Chapter-I

INTRODUCTION

In this era of technological advancement, scientific measures play an important role in the successful conduct of physical education, athletic training and other health related physical activity programme. Hence, more than ever, it is necessary for physical educators, coaches, trainers and fitness instructors to understand the role of scientific advancement in sports science and its uses for the enhancement of human performance. Over the past forty years the number of exercise physiology laboratories has increased tremendously. The experimental studies and researches conducted through this laboratories have contributed very much to the information and knowledge in this area. These influxes of knowledge have again contributed to the development of health related fitness and for the training of athletic teams in a better way. All these have enriched the scientific literature on the subject of sports science.

The scientific study of exercise physiology is becoming increasingly important with the growing realization of the relation of exercise to health. Field and laboratory observations of exercise in human subject are being supplemented with physiological and biochemical studies on laboratory animals. With the result many of the phenomena associated with acute and chronic exercise can now be explained at cellular and molecular levels (More house & Miller, 1976).
The sports performances are always interconnected and interlinked with many factors related to sports physiology, exercise physiology, biomechanics and anthropometric measurements. Sports performance area can be improved only through the co-ordinated functioning of allied branches mentioned above. In the above backgrounds those who work in this field should have thorough knowledge of these newly emerging branches of sports science.

Sports performance is indeed an aspect of complex human performances, which has several dimensions. Hence, several disciplines of sports sciences are required to work in a co-ordinated manner to explore the nature of sports performance, and the process of improving sports performance. In the last few decades several disciplines of sports sciences namely Sports Medicine, Sports Physiology, Sports biomechanics, Sports Psychology, Sports Nutrition, etc. have been established. These sports sciences work as an integrated whole to give a superb performance (Sing, 1991).

In recent times, the field of sports has become popular, since youth in quite large numbers from developed, developing and underdeveloped countries are participating in large numbers with a recreational and professional approach. The outcome of their quantitative participation is the resultant performance and vast improvement in the sports and games standards. The impact of knowledge of science on sports has raised the standard of sports manifolds during the past century. The improvement in performance has taken place due to the application of since at various levels, such as improvement in facilities, training methods, conditioning, nutrition, psychological, physiological, biochemical and anthropometrical invention strategies etc.
Inventing new games and sport forms have been one of the most creative activities in the human history. Through various games and athletics, the strength and enduring power of each muscle, sub-system and physiological faculty in the human body have been put on test. Sports fraternity has given the human kind an even playground for comparing each physical parameters of the human body with the best.

In the course of time, however, the personal challenges in various sports and games have slowly but inexorably grew into a group of challenges and further into national challenges. The drive to win, received support of the highest order. Nations aspiring to do well in sports, embarked upon a scientific quest for unedifying and analyzing the key reasons, responsible for excellence in any form of games and sports. These became priority research areas of national importance. For the last few centuries, the human physiology for fitness or athletic prowess has been very serious looked into, with purpose to find out and understand factors that improved performance in sports.

In Sports fraternity sports records may not be there for long. They are usually being broken constantly. This now appears to be axiomatic that records of performance and human endurance will go to registering new heights in the days to come. It is now established that ranking in International sports is an index to a nation’s development.

**PHYSIOLOGY**

The term physiology was derived from a Greek word ‘Physiologikos’ meaning discourse on natural knowledge, physiology deals with the normal functioning of human body (Shamal Kaloy, 2007).
Exercise physiology is the scientific study of physiological changes in athletes body with the effects of exercise, whether long term or short term. Different environmental changes, namely, altitude, climate, temperature, humidity, nutritional status etc have some close associations with the optimal performance of an athlete. (Shamal Kaloy, 2007)

For the physiological systems of the body to be fit, they must function well enough to support the scientific activity that the individual is performing moreover different activity make different demands upon the organism with respect to the circulatory, respiratory metabolic and neurologic processes which are specific to the activity. (Bangsbo, J. 1996).

**IMPORTANCE OF PHYSIOLOGY**

High level of performance in sports and games might be dependent upon the physiological make up and it was recognized that physiological proficiency was needed for the high level performance. (Gianetti, G et.al. 2008)

For specific physiological systems of the body to be fit, they must function well enough to support the particular game that the player is playing. Since different games make different demands up on the organism with respect of neurological, respiratory, circulatory and temperature regulating functions physiological fitness is specific to the activity. Physiological systems are highly adaptable to exercise. (Gianetti, G et.al. 2008)

In order to find out the influence of varied aerobic exercises on physiological variables, the researcher selected variables, vital capacity, resting heart rate, mean arterial blood pressure, breath holding time and respiratory rate. High level of performance in sports and games might be dependent upon the
physiological make up and it was recognized that physiological proficiency was needed for the high level performance. How much athletic ability present in a particular person is attributable to genetics, and how much is determined by training and other adaptations made by the athlete.

For specific physiological systems of the body to be fit, they must function well enough to support the particular game that the player is playing. Since different games make different demands up on the organism with respect of neurological, respiratory, circulatory and temperature regulating functions physiological fitness is specific to the activity. Physiological systems are highly adaptable to exercise or the purpose of this study, the physiological variables, vital capacity, resting heart rate and breath holding time were considered.

**VITAL CAPACITY**

Vital capacity is the maximum amount of air a person can expel from the lungs after a maximum inspiration. It is equal to the inspiratory reserve volume plus the tidal volume plus the expiratory reserve volume. A person's vital capacity can be measured by a spirometer which can be a wet (LMAO) or regular spirometer. In combination with other physiological measurements, the vital capacity can help make a diagnosis of underlying lung disease. The unit that is used to determine this vital capacity is milliliters (http://en.wikipedia.org/wiki/Vital_capacity)

A pulmonary measure often used to represent the capacity of the lungs is vital capacity. It is a major fraction of the total lung capacity; it is defined as the largest volume of air that can be exhaled after the deepest possible inhalation. It probably represents a structural component of the body, similar to other anthropometric assessments of body size, since it is known to correlate well with a variety of strength tests in young boys. (P.J.Strukic, 1981)
RESTING HEART RATE

Resting heart rate which is the number of beats felt exactly one minute. The average rate of the pulse in a healthy adult is 72 beats in each minute. There may be variation of up to five beats per minute within the normal range. The number of beats of a pulse per minute or the number of beats of the heart. The resting heart rate varies greatly among different people and in the same person under different situations. The American Heart Rate Association accepts as normal range from 50 to 100 beats per minute. The average rate is 72 beats per minute but the rate can accelerate to 220 per minute. The lesser heart rate given good performance for all the sports and games. (P.J.Strukic, 1981)

BREATH HOLDING TIME :

Breath holding time is defined as the duration of time through which one can hold his/ her breath without inhaling and exhaling after a deep inhalation. There are two types of breath hold time: Positive Breath holding time and Negative Breath holding time. Endurance type of training will improve the breath holding time. Breath holding time also plays a vital role in the sports performance.(P.J.Strukic, 1981)

BIOCHEMICAL VARIABLES :

Biochemistry is the study of the chemical processes in living organisms. It deals with the structure and function of cellular components such as proteins, carbohydrates, lipids, nucleic acids and other biomolecules. (www.freeonlinedictionary.com)
Exercises produces biochemical changes in the cardiorespiratory system and other important alterations in body composition such as proteins, carbohydrates, lipids and triglyceride levels (Scharhag, et al. 2008)

The investigator to find out the difference in the selected biochemical variables of different levels of athletic performance for this study.

**BLOOD**

Blood (Ramakrishnan, 1988), is considered a tissue consisting of Red blood corpuscles (erythrocytes), White blood corpuscles (Leukocytes), platelets and liquid plasma. It is a carrier for gas, oxygen, carbon-di-oxide, metabolites, and products of digestion, hormones, enzymes and clotting factor.

A 70 kg individual has a blood volume about six liters (85ml/kg) about one twelfth of the body weight and about three liters of plasma (45ml/kg). Blood has many diverse functions.

1. Respiration- transport of oxygen from the lungs to the tissues and carbon dioxide from the tissue to the lungs.
3. Excretion- transport of metabolic wastes to the excretory organs.
4. Maintenance of body temperature and osmotic pressure.
5. Defense against infection.
6. Transport of metabolites and hormones from the sites of production to target organs and enzymes, chiefly the plasma specific enzymes.

Hemoglobin (Ramakrishna, 1988) Heme is a prosthetic group of some conjugated protein in the body like hemoglobin, myoglobin and cytocromes,
which are of paramount importance in respiration. Hemoglobin is the combination of heme with globin through different linkage like salt linkages polar and van der Waal’s forces gives function of transport of oxygen and to a minor degree carbon-di-oxide during respiration. The oxygen that is inhaled should be taken to each cell to be used for cellular respiration by mitochondria in the utilization of nutrition like glucose. Heme alone without globin cannot combine with oxygen reversibly. Human hemoglobin contains 0.34 percent of iron which corresponds to the molecular weight of 16400. But, osmotic pressure weights of about 65000 for hemoglobin suggesting 4 irons per atoms per molecule of Hb.

**BLOOD CHOLESTEROL**

Cholesterol, a sterol, is the most familiar of all the derived lipids. Cholesterol synthesized from acetate in all animal tissues, is a precursor of cholic acid, vitamin D and the steroid hormones, including estradiol, progesterone, testosterone, and adrenal steroids. A high level of serum cholesterol and the cholesterol rich low density lipoprotein molecule are associated with an increased risk of coronary artery disease. Cholesterol deposits on the inner lining of the medium and larger arteries results in anthroposclerosis (McArdle et al. 1991).

Hemoglobin is the red pigment of blood present inside the erythrocytes. The most characteristic property of hemoglobin is the case with which it combines with O2 and dissociates from it. Hemoglobin is chief participant in respiratory phenomenon as well as acid base homeostasis. The physiological importance of hemoglobin is due to its capacity to combine reversibility with O2, oxygen combines with hemoglobin to form oxyhemoglobin readily at high
partial pressure as existing in lungs. Oxygen is also readily released from oxyhemoglobin at low O2 pressure, as prevailing in the tissues. This property of hemoglobin provides an effective and excellent system for the transport of O2 from the atmosphere (lungs) to the cells of the body.

Although research in this area has not always produced consistent data, physical training is generally found to result in increased blood volume and total hemoglobin content. Most of the increase in blood volume reflects an increase in the amount of plasma rather than an actual rise in the red blood cells volume. The blood’s hemoglobin concentration is therefore usually unchanged or slightly decreased after training. Both total blood volume and hemoglobin are important with respect to the oxygen transport system, particularly, during exercise at altitudes above sea level. Blood volume is also an important factor during exercise, since deep body heat is the dissipated into the environment. Aerobic exercise can also lower cholesterol risk, even in cases where the cholesterol level stays the same. And we can change that form, by changing the blood proteins that act as carriers for much of the cholesterol in the blood.

Hemoglobin is the red blood pigment, which binds with oxygen. Hemoglobin (Hb), a complex compound found in red blood cells that contains Iron (hemo) and Protein (globin) and is capable of combining with oxygen. Hemoglobin concentration in women is normally greater than 12.09/dl. Hemoglobin is nearly 100 per cent saturated with oxygen at a PO2 of around 100 mm Hg, the normal PO2 found in the alveoli at sea level. This means that very O2 can be further combined with Hb at a higher partial pressures of oxygen. One practical aspect of this fact relates to the breathing of pure O2 at sea level. It is
obvious that only an insignificant amount of O2 will be further added to the blood under these conditions.

**ANTHROPOMETRY:**

The Anthropometric measurement has assumed an important role among other branches of sports science. Anthropometric measurement is employed from the selection of suitable activity for an athlete to the direction of the athlete to the specialty event, suitable for him. Thus the subject plays an important role in the career of the athlete from the very beginning his career. The scientific literature has also revealed that elaborate study had been conducted in this field. The studies largely relate to the sports performance of athletes in relation to the anthropometric measurement. The possibilities for further studies on the subject are enormous. The measurement of structure and proportion of the body are called anthropometry. It has wide application as one of the essential parameters constituting the selective diagnosis of any game or sports. Measurement of body size include such descriptive information as height, weight and surface area, while measurement of body proportion describes the relationship between height and weight and among lengths, widths and circumference of various body segments. It has been found that top athletes in some sports tend to have those proportions that biomechanically aid the particular performance required (Zeigler, 1982).

The special features of the long distance activities demand varying requirements in physical dimension. Marathon runners are lean and thin when compared to the road cyclist. The length of lower extremities give mechanical advantage in Marathon runner. In long distance cycling the terrain is an important factor, which has greater influence on the body weight and muscles
recruitment pattern. These are evident from the scientific literature. Road cycling is a sport that requires performing in a great variety of terrains (i.e. level vs uphill roads) and competitive situations. In turn cycling performance in each of the competition terrains is partly determined by individual morphological characteristics (body mass, height, body surface and frontal areas, body mass index (BMI). Anthropometric variables might thus greatly differ depending on each cyclist's specialty (Lucia, 2005).

A great deal of research has been devoted by the researchers to know the contribution of cardiac performance, biochemical and anthropometric variables to improve the performance of endurance type sports.

Both distance running and distance cycling are counted as endurance type activities. To the knowledge of the research scholar, after going through the available literature, physiological adaptations and effect of anthropometric profiles have been treated in a very general manner in the completed studies. This study intends to differentiate the effort of endurance cycling and endurance running on athletics in terms of cardiac performance, biochemical and anthropometric variables.

**PSYCHOLOGY**

The word psychology come from the Greek word psycho, means mind or soul and logs mean science. So the word psychology is the science of the mind and soul. Psychology study human nature science of the mind and soul. Psychology is the study of human nature scientifically and rather than formulate condition. Psychology plays a major role in sports and in closely associated with psychological components.
Sports psychology is defined as the scientific study of human behaviour in sport. Like the other discipline with in sports and exercise science, sports psychology can be applied to varied skilled movement physical activities and exercise programmes, such as corporate fitness, exercise rehabilitation and health oriented exercise programmes as well as traditional physical education and competitive athletics. (Diane L. Cell, 1972)

ANXIETY

Anxiety is an emotional state, represented by a feeling of dread, apprehension, or fear. In humans, this can be defined by description using language.

Anxiety plays an important role in the acquisition of motor skills as well as in athletic performance. Anxiety can either enhance or inhibit performance whether its effect is positive or negative depends on how an individual athlete perceives the situation.

People with low trait level have been known to perform better in selected motor skills than those with high or trait levels. There is also positive relationship between participants in athletic competition.

A moderate level of anxiety seems best for the acquisition and performance of motor skills levels of anxiety either too high or too low tend to inhibit learning and performance.(Diane L. Cell, 1972)

A considerable amount of research in sport psychology has examined the nature of competitive anxiety and how it relates with various motivational and cognitive variables. The aim of that line of inquiry is to provide important information with regard to situations where athletes may experience negative
affective states, the antecedents of such situations, and the possible means that will enable sport performers to cope successfully with their negative emotions. Current research in sport (competitive) anxiety has primarily based its analysis on the multidimensional conceptualization and measurement of anxiety symptoms in other areas of psychology. Specifically, it has distinguished between cognitive anxiety (worry) and somatic anxiety (emotionality). They referred to negative expectations and cognitive concerns about oneself and the situation as the elements of cognitive anxiety, while the somatic component of anxiety was considered to reflect perceptions of physiological responses such as nervousness and tension (Morris, 1981).

A significant number of studies in sport psychology have explored competitive anxiety using a multidimensional measurement instrument, the Competitive State Anxiety Inventory-2 (CSAI-2), which measures cognitive and somatic anxiety as well as self-confidence. The results of those studies have provided support for the distinction between cognitive and somatic anxiety components, since they have been shown to have different antecedents, different temporal characteristics, different performance consequences, and also to respond differently to interventions. However, despite these significant advances, quite often the results of various studies have not been very enlightening or encouraging, such as in explaining much of the variance in performance (Jones, 1995).

One significant advance in the understanding of the nature of competitive anxiety was the introduction of the notion of “direction” of anxiety. This refers to how sport performers label the intensity of the cognitive and physiological symptoms they experience on a debilitating-facilitative continuum. Furthermore,
in an effort to illustrate mechanisms that may explain how sport performers interpret their anxiety symptoms, anxiety symptoms are perceived as facilitative or debilitative depending on athletes’ perceptions of the control they can exert over both the environment and the self, and also on their belief regarding their ability to cope with the anxiety they experience and to attain their goals (Hardy, 1990).

A number of studies have investigated the relationship between psychological skills and competitive anxiety. For example, Hanton, (2001) examined the intensity and direction of competitive state anxiety in swimmers who differed in their use of psychological skills. Findings showed that performers who reported a greater usage of relaxation strategies experienced lower levels of anxiety and interpreted symptoms as more beneficial to performance than their comparison groups. Maynard and colleagues found similar results when they employed an intervention approach with nonelite soccer players (Maynard et al., 1995a; 1995b). A number of other intervention investigations have also found support for the use of both individual skills and multimodal psychological skill packages in changing interpretations of symptoms in elite and non-elite populations respectively (Hanton, 2001).

The multidimensional conceptualization of competitive anxiety incorporating cognitive and somatic components has provided a clearer understanding of how athletes respond to competitive stressors (Jones, 1995; Woodman and Hardy, 2001). However, scales designed to assess the construct, such as the Competitive State Anxiety Inventory-2 (CSAI-2; Martens et al., 1990) and Sport Anxiety Scale (SAS; Smith et al., 1990), like many other traditional anxiety instruments, measure the “intensity” of cognitive and
perceived physiological symptoms that are purported to signify the presence of anxiety. Therefore, they do not consider the interpretation of symptoms in relation to the upcoming sporting event. Indeed, Jones (1991; 1995) proposed that researchers should examine the direction of anxiety, which refers to the extent that individuals’ interpret the intensity of their symptoms associated with pre competition anxiety as either facilitative or debilitating to performance (Swain, 1992).

The study of anxiety-related performance issues has been an active area of research in the sport psychology literature for several decades. A cognitive-based interactions approach states that anxiety occurs as a result of one’s inability to use or strained usage of their coping resources to meet the demands of a given situation. Competitive anxiety falls under the umbrella of this general definition of anxiety. However, competitive anxiety consists of both state-anxiety and trait-anxiety. Whereas state-anxiety is the transitory feeling of inadequacy or fear, trait-anxiety is an individual’s common behavior to respond anxiously to demands. Spielberg (1972) identified trait-anxiety by how anxious one feels in general and state-anxiety by how anxious one feels at a particular time in a particular situation. A rich literature has documented the role of state-anxiety as a component of competitive anxiety that effects athletic competition (Smoll, 1990).

This multidimensional theory of anxiety differentiates between cognitive and somatic anxiety. Whereas cognitive anxiety is characterized by negative thoughts about performance, inability to concentrate, and disrupted attention, somatic anxiety is characterized by perceptions of bodily symptoms of autonomic arousal such as butterflies in the stomach, sweating, shakiness,
clammy hands, tense muscles, and increased heart rate (Davidson & Schwartz, 1976). The distinction between cognitive and somatic anxiety is considered important because theoretical and empirical evidence demonstrates that each component is related to performance in a different manner. Nevertheless, research findings have consistently indicated that better athletic performance is associated with lower levels of cognitive and somatic anxiety and that athletes competing in individual competitions have higher cognitive and somatic anxiety than athletes competing in team competitions (Schwartz, 1976).

The directionality of an athlete’s perceived anxiety has also been explored as a contributing factor in pre-competitive anxiety. Specifically, the differences in intensity and direction of team competitors’ symptoms of competitive state anxiety were examined. Participants in their study consisted of both high and low level competitors who rated the intensity of perceived anxiety symptoms as either facilitative or debilitative to performances. Results indicated that the highly competitive performers reported their anxiety as more facilitative than the less competitive performers. Jones and Swain concluded that an athlete’s directional perceptions of anxiety contribute to understanding a competitive anxiety response.

**Competitive Anxiety**

Competition can cause athletes to react both physically (somatic) and mentally (cognitive) in a manner which can negatively affect their performance abilities. Stress, arousal and anxiety are terms used to describe this condition. The major problem in competition is letting your mind work against you rather than for you. You must accept anxiety symptoms as part and parcel of the
competition experience; only then will anxiety begin to facilitate your performance.

**Anxiety and Athletic Performance**

The feeling of restlessness and nervousness gradually leading to self-doubt is known as anxiety. It is common in sportspersons, who are required to present themselves and their skills to a large crowd. It is believed that the pressure of attaining excellence as marked by the audience is one of the greatest triggers that cause a sportsperson to choke.

Anxiety can be classified in two ways: trait anxiety and state anxiety. State anxiety is situational stress induced by situations in the game. A sportsperson’s autonomic nervous system is aroused in this state, which is the natural reaction of any individual. On the other hand, trait anxiety can be thought of as a world view that an individual uses when coping with stress.

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, shotput. 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 sportmen 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 sportspersons 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.

In sports, individuals who are state anxious and low on the trait anxiety in tough situations, often deliver good performances consistently. On the other hand, athletes who have higher levels of trait anxiety, added with state anxiety, tend to perform below expectations.

Sports talent is the sum total of pre-requisites (and possibilities of their development) possessed by a person which will enable him to achieve high performance in a sport in future. The pre-requisites include physical abilities, physiological profile, biochemical function, technical skills, physique, personality, motives and interest. High performance sports necessitate specific biological profiles of children, with outstanding motor functions, strong physiological and psychological traits.

The main objective of the present study is aimed to elaborate at different levels of athletes dependent changes in physiological biochemical, anthropometrical and psychological profiles. This study is made to find out the growth related changes of anthropometrical measurements, physiological, biochemical and psychological variables among different categories of athletes
which can be useful for selection of athletes and to identify the potential
deficiencies, and to undertake remedial measures to overcome the training
stresses.

1.1 STATEMENT OF THE PROBLEM:

The purpose of the investigation is to conduct a study of selected
anthropometrical, physiological, biochemical and psychological variables of
different categories of athletes.

1.2 DELIMITATIONS:

1. The study is delimited to three different groups of under 14 years, 14-16
   years and above 16 years athletes in Karnataka State.

2. The study is restricted to runners, jumpers and throwers.

3. The study is delimited to total 90 subjects, among that 30 athlete will be
   selected from each category.

4. The study is delimited to only the male athletes.

5. The study is delimited to selected anthropometric, physiological
   biochemical and psychological variables.

1.3 LIMITATIONS:

1. The previous training structure, load dynamics, food habits, life style is
   not considering while assessing the variables.

2. No motivational technique was used to motivate the subjects and
   differences in the performance due to lack of motivation was considered
   as a limitation of this study.
3. Influence of involvement in other physical activities, diet, inborn discriminations etc. should be considered as limitation of this study.

4. The equipment is used to assess the physiological and biochemical variables is standard and computerized and latest ones.

5. Laboratory errors were considered as another limitation of the study.

1.4 HYPOTHESES:

On the basis of literature reviewed, expert opinion and scholars understanding of the problem, it was hypothesized that:

1. There may not be any significant difference in the selected anthropometrical variables of different categories of athletes.

2. There may not be any significant difference in the selected physiological variables of different categories of athletes.

3. There may not be any significant difference in the selected biochemical variables of different categories of athletes.

4. There may not be any significant difference in the selected psychological variables of different categories of athletes.

1.5 SIGNIFICANCE OF THE STUDY:

At the elite level, the successful performance does not merely depend on one or two basic performance traits; it also relies on many more elements which individually as well as collectively contribute to the performance standard. For outstanding sports performance as well as general fitness physiological efficiency, biochemical variables, anthropometric profile and psychological variables of an individual count a lot. The runners, jumpers and throwers are
categorised as high fitness group in terms of cardiac performance, biochemical and anthropometric variables. It has to be found whether, there is disparity between these groups. The possibilities of physical activity and athletic participation in improving cardiovascular and physical fitness has been commonly accepted. The present study will be of significance in the following ways:

This study will provide a descriptive information of anthropometric measurements, physiological, biochemical and psychological variables of runners, jumpers and throwers.

1. The findings of the study will also provide comparative information of the selected anthropometric, physiological, biochemical and psychological variables among sub-junior, junior and senior athletes (runners, jumpers and throwers)

2. The result of this is likely to throw light abnormalities/beneficiaries if any among athletes in biochemical profile, anthropometric profile and physiological function.

3. This study will help the beginners to choose the activity according to their anthropometric profiles, physiological functions and biochemical tests.

4. The study will help to identify the levels of training related changes in different level of athletes and its anthropometrical, physiological, biochemical and psychological adaptation.

5. The study will help to set up the proportionate of anthropometric variables for different levels of athletes.
6. The still will help to set up the target of physiological variables to be achieved at different level of athletes.

7. The study will help to set up the limits of biochemical variables for different levels of athletes.

8. The study will help to assess the level of psychological variables at different levels of athletes.

1.6 DEFINITION OF THE TERMS:

Anthropometric Measurements

Anthropometric measurements are dimensions of the structure of the human body taken at specific sites to give measures of length, girth and width (Mathews, 1978).

Anthropometry traditionally used static measurements, it has now developed functional measurements of chest girth, thigh girth, calf girth, leg length, arm length etc.

Weight

Weight is a composite measure of total body size (Lohman & Co workers 1988.)

Height

Height is the length from the vertex of the head to the ground (Croney, 1981)

Thigh Girth

Thigh Girth is the estimated circumference between the greater trochanter and the proximal border of the patella. The inguinal crease has been chosen
instead of the trochanter as a proximal land mark (Lohman & Co worker, 1988).

**Calf Girth**

Calf Girth is estimate of cross-sectional muscle and adipse tissue areas of the Calf (Lohman & Co workers 1988).

**Arm Length**

Arm length is the distance measured from the acromion process at the top centre of the shoulder to the tip of the middle finger (Thomas Kirk Cureton, 1951).

The arm length was the distance from the rod held by the subject tightly in his hands to the acromion process. (Clarke and Clarke, 1989)

**Leg length**

Leg length is the distance measured from the outside edge of the foot to the upper edge of greater trochanter. (Thomas Kirk Cureton, 1951)

**Physiology**

Physiology is the study about the function of the body. (Astrand, 1977)

**Vital Capacity:**

The volume of air that can be moved out of the lungs after maximum inspiration is called vital capacity. (Morehouse and Miller, 1967)

The volume of air that can be made to pass in and out of the lungs by the most forcible inspiration and expiration is termed as the vital capacity of lungs (Moses, 1995).
Resting Heart Rate

Hart rate is the number of beats felt in exactly one minute and resting heart rate is defined as the number of beats per minute measured while the individual is at rest (Moses, 1995).

Breath Holding Time

Breath holding time is define as the duration of time through which one can hold his breath without the study of all living things. (Laurence E. orehouse and Augustus T.Miller, 1967).

It is defined as the duration of time through which one can hold his breath without inhaling or exhaling after a deep inhalation.

Blood Cholesterol :

The term cholesterol is derived from the Greek word, ‘Chola’ meaning bile and ‘steroes’ solid. It is a lipd or fatty substance essential for life and found in various tissues and fluids. Elevated levels of it in the blood have been associated with an increased risk of cardiovascular disease (Wilmore).

Total Cholesterol is the total amount of cholesterol in the blood (www.webmd.com)

Hemoglobin :

According to Murugesh (1993), “Hemoglobin contain globin, a protein which is conjugated with haem. (Hemoglobin=heam+globin) Haemmmolecule contains 4 pyrite rings with iron in the center. The hemoglobin content of the body is about 15 g per 100 ml of blood.
Hemoglobin means a complex compound found in red blood cells that contain 6% iron (heme) and 94% protein (globin) and it combines with oxygen to transport oxygen throughout the body (Ardy Friedberg, 1988)

**Blood Urea:**

In the body the urea is the major route for the metabolic process and also end product of nitrogen metabolism in human.

Urea is formed from ammonia, carbon dioxide, Alfa amonio nitrogen asperpate which required ATP.

**Uric Acid:**

Uric acid which is a end product of purine nueclotide itself in formation of bone and maintenance of the joints.

Uric acid formed by the catobolsim of the purins adenine and guanine elevated serum urate concentration is known as hyperuriceamia, this condition is called gout.

**Differential Count:**

Differential count may be defined as the individual count of the formed elements of the blood such as Leukocytes, Neutrophils, Eosinophils, and lymphocytes.

**Psychology**

Psychology is the science of the activities of an individual in relation to his environment. (Albert V.Carvon, 1980).

Sports performance and interventions or psychological skills focusing on the ability to reach optimal performance states (i.e. zone), management of
arousal & anxiety, self talk, imagery, goal setting, self-confidence, motivation and modeling have been found to contribute positively to sports performance. (Edward, 2004)

The use of psychological skills training, having high levels of confidence, work with a sport psychology consultant, ignoring or blocking out distractions, being highly committed to excellence, using relaxation, focusing on performance not outcome, having team meetings to discuss strategy and mental skills, and using a loss year prior as motivation

**Anxiety:**

Anxiety is a negative emotional state characterized by nervousness, worry, and apprehension and associated with activation or arousal of the body. (Gould, 2007).

Anxiety is a natural reaction to threats in the environment and part of the preparation for the ‘fight or flight’ response. This is our body’s primitive and automatic response that prepares it to ‘fight’ or ‘flee’ from perceived harm or attack. It is a ‘hardwired’ response that ensures survival of the human species. Sporting competition promotes similar psychological and bodily responses because there is often a threat posed towards the ego; your sense of self-esteem. Essentially, when the demands of training or competition exceed one’s perceived ability, anxiety is the inevitable outcome

It is used to describe the combination of intently of behaviour and direction of effect or emotion. The direction of effect characteristic or anxiety is negative in that it describes subjective feelings that are unpleasant