. While the goalkeepers had highest ectomorphic component, the forwards had highest mesomorphic component.
Dey, Kanna and Bathra (1993) in their study of National Kabaddi players found that they had higher percentage of body fat compared to normal sedentary individuals and their physique was endo-mesomorphic.

It is well established that unlike some of the morphological characteristics, some of the functional parameters such as agility, power, and reaction time will also play a major role in succeeding in a particular sports. These functional parameters are considered as inherited traits. However the training will improve these parameters to certain degree. Some individuals seem to be endowed with certain functional qualities more than others, even prior to training, and respond better to training and are likely to succeed in their chosen sports.

Raven, Gettman, Pollock and Copper (1976) conducted a study to evaluate the physiological functions of a professional Soccer team in the North American Soccer League. They reported that endurance, vertical jump, agility and low percent of body fat clearly differentiate the soccer players from the sedentary population.

While many researchers have focused their attention on the anthropometrical study of adult sportsmen, very few studies have been devoted to the anthropometrical study of young elite sportsmen. Furthermore, no known investigation has dealt with proportionality differences of young elite sportsmen. However, there have been very few studies, which have investigated the morphology of young male and female elite sportsmen. Hence there is a dearth of such studies especially in the field of Kabaddi, Football and
Hockey. Therefore the main purpose of the present investigation is aimed at analyzing the anthropometric and biomotor components of young elite Kabaddi, Football and Hockey players.

The techniques of body composition measurements yield quantitative data in terms of body density. Similarly, somatotyping techniques provide quantitative data for a comprehensive assessment of a person’s body form in terms of fatness, musculoskeletal development and linearity. These two techniques provide data with which one population can be directly compared with another irrespective of age, sex, race or body size.

Anthropometric measures on the other hand cannot be used in the direct comparison of two populations unless they are adjusted for height or ratios are worked out. Ratios, however pose statistical and interpretational problems (Carter 1978). For example, a large value of the brachio-antebrachial index could reflect a variety of conditions: large forearm versus normal arm length or any combination of largeness in the forearm and shortness in the arm. Secondly, because the variance of a ratio is an inextricable combination of the variance of the numerator and denominator, the use of such ratios in co relational matrix or analysis of variance defies meaningful interpretations (Ross Marfel Jones and Stirling 1982).

To circumvent these problems, Ross and Wilson (1974) developed a stratagem using a single unisex reference human or phantom for proportionality analysis called the phantom stratagem. Methodologically this approach has the advantage that all individuals are adjusted to the same stature and that separate
variables are all converted to z-scores, which facilitates between group. The details of deriving phantom z-scores will be discussed in the methods section.

**Purpose of the study**

The broad purpose of this study is to investigate selected anthropometrical and biomotor variables of young competitive sportsmen participating in Kabaddi, Football and Hockey. Study of anthropometrical and biomotor variables of competitive athletes who are still in various stages of physical development provide an opportunity to answer some of the questions such as:

1. Which of the anthropometric and biomotor variables discriminate effectively Kabaddi players, Football players, Hockey players and controls from each other?
2. What are the anthropometric and biomotor variables that discriminate effectively between division level and state level Kabaddi players, Football players and Hockey players?
3. Do anthropometric and biomotor characters vary according to growth and maturity?
4. Do the somatotype characters of sportsmen differ for different age groups?
5. Are the state level sportsmen, as a group more homogeneous in terms of their somatotype character than the division level sportsmen?
6. Do the Kabaddi players, Football players and Hockey players show more homogeneity in their somatotype characters than controls?

**Delimitation**

The study is delimited to the competitive male young athletes of 10 to 13 and 14 to 16 year old Kabaddi, Football and Hockey players who participated in sub-junior and junior Mysore division sports meet, competitive male young athletes of 10 to 13 and 14 to 16 year old Kabaddi, Football and Hockey players who participated in sub-junior and junior state level inter-school competitions and 10 to 13 and 14 to 16 year old controls who did not participate in any sports but were active.

**Limitations**

No special methods of controlling their living conditions, food habits, training schedules and social activities are imposed.

**Hypothesis**

**Anthropometric and Biomotor Related**

Based on the questions posed earlier and the available knowledge in the literature the following hypotheses were proposed to be tested.
Hypothesis 1

Stature adjusted body mass, biacromial width, biiliocrystal width, biepicondylar femur width, biepicondylar humerus width, tensed arm girth, fore arm girth, thigh girth, calf girth, subischial leg length, reaction time, agility, leg power, endomorphy, mesomorphy, ectomorphy, body density and percent body fat are the variable that discriminate effectively between male Kabaddi players, Football players, Hockey players and controls matched for age.

Hypothesis 2

Stature adjusted body mass, biacromial width, biiliocrystal width, biepicondylar femur width, biepicondylar humerus width, tensed arm girth, fore arm girth, thigh girth, calf girth, subischial leg length, reaction time, agility, leg power, endomorphy, mesomorphy, ectomorphy, body density and percent body fat are the variable that become better predictors of class membership as the Kabaddi, Football and Hockey players move to higher level of participation that is, from divisional level to state level of participation.

Hypothesis 3

Stature adjusted body mass, biacromial width, biiliocrystal width, biepicondylar femur width, biepicondylar humerus width, tensed arm girth, fore arm girth, thigh girth, calf girth, subischial leg length, reaction time, agility, leg power, endomorphy, mesomorphy, ectomorphy, body density and percent body fat are the variable that will become better predictions with an increase in the age of Kabaddi players, Football players and Hockey players.
Somatotype Related

Hypothesis 4

Kabaddi, Football and Hockey players will be more homogeneous in their somatotype ratings when compared to controls.

Hypothesis 5

Older age (14 – 16 years) Kabaddi players, Football players and Hockey players show lesser variability in somatotype ratings when compared to younger age (10 – 13 years) Kabaddi players, Football players and Hockey players.

Hypothesis 6

State level Kabaddi players, Football player and Hockey players will be more homogeneous in their somatotype ratings when compared to division level Kabaddi players, Football players and Hockey players.

Definition of Terms

The following terms are defined for the purpose of clarity and precision of some of the concepts used in this study.

1. Young athletes are male Kabaddi, Football and Hockey players between the age group of 10 to 16 years who as represented their district and division teams.
2. **Division level players** are male Kabaddi, Football and Hockey players between the age group of 10 to 16 years who represented their district teams in Mysore division sports meet.

3. **State level players** are male Kabaddi, Football and Hockey players between the age group of 10 to 16 years who represented their division teams in state level sports meet.

4. **Controls** are male individuals between the age group of 10 to 16 years who participated in various physical and recreation activities and did not train for higher level competitions in any sport.

5. **Anthropometry** is the technique of measurement of man, which provides various measurements and observations of the living man and the skeleton.

6. **Bio-motor movements** are the movements of a living organism including locomotor movements like running, jumping, hopping etc.

7. **Morphology** is the biological study of the form and structure of living organisms.

8. **Somatotype** is a description of human physique in terms of the relative dominance of three components of body build: endomorphy, mesomorphy and ectomorphy. It is expressed in a three digit number, each digit representing a component on scale of 1 to 7. The first digit indicates the degree of endomorphy, the second digit indicates the degree of mesomorphy and the third digit indicates the degree of ectomorphy.
Physique type or body build are used interchangeably with the somatotype.

9. **Somatoplot** is a point locating the three component somatotype of an individual rated by the Heath – Carter method on a two dimensional somatochart.

10. **Endomorphy** is the first component of the Heath-Carter somatotype and indicates the degree of fatness of an individual.

11. **Mesomorphy** is the second component of the Heath-Carter somatotype and indicates the degree of musculo-skeletal development of an individual.

12. **Ectomorphy** is the third component of the Heath-Carter somatotype and indicates the degree of linearity of an individual.

13. **Somatotype Dispersion Distance** is the distance between mean somatoplot and each individual somatotype.

14. **Body fat percentage** refers to the percentage of the total body weight that is made up of fat.

15. **Body composition** refers to the constituents of human body - lean mass and fat mass.

16. **Phantom Stratagem** is a stratagem devised by Rose et al. (1974), where various body dimensions are scaled to a standardized stature of a unisex human model, the phantom and expressed in terms of standard deviation distances. Such z- Scores make it possible to compare two populations irrespective of body size.
17. **Phantom z-score** is a statistical unit indicating the deviation of an anthropometric measurement from its value in a standardized unisex human model.

18. **Speed** of movement shall be defined as the rate at which a person can propel his body, or parts of his body through the space.

19. **Reaction time** is the interval of time between the presentation of the stimulus and the initiation of the response (Johnson and Nelson 1988).

20. **Agility** is defined as the physical ability, which enables an individual to rapidly change body position and direction in a precise manner (Johnson and Nelson 1988).

21. **Power** is the performance of work expressed per unit of time (Johnson and Nelson 1988).

**Significance of the study**

1. **Enable to select children’s for coaching**

   The present study, which is aimed at analyzing the morphological and biomotor variables of Kabaddi, Football and Hockey players throw light on the structure and functional aspects of athletes. The knowledge of above enables coaches, trainers and physical education teachers to adopt suitable techniques in selecting and coaching the children.

2. **Prediction of successful performance**

   Rozin (1973) has stated that knowledge of basic anthropometric parameters, including biomotor variables make it possible to predict an
individual’s success in a given sport. By knowing anthropometric parameters and difference between athletes and controls selection of children for particular sports will be easier. This may help in adopting and achieving success in training methods. This will avoid unnecessary waste of time and energy at the time of selection and training. This will also help in saving emotional embracement on the part of an individual child and restrict high expectations on the part of coach and parents.

3. To help / enable coaches to identify deficiencies and to overcome through compensatory training:

Malina (1984) speculated that morphological traits during early childhood provide early competitive advantages in certain sports, thus motivating the child to train and compete in a specific sport. Training at an early age that is at the time of growing age will be more effective and successive in particular sports rather training after grown up age. Selection of children’s for a particular sport by knowing morphological traits makes children’s to move them towards success faster. By having knowledge of morphological traits if coaches/physical education teachers or trainer identifies certain biomechanical disadvantageous body dimensions they can make that child to overcome that deficiency by giving a compensatory training.

By considering all above-mentioned aspects the present study may act as a guideline in the area of morphological and biomotor variables and its importance in various sports disciplines. If we look at the past studies made on
sportsmen of certain games, studies made on Football, Hockey and Kabaddi players are very less. Of above three disciplines studies made on Kabaddi players are very scanty. So the findings of this study in relation to the hypotheses mentioned earlier will provide some useful information about the morphological and biomotor variables of Football, Hockey and Kabaddi players.

It is also hoped that the present study will provide more knowledge about the relationship of body structure and performance in sports. From a practical standpoint, the information is important for coaches and trainers to adjust training regimes and concentrate on the variables that are specific to improve performance and achieve success in Football, Hockey and Kabaddi.