CHAPTER-I
INTRODUCTION

Since the beginning of the 21st century, multiple theories about science and other disciplines were found. The contemporary scientific world saw an array of discoveries and inventions. The theories are being challenged every day paving way to the new theories either challenging the earlier ones or supporting them and making them more advanced.

Research is the systematic process of discovering new facts and verifying old facts, their sequences, inter-relationship, casual explanations and the natural laws which govern them (Young, 1966)

Sharma (1990) states that the main two objectives of the research are to make amendments in the existing knowledge and to search for new things in the related field. Thus, research takes us ahead of current limits of knowledge.

Research has played an important role in the development of sports. The sports persons are more competitive now-a-days and always aim at the consistency of performance and thus, the gap between winning and losing has eventually narrowed. The sports scientists and coaches study each and every aspect of the players to make them yield maximum performance.

The developed countries have invented new means and methods on the basis of research. They have created an authentic system and environment for the sports so as to achieve those targets which seemed almost impossible or difficult in the recent past for the human body and are still making diligent efforts for the betterment.

On the basis of physical, emotional and psychological aspects of the sportspersons, the researchers have collected such a data so as to help in increasing the potential of the player in every sport. The sports performance depends on the complex combination of various factors such as physical, physiological, technical, tactical, psychological and environmental. They supersede each other depending upon the nature of sports. It is often seen that though the athletes are imparted with same training in view of all the above stated factors, the performance level of each athlete vary distinctly with respect to each other. It depends basically on the differences in body structure and body composition of each athlete because the different physical activities and sports demand different and particular type of body, size and proportion.
1.1 KINANTHROPOMETRY

The use of word “Kinanthropometry” has been gaining more popularity in the recent years. Kinanthropometry is a science which deals with measurements of body and those body parts which are related to kinetics and kinematics. The word kinanthropometry is an acronym of three Greek words “Kineein” means to move, “Anthropos” means man and “Metreein” means to measure.

Ross et al. (1978) defined kinanthropometry as the application of body measurements to the study of human size, shape, proportion, composition, maturation and gross functions so as to help to understand human movement in relation to growth, exercise, performance and nutrition.

International Society for the advancement of Kinanthropometry (IASK) defined kinanthropometry as, “Scientific specialization dealing with the measurement of humans in a variety of morphological perspective, its application to movement and those factors which influence movement including components of body build, body measurements, proportions, composition, shape, maturation, motor abilities and cardio- respiratory capacities, physical activity, including recreational activity as well as highly specialized sports performance.”

The kinanthropometry of physical characteristics are known to be of fundamental importance for individual development to achieve high level of performance in a specific sport. Knowledge of kinanthropometry equips us with technique of various body measurements like weight, height, diameters, circumferences, skinfolds and sportsmen are selected on the basis of physical characteristics for a particular sport (Singh & Malhotra, 1989). Kinanthropometry provides quantitative interface between human structure and function. For this reason the application of kinanthropometric knowledge is getting tremendous importance and popularity to identify the potential talents in sports for a particular event.

Kinanthropometric investigations have the basic importance in establishing the prerequisite characteristics of athletes for their maximum performance. Detailed information regarding kinanthropometric characteristics of athletes is certainly important in modern sports. It is a well known fact that most of the kinanthropometric characteristics are almost exclusively genetically determined therefore length and breadth measurements can not be changed with training (Norton & Olds, 2001). Therefore, the athletes in a particular sport must possess such specific characteristics
which are of advantage to them during the game (Sodhi & Sidhu, 1984). Besides the relationship with physical performance, kinanthropometric status is also important for sports trainers in order to direct young athletes into the sports they are best suited at the beginning of their careers.

Studies on the physical characteristics of the human body till date indicate that the morphological characteristics of athletes successful in a specific sport differ in somatic characteristics from the general population. Each individual is unique in physical characteristics. The extent of human variability is so large that no two individuals are alike. With this enumerable variety of human physique, it is a well known fact that some sports events are more suitable to individuals with specific physique than others. Specific physical characteristics such as body composition, size, type and structure are considered to be some of the key factors for the enhancement of high level performance in various sports events.

Kinanthropometry is a useful tool in the hands of sports scientists, human biology, physical anthropologist, sports coaches and physical educationists for the study of athletes in different sport specializations (Singh and Malhotra, 1989). Kinanthropometric measurements are also used to determine body size differences, somatotyping and body composition.

1.2 SOMATOTYPING

The human physique differs in many ways and variation in physical characteristics is an interesting aspect. This variety of human physique plays an important role to attain better performance in particular sports. Every game requires a specific type of body where as unsuitable body types in relation to the sports may build great stumbling block in the progress of the sports performance. Recognizing the importance of the different physique in the ancient times Hippocrates, a great Greek Philosopher of the 5\textsuperscript{th} century B.C. was the first expert who introduced a method of body classification in which the individuals were divided into two body types as ‘habitus phthisicus’ who had thin and lean body with long extremities and ‘habitus apoplecticus’ who had short, thick and massive bodies. Kretschmer a German psychiatrist, one of the earliest researchers in this field, classified human beings into three categories as asthenic or thin type, athletic or muscular type and pyknic or fatty type in the beginning of the 12th century. Further, Viola, an Italian man also in 12\textsuperscript{th} century developed a method to classify humans into four types as Longitype with long
limbs, Brachitype with broad limbs, Normotype within normal range and Mixedtype with mixed characteristics. In 1940 Sheldon and his associates, devised a method to analyze and quantify human body type called somatotyping. Further, Heath and Carter in 1967 modified this method into an objective method of somatotyping with anthropometric measurements.

According to Heath and Carter (1967) “A Somototype is a description of the present morphological conformation. It is expressed in a numeral rating consisting of three sequential numerals always recorded in the same manner. Each numeral represents the evaluation of the three primary components of physique which describe individual variations in human morphology and composition”

Physique refers to the shape, the size and type of an individual. All three factors are closely interrelated with each other and are manifestations of the internal structure and tissue components which are affected by the environmental and genetic factors (Sodhi and Sidhu, 1984)

One of the useful indirect techniques of evaluating physique characteristics is somatotyping. It is an established fact that the ideal somatotype for athletes varies according to the requirements of sport or event. The combined rating of each component describes an individual’s somatotype. If one component is dominant then the somatotyping describes that component (Carter & Heath, 1990; Duquet & Carter, 1996). Specific athletic events require different body types and weights for maximal performance (American Dietsics Association, 1987).

Somatotype analysis can provide a synthetic descriptive picture of the kinanthropometric characteristics of high level athlete. In this sense, the somatotyping method is believed to yield better results than simple linear anthropometric measurements (Rienzi et al., 1999), since it combines adiposity, musculo-skeletal robustness and linearity. The technique of somatotyping as a means of assessing body shape and composition independent of size has been applied to the description of groups of outstanding athletes. Application of the technique to Olympic athletes began with Cureton (1951) who studied swimmers as well as track and field athletes competing at the 1948 London Olympics. Somatotype studies were made by Tanner (1964) at the Rome Olympics while de Garay et al. (1974) conducted the largest study so far on athletes at the 1968 Mexico Olympics and Carter et al. (1982) studied athletes at the 1976 Montreal Olympics.
1.3 BODY COMPOSITION

Apart from the considerations of body size, the constitutional make up of body composition components are also important. The division of the body weight into various components can well be conceived by considering the major parts of the body, i.e. fat mass, muscle mass and bone mass (Singh & Malhotra, 1989).

Body composition of athletes is an important tool to evaluate the health of the athlete, to monitor the effects of a training program and to determine optimal competitive body weight and other components of body composition (Prior et. al., 2001). Knowing and understanding the effect of training and competition on body composition can help athletes control weight and alter body composition safely. Seasonal variations in body composition can be studied and used to find optimal body composition levels for health, recovery, training, and competing (Alburquerque et al. 2005). Following body composition trends in specific sports enable coaches and athletes to accurately prepare athletes for specific events/positions. Because of the importance of body composition in athletic health and performance, a practical, safe, and efficient method of measuring body composition is necessary.

Body composition, specifically body fat percentage is of great interest to athletes and is often negatively associated with athletic performance (Gomez, 2004; Malina, 2007; Sigurbjorn et al., 2000). Athletes represent a unique body composition fat free mass density is altered with changes in proportions of fat free mass components (Prior et al., 2001). Young, elite male athletes have greater lean body mass, strength, and power, lower percentage body fat and earlier maturation compared to their peers, while young, elite female athletes have a less “curvy” physique, lower percentage body fat and later maturation than their peers (Malina, 2007). It is obvious that athletes have different physiology and health consequences associated with body composition, which emphasizes that body composition is an important field of study.

Physical characteristics and body composition have been known to be fundamental to excellence in athletic performance (Mathur and Salokun 1985). Body composition can be a predictor of athletic performance, making it relevant to both athletes and coaches. Physical performance declines when body weight and percentage of body fat is at extreme level (Gomez, 2004), but depending on the sport, a higher or lower body fat level may be beneficial. Because of this, body composition trends in different sports can help identify/categorize potential participants. In
football, defensive linemen tend to have higher body fat than defensive backs, and in track and field, sprinters have lower body fat than throwers (Malina, 2007). In Olympic events, athletes involved in events where their body weight was supported (swimming, kayaking) had higher percentage body fat, while athletes in weight-bearing, anaerobic sports (100, 200, 400m) had much lower body fat (Fleck, 1983). Body composition is a safety issue in weight-dependant sports, like wrestling.

Percentage body fat, is an important factor in endurance events where the extra fat increases the cost of running, but does not give extra energy (Sigurbjorn et al., 2000). Rowland et al. (1999) demonstrated that there was a significant relationship between body fat percentage and running performance in children. In contrast to running events, lean body mass is a better predictor of performance than fat mass in strength events (Brechue & Takashi, 2002). Body composition is also an important determining factor for performance ability of an athlete. Excess body fat is detrimental to performance in most sports whereas, fat free body mass, especially muscle mass, is generally associated with performance.

1.4 ROLE OF KINANTHROPOMETRY, BODY COMPOSITION AND SOMATOTYPING IN SPORTS PERFORMANCE

The physical education teachers, trainers and coaches have understood the importance of various factors such as training, skill, personality, motivation in the sports performance but most important of them all is morphology, somatotyping, body composition and kinanthropometric characteristics because these factors are definite predictions of the degree of efficiency and level of success of sportsperson. The sports performance of athletes is greatly influenced by such factors as age, height, weight and body structure. It is also observed that persons of the same age group vary in body size and shape, the individuals of the same height differ greatly in body weight, the persons may weigh the same, but the relative proportion of muscle, fat, and bone will be varied (Johnson and Nelson 1982).

Body composition, kinanthropometric dimensions and morphological characteristics play a vital role in determining the success of sportspersons (Reco-Sanz, 1998; Willmore & Costill, 1999; Keogh, 1999). Performance demands, in present day peak sports have increased continuously and only those individuals, within whom factors influencing performance are on a high level can expect to succeed (Gualdi Russo, 1993; Rienzi, 2000). Kopecky & Pridalova (2001) stated that
Sports performance is determined in a differentiated way by somatic, functional, physiological and motor characteristics and capabilities. Therefore, the physique becomes a limiting factor of performance i.e. a direct reflection of the level of movement activities. This knowledge is of paramount importance when suitable types for various sports branches or events are sought. It is evident to have differences in body size and proportion, height and weight amongst different sports persons (Kansal et al., 1983) but recent studies have shown that size, weight, height show remarkable differences on the basis of field position also (Gray, 1936; Malhotra et al., 1973; Sidhu et al., 1984). Athletics incorporates a range of sporting disciplines and specific physique or morphological features play a major role in competition success. The body mass of winners in the Boston Marathon, the world’s oldest existing annual race has not varied over many decades suggesting this characteristic remains important.

There are many factors which contribute to the sports performance. Skill, psychological characteristics, powerful and capacious energy-production systems are all important factors in sports performance, but the main success factor in sports is body size, shape and morphology (Claessens et al., 1994). The study on athletes revealed that usually sprinters are muscular, marathoners are smaller and leaner and throwers are taller and heavier with higher levels of fat. A important concept is morphological optimization most likely to be associated with success in different sports (Norton et al., 1996).

It is a well known fact that a general relationship exists between morphology and performance. However specific morphological requirements still needed to be established for some sports. Ross et al. (1982) have argued that an individual’s somatotype is one of the best single biological identification tags and Carter (1985) continues to stress the view that morphological factors play a limiting role in human performance. The size, shape and proportions of athletes are important considerations in player’s performance and usually the better the performance the more critical the relationship will be (Bell & Rhodes, 1975; Toriloa, 1987). Moreover, Olympic studies indicated that successful sports performance is often hindered by lack of appropriate physique (Tanner 1964, Carter 1984).

While studying an individual’s kinanthropometric characteristics, somatotyping and body composition, the physical merits and demerits of that particular sportsperson in relation to his sport can be known. As the use of skinfolds and body composition techniques help in estimating the amount of fat in athlete, The
small quantity of fat in athletes generally helps to attain high sports performance. In most of the sports minimum level of fat is required for better performance, whereas increased levels may obstruct sportsmen from reaching their full potential. The sports which require the body projection such as jumping movements against the gravity, excessive fat and body weight hinder the sports performance. Whereas in long distance swimming and water polo the moderate level of fat is considered as an asset to performance by providing additional buoyancy. That is why the elite swimmers have optimal level of fat in their body.

The strongest relationship between kinanthropometric characteristics and performance is noticed in weight lifting and throwers because there is highest relationship between regional muscle mass and strength. In some sports absolute size is required while in other relative size of some body segments is more important. The body proportionality is also found significantly different in different sports events for both the genders. The female athletes have proportionally smaller musculoskeletal size in upper body as compared to lower body and also a different limb, torso and skinfolds distribution when compared to males of same sports. The size, proportions and skinfolds of young athletes are generally consistent with those of older athletes in the same sports.

Several studies on various body characteristics of different sports activities have also been carried out by many researchers and they concluded that strong relationship exist between structure and performance. For example, the jumpers have been found with long legs, short trunk and broader feet because height and long legs help them to have their center of gravity at a higher level which help them in crossing greater height (Amar, 1920; Kohlrausch, 1929; Krakower, 1935). Power to weight ratio is important for jumpers, therefore maximising muscle mass and maintaining low body fat level is desirable.

Throwers have greater body weight because when an object is thrown forward and upward an equal and opposite force is exerted on the thrower which disturbs his body balance. So the effect of this reaction will be more if the athlete is not having heavy body weight. Further to make the flight of the throwing implement longer in the air the greater height is also advantageous for the athletes (Sodhi, 1991). In the same way, height gives an edge to basketball players and volleyball players. Height helps in their excellence and is an advantageous factor for these players. On the other hand, the shorter height is more helpful for gymnasts and that is why China, Korea,
and Japan have produced more sportspersons in the field of gymnastics. The short body physique has helped them to excel in the field of gymnastics, weight lifting, light weight class in boxing. Europeans have greater height and so European nations have proved their sports acumen in volleyball, basketball, swimming, long jump, shot put. Bulky musculature helps the sports persons to bring laurels in the field of throwing events and heavy weight class in boxing.

The physique of an athlete may influence the technical and tactical aspect of the game. The training, physical activities, environment and nutrition can not change the segment length of athlete. So far efficient execution, suitable change in the technique and tactics in accordance to one’s segment size and structure may be beneficial at time during the game. It may be used tactically by the coaches and sportsmen from time to time. The physical performance components or physical fitness abilities such as speed, strength, evidences, agility and coordination, are also interwoven in the development of body structure. The outstanding development in these fitness abilities appears to finally determine the performance at any level of competition in sports.

A stiff competition is going on not only between sportsmen but also between the sports scientists, coaches and sports researchers. They are striving for better principles so as to generate new theories in the field of sports. Principles are based on facts and philosophy. When these facts are tested again and again by using different parameters, then the new facts that come across help in the formation of new principles. That is why, various researchers have already investigated the relationship between morphological characteristics and performance of elite jumpers and throwers (Morrow et al., 1982; Singh et al, 1987; Guennadi, 1990) but there is insufficient new information with regard to kinanthropometric characteristics, somatotyping and body composition in high and low performer jumpers and throwers. The purpose of this study is therefore to find out the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers and throwers of inter university.

1.5 STATEMENT OF THE PROBLEM

The purpose of the study is to find out the differences in kinanthropometric characteristics, somatotyping and body composition of low and high performer jumpers and throwers of inter university level.
1.6 OBJECTIVES

1. To know the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer throwers of inter university level.
2. To know the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers of inter university level.
3. To find out the differences in kinanthropometric characteristics, somatotyping and body composition among the various groups of throwers.
4. To find out the differences in kinanthropometric characteristics, somatotyping and body composition among different groups of jumpers.
5. To find out the differences in kinanthropometric characteristics, somatotyping and body composition between jumpers and throwers.

1.7 HYPOTHESES

1. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer throwers.
2. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers.
3. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition among different groups of throwers.
4. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition among different groups of jumpers.
5. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition between jumpers and throwers.

1.8 DELIMITATION OF THE STUDY

1. The study was delimited only to male athletes who have participated in All India Inter University Athletic Meet for the year 2005-2006 held at Manonmaniam Sundaranar University, Trinelvelli, Tamil Nadu.
2. The study was delimited to the jumpers (long jump, high jump, triple jump, pole vault) and throwers (shot put, discus, javelin, hammer throw) from 18 to 25 years of age group.
3. The study was delimited to 26 kinanthropometric characteristics of 160 male athletes.
4. The study was delimited to the selected structural aspects i.e. kinanthropometric characteristics, body composition and somatotyping.

1.9 LIMITATIONS

1. The inter university athletic meet was held only for five days and study was conducted only on inter university level jumpers and throwers. So, the number of subjects taken as low and high performer was a limiting factor.
2. The athletes studied in this work were from the different parts of the country so that the present sample can be heterogeneous in nature.

1.10 SIGNIFICANCE OF THE STUDY

The study may contribute towards the promotion of athletic performance in following ways:
1. The findings of the study may provide criteria for selecting best talent that exist for jumping and throwing events.
2. A comparative analysis of the physique of jumpers and throwers would be helpful in the evaluation and prediction of their performance in their respective events.
3. This study will also help to compare inter university jumpers and throwers with the international athletes.
4. The study may help physical education teachers and coaches by way of informing them about the kinanthropometric characteristics, somatotyping and body composition which the athletes require.
5. The study will add more knowledge in the existing literature and provide guidelines to the future researchers in kinanthropometry of jumpers and throwers.
1.11 DEFINITIONS OF OPERATIONAL TERMS

- **Anthropometry**: Branch of science concerned with comparative measurements of the human body, its parts, and its proportions and composition.
- **Body Composition**: is used to describe the percentages of fat, bone and muscle in human bodies.
- **Lean Body Mass**: The total body weight minus the fat mass. Lean body mass consists of water, bones, collagen, and muscle.
- **Percentage Body fat**: This describes the percentage of total weight that is composed of fat. Body fat percentage is that percentage of body mass that is not made up of bone, muscle, connective tissue and fluids; that is, everything else. This is referred to as 'fat-free mass'.
- **Body fat**: It is body mass not made up of bones, muscles, organs or water.
- **Body Mass Index (BMI)**: A measurement of the amount of body fat and lean body mass. It is calculated by dividing a person’s weight in kilograms by their height in meters.
- **Endomorphy**: It is the first component of somatotyping. It refers to the relative fatness of the physique.
- **Mesomorphy**: It is the second component of somatotyping. It refers to the relative musculoskeletal robustness in relation to stature.
- **Ectomorphy**: It is the third component of somatotyping. It refers to the relative linearity of and fragility of the body.
- **High Jump**: In this event the athlete has to clear the cross bar by jumping over maximum possible height. The common techniques of high jump are the straddle style, fosbury flop, the scissors style, western roll etc.
- **Pole Vault**: In this event with the help of a pole the athlete makes effort to clear the maximum possible height. The common techniques of pole vault are jack-knife method and fly away method.
- **Triple Jump**: It is also known as 'Hop, Step and Jump. Athlete runs with maximum controlled speed, takes off from the take off board with strong foot. Performing the hop, step and jump he tries to cover the maximum distance. The common techniques of triple jump are flat, steep and mixed techniques.
- **Long Jump:** In this event the athlete runs smoothly, rhythmically over the runway with maximum controlled speed and with a strong leg he jumps from the take off board and tries to land covering the longest distance. The common techniques of long jump are hang style, hitch kick and sail.

- **Discus throw:** It is a circular disc type implement made of wood, fiber glass or other suitable material and its weight is 2 kg for men. The thrower stands at the back edge of the circle with his back to the direction of throw, then with a strong rotatory movement of the body, the discus is thrown for maximum distance.

- **Hammer Throw:** It is an iron or brass ball attached with iron wire and handle. Its weight is 7.257 kg for men. Most athletes use two or three preliminary swings and four turns and at the end of last turn the fingers release their grip to throw the implement for maximum distance.

- **Javelin Throw:** It is a solid and hollow long implement constructed of metal or other suitable material of 800 gm. The athlete carries out a standard run-up, then using last five cross over strides the implement is thrown over the shoulders for maximum distance.

- **Shot Put:** It is a round shaped iron or brass ball, its weight is 7.260 kg. The aim is to put the shot for maximum distance. The common techniques for putting the shot are Perry O' Brien technique and rotational technique or Barystnikov technique.